



OWNER: HINDALCO INDUSTRIES LIMITED (HIL)

PROJECT

HINDALCO INDUSTRIES LIMITED 2X30MW CGPP

LOCATION

KANSARIGUDA, RAYAGADA, ODISHA

TECHNICAL SPECIFICATION FOR MAIN PLANT PACKAGE OF 2X30 MW CGPP

SPECIFICATION NO.: TCE.13833A-ME-6002-6001

Rev-R0



TATA CONSULTING ES LIMITED

JC BLOCK, SECTOR 3, BIDHANNAGAR, KOLKATA

WEST BENGAL 700106

OCTOBER, 2024

REVISION STATUS

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Client – Hindalco Industries Ltd

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TATA CONSULTING ENGINEERS LIMITED

TECHNICAL SPECIFICATION FOR MAIN PLANT SYSTEM

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CHAPTER-1

SCOPE OF ENQUIRY AND INFORMATION TO BIDDER

1.0 SCOPE OF ENQUIRY AND INFORMATION TO BIDDERS

1.1 SCOPE OF ENQUIRY

- 1.1.1 Aditya Alumina refinery complex in Kansariguda, Odisha is set up by Hindalco Industries Limited (HIL). The project is based on the Kodingamali bauxite deposit in the Rayagada district of Odisha approved by the Government of Odisha. This complex includes an Alumina refinery with a capacity of 0.85 million TPA and a cogeneration power plant to meet the steam and power demand.
- 1.1.2 This specification covers the design, engineering, manufacture, inspection, testing at Bidder's and/or his SUB-VENDOR's works, packing, transportation from place of manufacture to site, unloading, handling and storage at site, erection, testing at site, commissioning and carrying out performance testing of main plant package for proposed cogeneration power plant (CGPP) having two (2) units of 30 MW capacity consisting of steam generator, steam turbine– generator, electrical system, and C&I system along with all associated auxiliaries and accessories and associated civil works as specified herein at Aditya Alumina Refinery, proposed to be located at Kansariguda, Dist. Rayagada, Odisha India.
- 1.1.3 It is not the intent to specify completely herein, all the details of design and construction of the equipment / plant. However, the equipment/plant shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous commercial operation upto the Bidder's guarantees in a manner acceptable to the Purchaser / Owner's Engineer, who will interpret the meaning of specifications and drawings and shall reject any work or material which in his judgement is not in full accordance therewith.
- 1.1.4 All equipment/services necessary for proper erection, commissioning and performance testing of all items of the plant covered under this contract shall be provided by the Bidder. The cost of the same shall be included in the contract price.
- 1.1.5 The scope of work under this package shall include all necessary supply and services whether mentioned in these specifications or not, but which are necessary for the satisfactory, reliable and safe operation & maintenance of the plant and required for achieving guaranteed performance of the expansion project.
- 1.1.6 The scope of services will include design, engineering, manufacture, procurement of sub-contracted items, inspection & testing, transportation from place of manufacturing to site, unloading, storage, erection, painting, testing and commissioning and carrying out the performance guarantee tests & reliability run for CGPP.
- 1.1.7 The objective of Technical Specification is to cover the facility highlights and project essentials for implementation and to receive bid for main plant package along with associated documentation as mentioned in this specification from the bidder.
- 1.1.8 All equipment shall be new with sourcing from reputed make. The equipment shall also have proven design and successful operating history in similar installations. If manufacturer of any equipment is having technology collaboration or license agreement, the proof of validity for the same shall be furnished to owner. In case of boiler, steam turbine generator equipment, the design validation and

performance guarantee back-up shall be provided by the licensor. Bidder shall consider the cost associated with this back-up guarantee in their quoted price.

- 1.1.9 The bid price shall be all-inclusive and shall cover all items and services necessary for the successful completion of the project. Any equipment or services, if specifically, not included in the specification but found necessary for the safe and satisfactory functioning of the units shall be supplied, erected and commissioned by the bidder at no extra cost to the Owner.
- 1.1.10 Bidder shall bear all costs associated with preparation and submission of Bid as defined in the scope of work and Owner will not in any case be responsible or liable for these costs, regardless of the conduct or outcome of bidding process.
- 1.1.11 Any time prior to the deadline for submission of Bid, Owner may for any reasons, whether at their own initiative or in response to clarifications requested by Bidders, modify the enquiry including specification by amendment. The amendment will be notified in writing to all qualified Bidders to whom the Technical Specification Document has been issued and will be binding on them. The Bidder shall acknowledge the receipt of the amendment promptly upon the receipt of the same. In order to give Bidder's time in preparing of Bid due to an amendment, Owner may, at his discretion extend the deadline set for submission of the Bid.

1.2 INSTRUCTION TO BIDDERS

1.2.1 GENERAL INSTRUCTION

- 1.2.1.1 The Owner will receive Bids submitted by Bidder in accordance with the terms set out herein. All bids shall be prepared and submitted in accordance with these instructions to the Bidders. Owner reserves the right to reject Bids received after the time and date mentioned in covering letter.
- 1.2.1.2 The submission of any Bid, along with the related documents and specification, shall constitute an agreement that the Bidder shall have no cause of action or claim against the Owner for rejection of its Bid or if the Owner may elect to withdraw the invitation to Bid. The Owner shall always be at liberty to reject or accept any Bid or
- 1.2.1.3 Bids at its sole discretion and any such action shall not be called into question and the Bidder shall have no claim in that regard against the Owner. The Owner is not bound to give any reasons for the rejection of any or all the Bids.
- 1.2.1.4 The Bidder shall note the following:
 - a) Not more than one (1) Bid for the work shall be submitted by one (1) Bidder or one (1) firm of Bidders.
 - b) If the Bidder deliberately gives wrong information in its Bid to create circumstances for the acceptance of its Bid, the Owner reserves the right to reject such Bid and / or cancel the order, if placed.
 - c) Bid documents submitted by the Bidder shall become the property of the Owner and the Owner shall have no obligation to return the same to the Bidder.

d) Bid must cover the entire scope of work as specified in Bid specification.

- 1.2.1.5 The Bid Price shall include the cost of all Bidder's and other miscellaneous equipment, materials, services and works needed to complete and remedy defects and deficiencies, if any, in accordance with the Contract.
- 1.2.1.6 Bidder must, during the Tender Period, acquaint themselves with social security, security & safety, pollution control, permit, license and other relevant rules and regulations of the locality / country where the plant will be installed.
- 1.2.1.7 Bidders to quote the price in Indian Rupees (INR) only.
- 1.2.1.8 Prices quoted shall be firm throughout the completion period including the Final Acceptance of the Plant.
- 1.2.1.9 Bid Prices shall include for all travel, accommodation and living costs of management and engineering staff as may be necessary for the proper performance of the Contractors' responsibilities under the Contract and shall include all expenses incurred in attending meetings in connection with the Contract as Owner may require.

1.2.2 TIME SCHEDULE

Bidder shall indicate in his offer the best possible completion schedule for the Project. The basic consideration and essence of the Tender Specification is the strict adherence to the time schedules mutually agreed to and stipulated in the Contract.

1.2.3 COST OF PREPARATION OF BID

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

1.2.4 SITE VISIT

- 1.2.4.1 Bidder shall at his cost and responsibility inspect the site, examine and obtain at its 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, flood levels, sub-soil conditions, natural drainage, and all information that may be necessary for preparing its 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.

1.2.4.2 The Bidder and any of his personnel or agents will be granted permission by the Owner to enter upon his premises and lands for the purpose of such visit, but only upon the express condition that the Bidder, his personnel, and agents will release and indemnify the Owner and his personnel and agents from and against all liability in respect thereof, and the Bidder himself will be responsible for death or personal injury, loss of or damage to property, and any other loss, damage, costs, and expenses incurred as a result of the inspection.

1.2.4.3 The submission of a Bid by the Bidder will be construed as evidence that the Bidder has examined the site conditions in detail, and the Bidder shall not raise later any claims/disputes for any additional cost or extension of contractual time for completion against the Owner. The Owner shall not be liable for the same in any manner whatsoever.

1.2.5 CLARIFICATION OF TENDER DOCUMENTS

1.2.5.1 The Bidder is required to carefully examine the Tender Documents and fully ascertain himself as to all the conditions and matters, which may in any way, affect the contract to be performed or the cost thereof.

1.2.5.2 If any Bidder finds discrepancies or omissions in the Tender Documents or is in doubt as to the true meaning of any part, he shall at once request in writing by E-mail to the Owner for any interpretations/ clarifications. The Owner shall issue interpretations and clarifications in writing.

1.2.5.3 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.

1.2.6 AMENDMENT TO SPECIFICATION

Any time prior to the deadline for submission of Bid, Owner may for any reasons, whether at their own initiative or in response to clarifications requested by Bidders, modify the enquiry including specification by amendment. The amendment will be notified in writing to all qualified Bidders to whom the Technical Specification Document has been issued and will be binding on them. The Bidder shall acknowledge the receipt of the amendment promptly upon the receipt of the same. In order to afford Bidders time in preparing of Bid due to amendment, Owner may, at his discretion extend the deadline set for submission of the Bid.

1.2.7 LANGUAGE OF BID

All correspondence and documentation pertaining to this Contract shall be in the English language only. The official text of this Contract shall be English, regardless of any translation that may be made for the convenience of the Parties. All correspondence, information, literature, data, manuals, definitive documents, notices, waivers and all other communication, written or otherwise, between the Parties in connection with this Contract shall be in English.

1.2.8 SUBMISSION OF BID

1.2.8.1 The offer complete in all respects shall be submitted in four (4) separate parts as under:

- Part A: Technical Offer
- Part B: Commercial offer (without prices)
- Part C: Price offer
- Part D: Bidder's credentials

1.2.8.2 The technical offer shall be submitted in the form of e-mail.

1.2.8.3 Kindly, note that the Part A and Part B shall contain no price details and offers submitted with price details are liable for rejection. The price offer shall be submitted in separate envelope i.e. Part C on the prescribed format for price schedule.

1.2.8.4 Bidder's credentials shall be submitted in Part D which shall contain Bidder's experience list, list of installations of similar capacity plants in India and abroad, operational records and customer's testimonial.

1.2.8.5 The bid shall be submitted at the following email-ids on or before the stipulated due date.

Sr. No.	SALIENT FEATURES	DETAILS	
		'TO' in mail	'CC' in mail
a)	Place for Submission of the Technical Offer (Part A)	Mr. Dillip Sahoo - dillip.k.sahoo@adityabirla.com Mr. Partha Sarathi Ghosh- pghosh@tce.co.in	Mr. Gaurav Singh- gaurav.singh@adityabirla.com Mr. M Stalin- stalin.muthaiyan@adityabirla.com Mr Srikant Kar- srikanta.kar@adityabirla.com Mr. Ramesh Ch. Dhuvada- rameshchandra.d@adityabirla.com Mr. Kausiki Sarana Mishra- Kausikisaran.misra@adityabirla.com

			Mr Jagannath Nahak- jagannath.nahak@adityabirla.com Ms. Mangu Shrivani- mangu.shrivani@adityabirla.com Mr Mazhar Beig-President Mazhar.beig@adityabirla.com
b)	Place for Submission of the Commercial and Price Offer (Envelope B & C)	To be intimated during technical discussion.	
c)	Contact Person with details for any clarifications	Mr. Dillip Sahoo - Project Manager Hindalco Industries Limited Kansariguda, Rayagada, Odisha, 765015 E-mail: dillip.k.sahoo@adityabirla.com Mob. No: +91 7752020865 Mr. Partha Sarathi Ghosh - Project Manager Tata Consulting Engineers Limited JC 30/A Block, JC Block, Sector 3, Bidhannagar, Kolkata, West Bengal 700106 E-mail: pghosh@tce.co.in Mob. No.: +91 8617041400	

1.2.8.6 Owner reserves the right to verify all statements / information submitted to confirm the Bidders claim on the performance of equipment offered and capabilities of the Contractor to perform the Work. Owner may inspect the facilities of Contractors. Owner may also visit the plant/s mentioned in the reference list by the bidder where all such works/equipments have been completed by the bidder. Bidder shall co-ordinate and arrange for the required visits. However all expenses of Owner's Officials / Owner's Representative for such visits will be borne by the Owner.

1.2.8.7 Bids not meeting the requirements as stated above may be rejected.

1.2.8.8 Bids should be complete in all respects and should be in accordance with the provisions of the Tender Documents. Owner reserves the right to accept/reject, Part Bids or incomplete Bids, or those bids which are not in accordance with the provisions of Tender documents.

1.2.8.9 Owner reserves the right to accept / reject any or all bids without assigning any reason thereof at any stage and in such a case no bidder/intending bidder shall have any claim arising out of such action. No further correspondence shall be entertained in this regard.

1.2.8.10 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.

1.2.9 SIGNATURE ON BID

1.2.9.1 The bid must contain the name, designation and place of business of the person or persons submitting the Bid and must be signed on each page and sealed by the Bidder with his usual signature.

1.2.9.2 Erasures or other changes in the Bid documents shall carry the initials of the person(s) signing the Bid.

1.2.9.3 The Tender Documents shall be deemed to be part of the bid and the Compliance with the conditions thereof by the Bidders is mandatory.

1.2.10 INFORMATION REQUIRED WITH THE BID

1.2.10.1 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. Bid must also indicate where each principal item of equipment has been supplied and is in satisfactory commercial operation. 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 enquiry specifications shall be submitted with the Bid. The Bidder must also submit along with their Bid, the document related to the representations and warranties.

1.2.10.2 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.

1.2.10.3 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.

- 1.2.10.4 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.
- 1.2.10.5 Bidder will furnish the Bid with all relevant information as called for in of the specification. Bids with incomplete information are liable for rejection.
- 1.2.10.6 The Bidder shall furnish their bid in compliance with the technical specification and commercial terms & conditions in all respect as set forth in this tender document. Deviation, if any, shall be separately highlighted.
- 1.2.10.7 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 may be forthwith disqualified.

1.2.11 PRICE BASIS

- 1.2.11.1 Bidders shall quote in their proposal, lump sum firm price for the entire scope of works covered in this specification along with price break-up for supply and services.
- 1.2.11.2 The Price Bid shall remain firm throughout the Contract Period of the Contract and comply with the Technical Specifications and other requirements covered in the Specification.
- 1.2.11.3 The Bidders shall indicate the following in the Bid:

Duties and taxes as applicable, the terms of delivery and declaration Forms/certificates etc; required to be issued by the Owner,
- 1.2.11.4 Items in Price Schedule against which no rate or Price is entered by the Bidder, will not be paid for by the Owner when executed and shall be deemed covered by the rates indicated for other items and prices.

1.2.12 POLICY FOR BIDS UNDER CONSIDERATION

- 1.2.12.1 Bids shall be deemed to be under consideration immediately after they are opened and until such time the Owner makes official intimation of award / rejection 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 Owner and / or his employees / representatives on matters related to the Bids under consideration. The Owner if necessary will obtain clarifications on the Bids by requesting for such information from any or all the Bidders, either in writing or through formal meetings as may be necessary. Bidders will not be permitted to change the substance of their Bids after the Bids have been opened.

1.2.13 DEADLINE FOR SUBMISSION OF BIDS

- 1.2.13.1 Bids must reach the address specified not later than the date and time indicated in the covering letter.
- 1.2.13.2 The Owner may, in exceptional circumstances and at his own discretion, extend this deadline for the submission of bids by amending the Tender documents. In such case all rights and obligations of the Owner and Bidders under this Tender shall be subjected to the extended deadline.
- 1.2.13.3 Owner reserves the right to reject any bid received after the deadline prescribed. The Owner shall not be responsible for delays due to post or courier.

1.2.14 EFFECT AND VALIDITY OF BID

- 1.2.14.1 The submission of any Bid connected with these documents and specifications shall not constitute an agreement and the Bidder shall have no cause of action or claim, against the Owner for rejection of his Bid. Only the Final Proposal shall be part of the Contract to be awarded pursuant hereto, notwithstanding any thing to the contrary contained herein. The Owner shall always be at liberty to reject or accept any Bid or Bids or to annul the bidding process and reject all Bids at anytime at his sole discretion and any such action will not be called into question and the Bidder shall have no claim in that regard against the Owner and the Owner shall have no obligation whatsoever to inform the affected Bidder or Bidders about the ground (s) or reason(s) for its such action.
- 1.2.14.2 The Bid should be kept valid for acceptance for a period of one hundred and eighty (180) calendar days from the last date of submission of the Bids. Bids valid for a shorter period run the risk of rejection.
- 1.2.14.3 In exceptional circumstance, prior to expiry of the original bid validity period, the Owner may request that the bidders extend the period of validity for a specified additional period. The request and the responses thereto shall be made in writing. It is understood that the bidder agrees to reasonably consider such a request. A bidder agreeing to the request will not be permitted to modify his bid.

1.2.15 CORRECTION OF ERRORS

- 1.2.15.1 Bids determined to be substantially responsive will be checked by the Owner for any arithmetic errors. Errors will be corrected by the Owner. Where there is a discrepancy between the amounts in figures and in words, the amount in words will govern. The amount stated in the Bid will be adjusted by the Owner in accordance with this procedure for the correction of errors and, with the concurrence of the Bidder, shall be considered as binding upon the Bidder. If the Bidder does not accept the corrected amount of Bid, his Bid will be rejected.
- 1.2.15.2 The owner reserves the right to accept or reject any variation or deviation. Alternate offers, for other than the configurations allowed in the Tender Documents will be considered by the Owner if found techno-commercially attractive to the Owner Alternate Offers of only such Bidders will be evaluated whose Primary Bids are found to be responsive.

1.2.16 EVALUATION OF BIDS

1.2.16.1 **Evaluation of Technical and Commercial bid**

The Owner will open Envelope A & B comprising the technical and commercial Bids of the Bidders.

Bids which are found deficient on general scrutiny will be treated as non-responsive and shall be rejected. Such deficiencies are:

- (i) Bids not properly signed.
- (ii) Furnishing of incomplete or incorrect information and / or documents.
- (iii) Bids are not substantially responsive. For this purpose a Bid shall be substantially responsive if it conforms to all the terms and conditions of this Tender without any material deviation. No recourse shall be made to any extrinsic evidence or material to determine a Bid's responsiveness and the same shall be based on the contents of Bid itself.
- (iv) Original copy of bid is not signed on each page by the Bidder.
- (vi) Bid is not signed by a duly authorised person holding powers of attorney to sign the bid as required by the Tender.

1.2.16.2 **Detailed Scrutiny**

The detailed scrutiny shall comprise Technical Scrutiny and Commercial Scrutiny as under:

The Owner will carry out a detailed scrutiny of each responsive Bid in order to determine whether the Bid is in accordance with the requirements set forth in the Tender Documents. In order to reach such a determination, the Owner will examine and compare the Bid on the basis of the information supplied by the Bidders, taking into account the following factors;

- (i) Overall completeness and compliance with the relevant technical & commercial aspects and requirements of the Tender Documents; variations including deviations as identified in Schedules, suitability of the facilities offered in relation to the environmental and climatic conditions prevailing at the Site; and quality, function and operation of any process control concept included in the Bid.
- (ii) Other relevant factors, if any, listed in the Data Sheets and other sections of Bid or that Owner deems necessary or prudent to take into consideration.

The Scrutiny would also involve the Owner obtaining clarifications from the Qualified Bidders and the discussions with them in order to analyse the variations in specified scope and / or technical /commercial variations from Tender Documents

Bids which are found deficient on detailed scrutiny will be rejected. Such deficiencies are:

- (i) The bid does not include all information as required under 'Bidder's Submittals'

- (ii) The bid is conditional.
- (iii) Documents referred to in the Bid are found to be incorrect or disclose that the Bidder is not financially sound or competent to make the bid.
- (iv) The owner is subject to any restraint in respect of use and / or operation of any of its facility.
- (v) The Bidder does not furnish all clarifications regarding the Bid requested by Owner either in writing or through formal meetings as may be necessary.

In respect of the Bids not found deficient, each relevant Bidder shall be required to submit Price Implication Bid in respect of resolved commercial and technical issues in a separate envelope, which together with the Bid is in compliance with the Tender Documents except for the listed unresolved variations/ deviations prepared by the Owner.

1.2.16.3 Final Evaluation

Evaluated Price in INR shall be determined by summing up of the following:

- (a) Total Lump sum Price.
- (b) Adjustment for errors as defined above.
- (c) Cost loading for unresolved variations/ deviations both technical and commercial as determined by Owner.
- (d) Performance Evaluation Loadings for guaranteed performance parameters.
- (e) Loading factors for delay in delivery beyond the specified completion schedule.
- (f) Each bid will be assessed for its' total cost of ownership for the life time of the plant taking into consideration among other things the cost of operating & maintaining the plant equipment's, as applicable.

1.2.17 AWARD OF CONTRACT

- 1.2.17.1 Owner may invite the Bidder for price negotiation. Bidders shall attend such negotiation meetings and if requested by Owner shall provide the analysis of rates/ break-up of amount quoted by him to demonstrate the reasonability. As a result of negotiation, Bidder may offer rebate on his earlier quoted price.
- 1.2.17.2 After selection of the successful Bidder, a Letter of Intent ("LOI") shall be released by the Owner in favour of such a Bidder. This Bidder shall have to give a Letter of Acceptance ("LOA") within a period of one week from the date of issue of LOI. If the Owner does not receive LOA within this period, the next eligible Bidder may be considered.
- 1.2.17.3 After receipt of the LOA by the Owner, the Bidder shall enter into the Contract with the Owner.

1.2.17.4 Owner/Consultant shall not be obliged to furnish any information/clarification/explanation to the unsuccessful Bidders as regards non-acceptance of their bids.

1.2.18 CONTRACT PERFORMANCE SECURITY

1.2.18.1 The Contractor shall submit to the Owner within fifteen (15) days from the date of issuance of Letter of Acceptance a bank guarantee towards Performance of Contract equivalent to 10% of the Contract Price in a format acceptable to the Owner. The bank guarantee shall remain valid till the expiry of warranty period. The value of the bank guarantee shall be modified by the Contractor in accordance with any adjustment to the Lump Sum Price allowed under this Contract.

1.2.19 CORRUPT/ FRAUDULENT PRACTICES & ETHICS PACT

1.2.19.1 Owner requires that Bidders/ Suppliers/ Contractors observe the highest standard of ethics during the entire process of bidding from the purchase of Tender Documents up to the award of Contract for the tendered package and thereafter in execution.

Owner will reject a proposal for award if he determines that the bidder recommended for award has engaged in corrupt or fraudulent practices in competing for the Contract in question.

1.2.19.2 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, at the option of the Owner, shall be cancelled and the Contract Performance Bank Guarantee deposited shall be appropriated by the Owner as the mutually agreed reimbursement of Owner's cost and loss and damage to Owner or treated as a default of Contractor.



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TATA CONSULTING ENGINEERS LIMITED

TECHNICAL SPECIFICATION FOR MAIN PLANT SYSTEM

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CHAPTER-2

DESIGN BASIS

2.0 DESIGN BASIS

2.1 SITE CONDITION

1.0	Location of the Plant	:	Kansariguda, Odisha, India
a.	Nearby Railway station	:	Singaramba Railway Station – 0.9 KM SE
b.	Nearby Airport	:	Visakhapatnam Airport – 152 KM
c.	Nearest Highways	:	SH-44, 6.0 KM, NE & SH-4, 8.5 KM SE
d.	Nearest Town	:	Tikri, 6.0 KM, N
e.	Elevation above MSL	:	840M
2.0	Ambient Temperature		
a.	Dry Bulb Temperature Maximum	:	46.6 ⁰ C
b.	Dry Bulb Temperature Minimum	:	3 ⁰ C
c.	Average Annual Maximum Temp.	:	34.20 ⁰ C
d.	Average Annual Minimum Temp.	:	11.4 ⁰ C
3.0	Barometric Pressure		
a.	Maximum	:	0.915 kg/cm ² (a)
b.	Minimum	:	0.900 kg/cm ² (a)
c.	Design	:	0.900 kg/cm ² (a)
4.0	Relative Humidity		
a.	Maximum	:	99%
b.	Minimum	:	35%
5.0	Total Annual rain fall average(mm)	:	1647.8 mm
6.0	Rainfall Data		
a.	Total Annual Rainfall	:	1647.8mm
b.	Rainfall intensity	:	85 mm/ hour
c.	Maximum Rainfall	:	354mm in 24 hrs
d.	Design daily rainfall	:	96mm/day
7.0	Wind Design Data	:	44m/s
8.0	Seismic Zone	:	Zone II
9.0	Auxiliary Power System		
a.	Power Evacuation	:	33kV, 3 phase, 3 wire, 50 Hz, Solidly Earthed.
b.	Generation Voltage	:	11kV, 3 phase, 50Hz, NGTR Earthed.
c.	Plant MV Auxiliary Supply	:	6.6kV, 3 phase, 3 wire, 50 Hz, restricted Earthed.

d.	Plant LV Auxiliary Supply	:	415V, 3 phase, 4 wire, 50 Hz, Solidly Earthed.
e.	Plant Emergency Supply	:	415V, 3 phase, 4 wire, 50 Hz, Ungrounded
f.	Plant DC Supply	:	220V, 2 wire, unearthed.
g.	Plant UPS Supply	:	230V, 1 Phase, 2 wire, 50 Hz.
h.	Panel lighting and space heaters	:	240V, 1 phase, 2 wires, 50 Hz.
i.	Metering, control & protection	:	220V DC control supply for protection, control supply for breaker feeders & Numerical Relays. 230V AC supply for contractor controlled feeder in LT switchgear.
j.	For Motors rated above 200kW	:	6.6kV, 3 phase, 3 wire, 50Hz earthed through resistance.
k.	For motors rated above 0.2kW up to 200kW	:	415V AC, 3-phase, 4 wire, 50 Hz. Effectively earthed.
l.	For motors rated up to 0.2 kW	:	240V, 1 phase, 50 Hz, effectively earthed.
m.	Dc motors starters, Dc solenoids, Dc alarm	:	220V DC, 2 wire, unearthed DC
n.	Frequency	:	50 Hz (+3% to -5%)
o.	Design Ambient Temperature of electrical equipment	:	50 Deg. C
p.	Relative Humidity for design of Electrical equipment	:	90%

2.2 FACILITY DESIGN CRITERIA

The proposed cogeneration power plant shall comprise of two (2) units. Each unit shall comprise of one (1) no. steam generator and its auxiliaries, one (1) no. steam turbine generator and its auxiliaries balance of plant systems with most efficient and proven machines utilising state-of-art technology available in the world. The plant shall be designed for a useful life higher than 25 years.

The plant design should allow for the future addition of another unit of similar capacity with minimal retrofitting to the existing facility. All the common facilities shall be designed for continuous operation of both the units. Also, the plant must be capable of operating with a single unit without any issues affecting performance or operations.

The design of the Facility shall take into account and comply with all statutory requirements in addition to the applicable codes listed in Clause 2.3 hereof. The ratings and capabilities for the Facility and all equipment shall be such that the Facility and all portions thereof can operate continuously at guaranteed net plant output as well as at minimum load, including operational events such as startup and shutdown, over the entire range of ambient conditions prevailing at the Site. The ratings and capabilities of all equipment and systems shall also meet the specified sizing criteria for respective

equipment and systems and shall not limit operation of the unit at its maximum capability, i.e., operation of boiler and turbine at their maximum ratings, without exceeding any safety and emission limits.

The Facility shall be provided for safe, reliable, ease of maintainability, cost effective operation where continuity of supply of steam and power to refinery plant is the first consideration. Only those systems which have been field-proven and fully integrated shall be used. All equipment shall be sized to ensure satisfactory operation under system variations conditions of voltage, frequency, load, weather, temperature, and to safely withstand sudden variations of load and voltage as may be met under working conditions, including those due to startup loads, transient short-circuit and other fault conditions.

The design shall incorporate every reasonable safeguard and provision for the safety of all personnel concerned in the construction, commissioning, operation and maintenance of the installation.

The plant shall be designed to perform in the most efficient manner at 100% maximum continuous rating (MCR). However, at times, the unit shall be able to operate on part load depending on the requirement. The unit and auxiliaries shall be suitably designed considering the requirements as mentioned in Specification. The unit shall also be capable to operate at valve wide open (VWO) condition of 105% TMCR. The rated system frequency is 50 Hz.

The design parameters and technical requirements are provided under the attached technical datasheets and the following requirements shall be satisfied by the Bidder:

- a) Higher efficiency to lower operating cost and better plant performance.
- b) Utilization of proven design for extended plant life and system reliability.
- c) Redundancy in the equipment to assure a high degree of plant availability.
- d) Design, construction & operational safety in compliance to Owner's requirements & statutory rules.
- e) Lower start up time, quick ramp up & down and better unit response.
- f) Capability of adequate cold / warm / hot start-up of the unit in a year.
- g) State-of-the- Art control & automation system for unit & auxiliaries.
- h) Equipment layout for easy maintenance & manoeuvring in the plant.
- i) Protection of surrounding natural environment and ecosystem.

2.3 CODES AND STANDARDS

All equipment, systems and services covered under this specification shall comply with all currently applicable statutes, regulations, and safety codes in the locality where the equipment will be installed. All codes and standards referred to in Technical Specification shall be understood to be the latest version on the date of offer made by the bidder unless otherwise indicated.

The editions and addenda of the following codes and publications, effective as of the date of the Contract, shall apply to all work performed unless other codes, standards and regulations are proposed and approved by the Owner.

The Metric units/SI units shall be used in all data/ drawings submitted against this package.

In the event of any conflict between the codes and the standards referred to elsewhere in the contract and the requirements of this contract, more stringent of the two shall govern.

MECHANICAL

- AGMA-American Gear Manufacturer's Association
- AMCA - Air Moving and Control Association
- ABMA - American Boiler Manufacturer's Association
- ABMA - American Bearing Manufacturers Association
- AGA - American Gas Association
- ANSI - American National Standards Institute
- API - American Petroleum Institute
- ASHRAE - American Society of Heating, Refrigeration, and Air Conditioning Engineers
- ASME - American Society of Mechanical Engineers
- Boiler and Pressure Vessel Code:
 - Section I - Power Boilers
 - Section II – Materials
 - Section V - Non-destructive Examination
 - Section VIII - Pressure Vessels
 - Section IX - Welding & Brazing Qualifications
 - B31.I - Power Piping
- ASNT - American Society for Non-destructive Testing
- ASTM - American Society for Testing and Materials
- AWS -American Welding Society
- AWG - American Wire Gauge
- AFBMA - Anti-Friction Bearing Manufacturers Association
- AWWA - American Water Works Association
- EJMA - Expansion Joint Manufacturing Association

- HEI - Heat Exchanger Institute
- HI - Hydraulic Institute Standards
- NFPA - National Fire Protection Association
- SSPC - Steel Structures Painting Council
- TEMA - Tubular Exchanger Manufacturer Association
- HIS- Hydraulic Institute Standard
- ASHRAE- American Society of Heating, Refrigeration and Air Conditioning Engineers
- ASME PTC- ASME Performance Test Code
- ASME TDP – 1
- Indian Boiler Regulations (IBR)
- International Standards Organisation Regulation: R831.
- National Board of Boilers and Pressure Vessel Inspectors.
- Chief Inspectorate of Factories in Odisha
- Chief Electrical Inspectorate in Odisha
- Indian Electricity Rules
- In all cases of disparity between American or equivalent standards and the Indian Boiler Regulations, the provisions of the latter shall prevail. It shall be the responsibility of the Bidder to satisfy the Indian Boiler Inspectorate Authorities that all stipulations of these regulations have been complied with before starting fabrication of the units.

ELECTRICAL AND CONTROL & INSTRUMENTATION

- BIS- Bureau of Indian Standard.
- ANSI-American National Standards Institute
- IEEE - Institute of Electrical and Electronics Engineers
- NEC - National Electrical Code
- NEMA - National Electrical Manufacturers Association
- IEC - International Electrotechnical Commission
- CEA – Central Electricity Authority

CIVIL/STRUCTURAL/ARCHITECTURAL

<u>Standard/Code No</u>	<u>Description</u>
1. BRICK BLOCK, MORTAR	
IS-4860	Acid Resistant Bricks
IS-1077	Common burnt clay building bricks.
IS-2185	Concrete masonry units
Part-1	
Part-2	
Part-3	
IS-4457	Ceramic unglazed vitreous acid resisting tiles.
IS-4832	Chemical resistant mortar
Part-1	
Part-2	
Part-3	
IS-4443	Resin type chemical Resistant mortar.
IS-9510	Bitumen Mastic - A.R. Grade
IS-1580	Bituminous Compounds
IS-4995	Chemical resistant mortar
Part-II	
2. CEMENT	
IS-269	Ordinary Portland Cement (OPC)
IS-455	Portland Slag Cement (BFS)
IS-1489	Specification for Portland Pozzolana Cement (PPC)
Part I	
Part II	
IS-12330	Sulphate Resisting Portland Cement.
3. CONCRETE	
IS-456	Code of Practice for Plain & Reinforced Concrete.
IS-516	Method of test for strength of concrete.
IS-3370	Design of Liquid Retaining Structures.
Part-I	
Part-II	
Part-III	
Part-IV	
IS-4991	Blast proof design of structures.
4. STRUCTURAL STEEL	
IS-800	General construction in steel Code of practice

<u>Standard/Code No</u>	<u>Description</u>
IS-806	Code of Practice of Steel tubes in general construction
IS-808	Dimensions for Hot Rolled Steel beam, column, channel and angle sections.
IS-816	Metal arc welding for general conditions in mild steel.
IS-813	Scheme of symbols for Welding.
IS-9595	Metal arc welding of carbon & carbon manganese steel.
IS-2062	Steel for general structural purposes.
IS-3502	Steel Chequered plates
IS-1363	Hexagon head bolts, screws, nuts of product grade C (Size range M5 to M64)
Part 1,2	
Part 3	
IS-1364	Hexagon head bolts, screws, nuts of product grades A & B
Part 1 to 3	
Part 4	
Part 5	
IS-2062	Steel for general structural Purpose.
IS-3502	Steel Chequered plates
IS-1363	Hexagon head bolts, screws, nuts of product grade C (Size range M5 to M64)
Part 1,2	
Part 3	
IS-1364	Hexagon head bolts, screws, nuts of product grades A & B
Part 1 to 3	
Part 4	
Part 5	
IS-1161	Steel tubes for structural purpose
IS-801	Code of Practice for use of Cold formed light gauge steel structural members in general building construction.
IS-2629	Recommended practice for hot dip galvanizing on iron & steel.
IS-2633	Methods of testing uniformity of coating of zinc coated articles.
IS-6745	Method of determination of mass of zinc coating on zinc Coated iron & steel articles.
IS 3640	Hexagon fit bolt

5. DOORS & WINDOWS

Standard/Code No

Description

IS-1948	Aluminium doors, windows, and ventilators.
IS-1949	Aluminium windows for Industrial buildings.
IS-1038	Steel doors, windows, and Ventilators.
IS-1361	Steel windows for industrial Buildings
IS-4043	Symbolic designation of direction of closing of doors etc.
IS-4021	Timber doors, windows, and ventilator frames.
IS-1003	Timber paneled door & window shutters.
Part-1	
Part-2	
IS-2191	Wooden flush door shutters
Part-1 & 2	
IS-1081	Fixing & glazing of metal (steel & aluminium) doors, windows & ventilators.

6. FOUNDATION ENGG.

IS-8009	Calculation of Settlement of foundation.
Part-1	
Part-2	
IS-2974	Design and construction of machine foundations.
Part-1	
Part-2	
Part-3	
Part-4	
Part-5	
IS-2950 (Part I)	Design and construction of Raft Foundation.
IS-1892	Sub surface investigation for Foundations.
IS-1904	Design & construction of foundations in soils: General requirements.
IS-11089	Design and construction of Ring foundation
IS-2911	Design and construction of pile foundation.
Part-1 Sec. 1,2,3,4	
Part-2	
Part-3	
Part-4	
IS-1080	Design and construction of Shallow foundation.
IS-6403	Determination of bearing capacity of shallow foundations.

7. FUNCTIONAL DESIGN OF BUILDINGS

IS-2440	Code of Practice for daylighting of buildings

<u>Standard/Code No</u>	<u>Description</u>
IS-6060	Code of Practice for daylighting of factory buildings.
8. LOADING STANDARDS	
IS-875	Loading Standards
Part 1	
Part 2	
Part 3	
Part 4	
Part 5	
IS-1893	Criteria for earthquake resistant design of Structures.
Part 1	
Part 4	
IS-4326	Criteria for earthquake Resistant design & construction of bldgs.
IS-13920	Ductile detailing of RC Structures subjected to Seismic forces.
9. REINFORCEMENT	
IS-432	Mild Steel & medium tensile bars & wires for concrete
Part 1	
Part 2	
IS-1786	High strength deformed steel bars & wires for concrete reinforcement.
IS-2502	Bending and fixing bars for Concrete reinforcement.
IS-5525	Recommendation for detailing.
10. WATER PROOFING AND DAMP PROOFING	
IS-4365	Application of bitumen mastic
IS-7198	Damp proofing using bitumen felts.
IS-1346	Waterproofing of roof using bitumen felts.
IS-2645	Integral cement water proofing Compounds.
11. DESIGN AIDS	
SP-7	National building Code of India.
SP-34	Handbook on concrete reinforcement detailing.
SP-36	Compendium of Indian standards on Soil Engg.
Part 1	
Part 2	

<u>Standard/Code No</u>	<u>Description</u>
12. Misc.	
IS-732	Code of practice for electrical wiring installations
IS-2309	Practice for protection of buildings and allied structures against lightning
IS-2750	Steel scaffoldings
IS-2932	Enamel, synthetic, exterior (a) under coating (b) finishing –specification
IS-2933	Specification for Enamel, exterior (a) under coating, (b)finishing.
IS-3043	Code of practice for earthing
IS-3346	Method for the determination of thermal conductivity of thermal insulation materials (two slabs guarded hot-plate method)
IS-3677	Unbonded rock and slag wool for thermal insulation
IS-3696	Safety code for scaffolds and ladders (Part 1 &2)
IS-3938	Specification Electric wire rope hoists cranes, lifting Chains and related equipment
IS-4014	Code of practice for steel tubular scaffolding Part 1&2
IS-4289	Flexible cables for lifts and other flexible connections: Part1 Elastomer insulated cables
IS-4456	Methods of test for chemical resistant mortars: Part 1 Silicate type and Resin type
IS-4457	Ceramic unglazed vitreous Acid resisting tiles-Specification
IS-4998	Design of reinforced concrete chimneys: Criteria 2015
IS-5410	Cement Paint
IS-269	OPC cement - Specification
IS-8183	Bonded Mineral wool
IS-13213	Polyurethane full gloss enamel Specification
IS-13311	Non-destructive testing of concrete –Method of test part-1 Ultrasonic pulse velocity
IS-13947	Low voltage switchgear and control gear: Part 1 General rules
IS-14946	Zinc Ethyl silicate Primer, two components specification
IS-15917	Building Design and erection using mixed/composite construction code of practice

Standard/Code No

IS-15498

Annexure-14

Description

Guidelines for improving the cyclonic resistance of Low-rise houses and other buildings/structures

International Standards and Recommended Practices Aerodromes - International Civil Aviation Organization. Indian Electricity Rules.

2.4 ENVIRONMENTAL GUIDELINES

2.4.1 Noise Emission

During construction, noise mitigation strategies shall be employed to minimize impact to the surrounding community. As a minimum, permanent plant equipment, excluding equipment, used during emergency or abnormal operating conditions, such as, Safety Valves, start-up vent and pressure relief valves shall not exceed 85 dBA at one meter away and a height of 1.5meters.

Far Field Noise

Testing shall be conducted in accordance with a project-specific test plan prepared by the Bidder and approved by the Owner in conformity to applicable standards. Sound level surveys shall be conducted in accordance with the approved procedure to evaluate compliance with the Noise Emissions Limit and witnessed by the Owner or Owner's Engineer, or both. Testing for and corrections to a free field condition shall conform to applicable standards, such as the measured noise level produced shall not exceed 85 dBA at a distance of 1.0 m and 1.5 m height from its boundary in any direction under any load condition by any rotating equipment except for TG, HP & LP bypass valves, air motors, safety valves and regulating drain valves. The noise level for TG, regulating drain valves and for air motors shall not exceed 90 dBA and 95 dBA respectively, and that for safety valves and associated vent pipes shall not exceed 105 dBA. If necessary, suitable by the use of low noise trims, baffle plate silencers/line silencers, acoustic lagging (insulation), thick-walled pipe work as and where necessary.

Environmental requirement shall be complied with, and Guaranteed Emissions shall be met. Guarantees shall be verified by tests conducted in accordance with all national and local requirements. Test procedures shall be developed and submitted to the Owner for approval 180 days before the tests.

2.4.2 Exhaust Gas Emissions and Air Quality

Exhaust gas emissions shall not exceed the emission rates as mentioned below and these requirements apply under all normal operating conditions.

Guarantees shall be verified by tests conducted in accordance with all national and local requirements. Test procedures shall be developed and submitted to the Owner for approval 180 days before the tests.

ATMOSPHERIC EMISSIONS

Items	Parameter	Units	Guaranteed Value
1	Sulphur Dioxide (SO ₂)	mg/Nm ³	<100 mg/Nm ³ @6% O ₂ Dry basis
2	Nitrogen Oxides (NO _x as NO ₂)	mg/Nm ³	<100 mg/Nm ³ @6% O ₂ Dry basis
3	Particulates	mg/Nm ³	<30 mg/Nm ³ @6% O ₂ Dry basis
4	Mercury	mg/Nm ³	<0.03 mg/Nm ³ @6% O ₂ Dry basis

The absolute atmospheric emissions guarantee applies to the full range of fuels specified in the technical specification under any operating condition.

Bidder shall be required to provide continuous on-line emission monitoring at stack, as required by the regulatory authorities. Also, provision shall be kept in boiler for installation of SNCR in future.

2.4.3 Flue Gas Emission for the Diesel Generator Set

The emission of the diesel generator shall comply with the requirements as mentioned below:

For Emergency Diesel Generator:

Items	Parameter	Units	Guaranteed Value
1	NO _x + HC	g/kWh	≤ 4.0
2	CO	g/kWh	≤ 3.5
3	PM	g/kWh	≤ 0.2
4	Smoke Limit (light absorption coefficient, m ⁻¹)		≤ 0.7

For Black Start Diesel Generator:

Items	Parameter	Units	Guaranteed Value
1	NO _x (as NO ₂) (at 15% O ₂), dry basis	ppmv	710
2	NMHC (as C) (at 15% O ₂)	mg/Nm ³	100
3	PM (at 15% O ₂)	mg/Nm ³	75
4	CO (at 15% O ₂)	mg/Nm ³	150

2.5 ANALYSIS OF FUEL, LIMESTONE & WATER

2.5.1 COAL ULTIMATE ANALYSIS (As Received Basis)

Sl. No.	Particulars	Unit	Performance Coal	Range for Design Coal		
			Indian Coal	Indian Coal	South African Coal	Indonesian Coal
1	Carbon	%	33.48	33.22 - 43.71	54 – 67	52 – 72
2	Hydrogen	%	2.5	1.86 - 2.42	3.1 – 4.2	4 – 4.5
3	Nitrogen	%	1.09	0.64 - 0.87	1.3 - 1.7	0.9 – 1.2
4	Sulphur	%	0.46	0.23 - 0.62	0.7 – 0.85	0.5 – 1.0
5	Oxygen	%	8.04	6.82 - 9.75	6.5 - 16	11 – 21.5

6	Moisture	%	15.05	12.37 - 15.02	8.0 - 10	23 – 40
7	Ash	%	39.38	31.92 - 50	21 - 27	5 – 8
8	GCV	kCal/kg	3268	2987 - 3952	5020 - 5720	3800 - 5200

2.5.2 FUEL OIL (LDO)

SL.NO.	TYPE	VALUE
1.0	Water Content, %v	Max. 0.25
2.0	Flash Point (P.M.C.C.), °C	Min. 66
3.0	Viscosity (Kinematic) @ 40°C, cSt	Min. 2.5 Max. 15.7
4.0	Pour Point, °C	Max. 12 for Winter* Max. 21 for Summer*
5.0	Carbon Residue (Ramsbottom), %w	Max. 1.5
6.0	Copper Strip Corrosion (3 hr. @ 100°C)	Not worse than No. 2 Strip
7.0	Sulphur, %w	Max. 1.8
8.0	Acidity (Inorganic), mg KOH/g	NIL
9.0	Sediment by Extraction, %w	Max. 0.10
10.0	Ash, %w	Max. 0.02
* Winter shall be the period from November to February and rest of the months of the period shall be called summer		

2.5.3 FUEL OIL (Bio-Diesel)

SL.NO.	TYPE	VALUE
1.	Density at 15° C	860 - 900 kg / m ³
2.	Ester Content	96.5 %
3.	Flash point (closed cup)	101°C
4.	Water Content	500 mg / Kg, max.
5.	Total Contamination	24 mg / Kg, max.
6.	Kinematic viscosity at 40°C	3.5-5.0 cSt
7.	Ramsbottom carbon residue, % mass	0.05
8.	Sulfated ash % mass	0.02
9.	Sediment by Extraction, %w	Max. 0.10
10.	Sulfur	50 mg / Kg max

SL.NO.	TYPE	VALUE
11.	Copper strip corrosion 3 hrs. 50°C	Class 1
12.	Cetane Number	51 min.
13.	Acid Value, mg KOH/g	0.50 max.
14.	Methanol or Ethanol	0.2 % m/m, max
15.	Monoglycerides	0.7 % mass max
16.	Diglycerides	0.2 % mass max
17.	Triglycerides	0.2 % mass max
18.	Free glycerine	0.02 % mass max
19.	Total glycerine	0.25% by mass max.
20.	Phosphorus content	4.0 mg/Kg, max
21.	Na + K content	5.0 mg/Kg, max
22.	Ca + Mg content	5.0 mg/Kg, max
23.	Iodine Value	120 g/100 gm, max
24.	Oxidation Stability	8 hours min, at 110°C
25.	CFPP, °C at summer	18
26.	CFPP, °C at winter	6
27.	Lenoleic acid methyl ester	12 m/m max
28.	Polyunsaturated methyl ester	1 m/m max
* Note: Bio-Diesel analysis given as per IS 14607:2016		

2.5.4 LIMESTONE ANALYSIS

SL. NO.	CONSTITUENTS	UOM	Average Value
1	CaO	%	72-80
2	SiO ₂	%	2.37
3	Others	%	
	MgO (Magnesium Oxide)	%	2 – 5
	R ₂ O ₃	%	2 – 3
	LOI (Loss of Ignition)	%	5 – 15
	Miscellaneous	%	1
4	Moisture	%	Max. 2

2.5.5 BEDMATERIAL ANALYSIS

SL. NO.	CONSTITUENTS	% BY WEIGHT	
		Typical	Range
1.0	SiO ₂	82.2	<85
2.0	AlO ₃	9.7	6 – 15
3.0	Fe ₂ O ₃	1.8	< 2
4.0	Volatile CaO	1.2	0.3-2.5
5.0	MgO	0.4	0.2-1
6.0	Na ₂ O	1.9	1-3.5
7.0	K ₂ O	2.8	2-6
8.0	H ₂ O	0.1	<0.3
9.0	Loss of Ignition	0.95	<1
10.0	Acid soluble Alkali	0	<0.5
11.0	Chlorides	0	≤ 0.05
Sand size is: a) 99% passing 0.8 mm screen opening b) 50% passing 0.15 – 0.3 mm screen opening c) <5% passing 0.1mm screen opening d) Sphericity factor: >0.85; Softening point >1100; Fusion temperature ≥ 1250°C e) Seashore sand shall not be allowed.			

2.6 WATER ANALYSIS

A. DEMIN WATER

Demin water shall be used for Cycle makeup, CCW overhead tank makeup, boiler initial filling and chemical dosing etc.

PARAMETER	UNIT	VALUE
pH	-	6.8 to 7.2
Conductivity	μS/cm	< 1
SiO ₂	Ppb	< 20

B. RAW WATER SERVICE WATER QUALITY:

Raw water shall be used as service water for BTG area

PARAMETER	UNIT	VALUE
pH	-	5.0 to 7.0
Turbidity	NTU	< 5



Client – Hindalco Industries Ltd

Project – 2X30 MW CGPP

TCE.13833A-ME-6002-6001, Rev-R0



TATA CONSULTING ENGINEERS LIMITED

TECHNICAL SPECIFICATION FOR MAIN PLANT SYSTEM

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CHAPTER-3

SCOPE OF WORK, TERMINAL POINTS & EXCLUSIONS

3.0 SCOPE OF WORK, TERMINAL POINTS & EXCLUSIONS

The scope of work under bidder shall include all necessary supply and services whether mentioned in these specifications or not, but which are necessary for the satisfactory, reliable , safe operation & maintenance of the plant and required for achieving guaranteed performance of this project.

It is believed that the bidder has technical expertise in execution of similar power plants and they will notify to owner for any errors or omissions in the specification and provide alternatives, where they believe it is needed.

All equipment/services necessary for proper erection, commissioning, and performance testing of all items of the plant covered under this contract shall be provided by the Bidder. The cost of the same shall be included in the contract price.

It is the responsibility of Bidder to conduct site visit and collect all necessary information required before submission of their offer.

3.1 GENERAL

- 3.1.1 Project execution plan.
- 3.1.2 Project scheduling, management, progress metrics and reporting.
- 3.1.3 Basic Engineering of all equipment and equipment systems
- 3.1.4 Detailed design of all the equipment and equipment system(s)
- 3.1.5 Erection of Equipment, Piping and all Instruments shall be as per approved vendor documents and Owner's given document / specification .
- 3.1.6 Environment, health, safety and security plan and management.
- 3.1.7 All plant layouts, General Arrangement Drawings, P&I Diagrams, piping layout & isometric drawings etc.,
- 3.1.8 All system design calculations including piping flexibility analysis
- 3.1.9 Technical data sheets
- 3.1.10 Detailed Design & Engineering Electrical system studies.
- 3.1.11 Purchase specifications and equipment procurement.
- 3.1.12 Sub-Vendor's drawings reviews and approval.
- 3.1.13 Procurement, shop testing and certificates.
- 3.1.14 Packing, transportation, transit insurance, delivery to site, unloading, & storage at site.
- 3.1.15 Temporary storage, fabrication & assembly yard.
- 3.1.16 Onsite handling and installation.
- 3.1.17 Painting and preservation including requisite number of nitrogen cylinders
- 3.1.18 Corrosion protection.

- 3.1.19 Project QA and QC plan and management.
- 3.1.20 As built drawings and Engineering Data Base.
- 3.1.21 DCS data base.
- 3.1.22 Cabling and terminations data base.
- 3.1.23 O&M Manuals.
- 3.1.24 Training of Owner's personnel.
- 3.1.25 3D Model
- 3.1.26 Hydro-test, dry out, chemical cleaning, steam blowing activities including temporary arrangements (i.e silencer)
- 3.1.27 Emissions monitoring & environmental testing services (including third party contracting) used during performance and compliance testing.
- 3.1.28 Fabrication, pre-assembly, if any.
- 3.1.29 Pre-commissioning tests, functional tests, start-up, commissioning and testing.
- 3.1.30 Trial Run, Reliability run and performance guarantee tests along with test instruments.
- 3.1.31 Supply of mandatory spare part as listed with this specification.
- 3.1.32 Spare parts for start-up and commissioning, two (2) years O&M spares.
- 3.1.33 Special tools and tackles for installation and maintenance.
- 3.1.34 Supply of lubricants, chemicals & consumables up to handing over of the plant to the Owner after successful completion of Acceptance tests.
- 3.1.35 Disposal of the excess materials after commissioning and handing over.
- 3.1.36 Construction of all temporary facilities and services associated with this work and dismantling the same after completion of work.
- 3.1.37 HSE studies and Risk Assessment including HAZOP study.
- 3.1.38 All statutory clearances and approvals, safety related permits including liaison and coordination work with the respective local regulatory authorities. Applicable fees shall be borne by Customer.
- 3.1.39 Arrangement of permits & licenses from local authorities
- 3.1.40 All transportation logistics permits
- 3.1.41 All chemical handling and storage permits
- 3.1.42 All hazardous, explosive material handling & waste management permits
- 3.1.43 Compliance to all local laws and regulations

3.2 MECHANICAL SYSTEM & EQUIPMENT

- 3.2.1 Two (2) nos. internally controlled extraction cum condensing type steam turbine generator along with lube oil & control system with oil centrifuge, governing system, TG integral piping and drain connections, turbine flash tank, water cooled condenser, air evacuation system, condensate extraction pumps, deaerators, boiler feed pumps, auxiliary steam system, , make-up water system, low pressure dosing system and associated auxiliaries.
- 3.2.2 Two (2) nos. circulating fluidized bed (CFB) combustion type boiler including Superheaters (including mechanical and electronic safety valves, drains, start up vents, air release valves, nitrogen connections, sampling connection, desuperheating spray system) Economizer with recirculation piping (as required), air & flue gas system (including primary air fans, secondary air fans and induced draft fans with all necessary ducting work, dampers and expansion joints), bunkers for fuel, bed material and limestone, feeding system, fuel oil storage and supply system, soot blowers (if required), sample coolers, electro-static precipitator, continuous & intermittent blow down tanks, high pressure dosing system, necessary interconnecting piping, valves, fittings, electrical and instrumentation.
- 3.2.3 Following Pressure reducing desuperheating system (PRDS) and desuperheaters
- De-superheater- Medium Pressure Extraction steam to process from turbine extraction.
 - De-superheater- Low Pressure Extraction steam to process from turbine extraction.
 - Pressure reducing desuperheating system (MP PRDS)- Medium pressure steam to process from main steam with 100% redundancy
 - Pressure reducing desuperheating system (LP PRDS)- Low pressure steam to process from MP steam with 100% redundancy
 - Pressure reducing desuperheating system (LP PRDS)- Auxiliary steam to plant auxiliaries (ejector, gland sealing, VAM etc.) with 100% redundancy.
- Above are the minimum PRDS & Desuperheater requirement. Bidder shall include additional PRDS & Desuperheaters (if any) based on final HMBD.
- 3.2.4 Complete power cycle piping system comprising main steam, boiler feed discharge, Deaerator, condensate, MP and LP extraction system, PRDS system etc., as well as integral piping system and low-pressure piping system with hangers and supports, valves and specialities, insulation etc., as required for the main plant within battery limit of Bidder.
- 3.2.5 Electronic Relief Valve at suitable locations of main steam header, MP process steam header & LP process steam header.
- 3.2.6 Piping system for supply steam from LP process steam header to Deaerator including control valves, isolation valves, non-return valves, fittings, specialities, supports, instrumentation etc.
- 3.2.7 Condensate storage tank, condensate transfer pumps for cycle make up.
- 3.2.8 Steam and water sampling system
- 3.2.9 Instrument air and service air distribution system.
- 3.2.10 One (1) no. passenger elevator of 800 kg for TG building and One (1) no. of 1500 kg capacity passenger-cum-goods elevator common for boiler area shall be considered.

- 3.2.11 Design of pipe cum cable rack for the pipes/cables in BTG area. Provision shall be kept for other pipes/cables while designing the pipe cum cable racks.
- 3.2.12 Galleries, walkways, platforms, hand rails, ladders
- 3.2.13 Condenser online tube cleaning system & Debris filters.
- 3.2.14 All other miscellaneous tanks as required for the main plant.
- 3.2.15 AC & Ventilation system.
- 3.2.16 One (1) No. EOT crane at STG building and Miscellaneous Cranes & hoisting equipment at other areas
- 3.2.17 Complete thermal insulation, acoustic insulation and refractory for insulation as required for the boiler, turbine, piping and other equipment for personnel protection and prevention of heat loss.
- 3.2.18 Service water and potable water supply and distribution systems
- 3.2.19 Boiler and turbine area sumps & sump pumps
- 3.2.20 Painting works including final touch up paints.

3.3 ELECTRICAL SYSTEM AND EQUIPMENT

- 3.3.1 Generator with brushless excitation system and Automatic Voltage Regulator.
- 3.3.2 Generator Auxiliary Cubical (GAC) with Line side Current Transformer (CT), Voltage Transformer (VT) and Surge Capacitor (SC), Neutral Grounding Transformer and Resistor
- 3.3.3 Segregated Phase Busduct (SPBD) to interconnect Generator with GAC to Generator Transformer.
- 3.3.4 Protection & Relay panels of Generator.
- 3.3.5 Generator Synchronizing and metering system.
- 3.3.6 6.6kV Unit and Station Switchgear.
- 3.3.7 415V PCC, MCC, PDB for Boiler, STG and ESP system.
- 3.3.8 6.6kV/0.433kV Unit Service Transformers
- 3.3.9 Variable Frequency Drive (VFD)
- 3.3.10 DC system including Batteries, Chargers and DCDB
- 3.3.11 UPS with Static switch, ACDB and Constant Voltage and Constant Frequency (CVCF)
- 3.3.12 MV Motors, LV Motors and Actuators
- 3.3.13 MV Power Cable, LV Power Cables, and Control Cables
- 3.3.14 Cable Trays with supporting structures
- 3.3.15 Plant Illumination system

3.3.16 Earthing and lightning protection system

3.3.17 Black Start Diesel Generator

3.3.18 Emergency Diesel Generator

3.3.19 Energy Management System

3.4 INSTRUMENTATION AND CONTROL EQUIPMENT

Unless otherwise specified, all the requirements/quantities specified are on per unit basis.

- 3.4.1 Distributed Control System (DCS) of uniform hardware complete with data highways, operator stations with LED screens & LVS, engineering workstations, historical storage unit, all other peripherals, interfacing with other plant control systems cabling etc. for operation / monitoring and control of main power plant.
- 3.4.2 Boiler Protection System /Burner Management System i.e protection & interlocks shall be TMR system or SIL 3 certified System. The SIL 3 certified safety system shall be of the same family as of DCS and shall reside on the plant data highway along with the DCS controllers. The same shall be implemented in independent controllers and shall be as per NFPA 85.
- 3.4.3 Turbine integral control system shall be provided in hot redundant configuration and shall comprise of Turbine Governing system, Turbine Supervisory Instrumentation (TSI), and Automatic Turbine Run-up system (ATRS). Turbine Protection System i.e protection & interlocks shall be TMR system or SIL 3 certified System.
- 3.4.4 Vibration Analysis System for Steam Turbine.
- 3.4.5 Coal, Limestone and Ash Handling system shall be monitored and controlled from PLC based control system with soft link and critical signals hardwired with DCS
- 3.4.6 Other systems like the Compressed air system, Emergency DG set, Fire protection system, Fire detection & alarm system, etc. that are implemented in MPC/PLC shall be interfaced with the Plant DCS through soft link and critical signals shall be hardwired.
- 3.4.7 Smart soot blower control (if required) shall be PLC based intelligent control system.
- 3.4.8 Dedicated microprocessor / PLC based system for the ESPs as described under the Electrical section of the specification. Hardwired signals and redundant OPC links to the DCS for monitoring of this system shall be provided.
- 3.4.9 Details of control systems and hardware envisaged for the total power plant with interfacing requirements with plant DCS are detailed in subsequent, Annexure-1 (Operation and Control Concept and Interface and Hardware requirement).
- 3.4.10 Sequence of Events Recording system integral to the DCS and safety system with 1 ms resolution or better shall be provided

- 3.4.11 Wherever the same process parameter is used for both the safety system and the DCS, the corresponding field sensors shall be connected to the safety system and the input signal to the DCS shall come as hardwired outputs from the safety system to the DCS.
- 3.4.12 The DCS and safety systems shall be provided unit-wise and independent set of controllers of these systems shall be provided for equipment / systems common to both units.
- 3.4.13 The DCS based control system shall be interfaced to the GIS and AIS SCADA system. (refer electrical section for details) through redundant OPC links and hardwired signal exchange.
- 3.4.14 Historical data storage and retrieval system with redundant historians implemented with RAID-1 configuration.
- 3.4.15 DCS shall also implement the basic requirements of plant performance monitoring (Plant heat rate, SG efficiency, Auxiliary power consumption etc.) as per relevant ASME standard
- 3.4.16 DCS shall be provided with HART /Foundation field bus compatible I/O cards. For minimum requirements of Foundation Fieldbus system refer Annexure-II.
- 3.4.17 1 no. of 70" LCD TV screen / unit interfaced to one of the OS of the DCS.
- 3.4.18 Master Clock System (100% redundant) with associated time synchronisation equipment, cabling, slave clocks, etc. shall be provided. For details refer Table 1. Additionally Time sync to be consider for all protection relays, CILMS.
- 3.4.19 2 x 100% UPS supply (220V) for plant I&C loads (control systems including HMI, master clock system, VMS, CEMS, SWAS, field instrumentation etc) complete with its distribution .UPS and UPS power distribution to all I&C loads in Bidder's scope is included in the Bidder's scope. DC power requirement shall be derived by the Bidder from the UPS using appropriate redundant power supplies and diode ORing units. All distribution boards shall be provided with adequate (minimum 20% after commissioning) wired spare breakers. I&C equipment such as control systems including HMI, master clock system, VMS, CEMS, SWAS (except chillers), field instrumentation (incl. flame scanners, drum level indicators, etc.) CCTV system, etc. shall be powered by the UPS.
- 3.4.20 Control Desks and cabinets including Control room and equipment room panels, consoles, panels, cabinets, racks, chairs etc
- 3.4.21 All field Instruments and sensors including pipe mounted items, flow elements (FE) and accessories., final control elements like control valves, de-superheaters, control dampers and actuators etc
- 3.4.22 Foundation fieldbus-based transmitters with associated spur and field barriers, flow elements (FE) and accessories; final control elements like control valves, control dampers and actuators etc.
- 3.4.23 Latest version of DD files shall be provided by Instrument vendor.
- 3.4.24 Foundation field bus field manager (with software).
- 3.4.25 All HT drives shall be provided with bearing temperature & vibration monitoring for each bearing of drive motor & driven equipment and motor winding temperature monitoring. Vibration sensors

shall be provided on X & Y directions on DE & NDE of drive & motor. Vibration sensors with transmitters shall be provided with 4-20mA output from field hardwired to DCS.

- 3.4.26 Steam And Water Analysis System (SWAS) complete with sampling system and analysers & instruments.
- 3.4.27 Continuous Emission Monitoring System (CEMS)
- 3.4.28 All junction boxes) (Signal and power), transmitter racks (as applicable), cubicles, enclosures, local panels, marshalling panels, pneumatic and process hook up hardware and other erection materials and accessories including Earthing system (separate electronic and frame earth).
- 3.4.29 Canopy shall be provided for field instruments and all the Junction boxes (PJB, CJB and FF JB.)
- 3.4.30 Supply, laying & termination of all Instrumentation cables, Control cables, Compensating cables, Special cables, Pre-fabricated cable, Redundant Data Highways, foundation fieldbus cables etc., including the field cables for all types of applications, Control and power cable megger (before laying) etc.
- 3.4.31 Supply & installation of branch cable trays for connecting upto main/sub-main cable trays (branch cable tray within the battery limit) starting from field sensors/devices in Bidder's scope.
- 3.4.32 Redundant communication with the refinery DCS (other's supply) shall be considered. The mode of communication shall be shared during detail engineering. Bidder shall consider two number (2) Ethernet communication modules (in the technical scope) and approx. 2 kms fibre optic cables along with cable trays for the same.
- 3.4.33 Maintenance and erection tools and tackles
- 3.4.34 Essential spares
- 3.4.35 Inspection and testing for I&C system equipment
- 3.4.36 CONSUMABLES: All consumables required for Operation and Maintenance of the plant .
- 3.4.37 Erection, Field Testing And Commissioning: The Bidder's scope includes Erection, pre-commissioning checks, testing, calibration and commissioning of all Instrumentation and Control system equipment for the complete power plant supplied under this contract to the complete satisfaction of the Owner. The scope includes provision of all necessary erection materials, consumables, tools and tackles, provision of calibration/testing equipment required for erection/testing/commissioning and handing over the same to Owner after completion of erection/testing/commissioning. Contractor's scope of work will also include any additional instruments supplied by other contractors/Owner which is required for proper & satisfactory performance of the power plant (subject to mutual agreement with Owner regarding cost implication).
- 3.4.38 Engineering Documentation.
- 3.4.39 O & M manuals

3.4.40 Training Of Purchaser's Personnel

3.5 CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

The scope of work consists of design, preparation of detailed drawings and documents for all structural steel building / structures, preparation of GA drawings & layout drawings under the scope of contract in the BTG island area excluding chimney.

Supply, Fabrication & Erection of the technological structures like EOT Crane for TG, other crane & hoists for BTG auxiliaries, Boiler, ESP, Duct and Duct supports etc. shall be in the Bidder's scope. Detail scope of work has been described in the chapter no. 8.

3.6 SITE SUPERVISION AND CONSTRUCTION

- 4.6.1 All handling equipment and cranes
- 4.6.2 All construction equipment
- 4.6.3 All skilled and unskilled labours
- 4.6.4 All site supervision, planning, management, construction, technicians, engineering staff and specialist staff
- 4.6.5 Safety equipment, procedures, training, supervision and incidence reporting
- 4.6.6 Site security
- 4.6.7 Unloading and storage areas
- 4.6.8 Sanitary waste management
- 4.6.9 Sub-Contractor supervision
- 4.6.10 Construction consumables
- 4.6.11 Erection checking
- 4.6.12 Progress reporting
- 4.6.13 Construction Power connection and distribution
- 4.6.14 Construction Water
- 4.6.15 Construction lighting
- 4.6.16 Telephone and communication systems

3.7 TERMINAL POINTS

The Terminal Points for the main plant are as indicated in the table below. Unless indicated otherwise, the Bidder shall have the responsibility for the final connection of the facility at each of the Terminal Point.

TP. No.	Particular	Terminal Points
	<u>Mechanical</u>	
7.1.1	Fuel	At the inlet of fuel bunker
7.1.2	Limestone	At the inlet of limestone bunker
7.1.3	Bed Material	At the inlet of bed material bunker
7.1.4	Fuel Oil	At fuel oil unloading tanker outlet connection. Minimum 10 m connection hose (with end connection) shall be provided by bidder at unloading tanker outlet.
7.1.5	Bed Ash	At the bed ash cooler outlet flange including knife gate valve (KGV).
7.1.6	Fly Ash	Outlet flange of FA Hoppers with isolation valve (knife gate valve at the outlet of ESP hopper & plate gate valve for other hoppers)
7.1.7	MP Process Steam	At CGPP boundary
7.1.8	LP Process Steam	At CGPP boundary
7.1.9	Make up water	at level control station of each make up water storage tank
7.1.10	Return Condensate	At 4 nos of pipelines at a single area of CGPP boundary
7.1.11	Instrument Air & service Air	At STG building respective air receiver tanks
7.1.12	Condenser cooling Water	Supply and discharge CW water piping upto 1.5 meters beyond first row columns of TG building at each condenser
7.1.13	DM cooling water for auxiliary equipment	Supply line: At one point (6 m away) near each boiler front row column. Return line: At one point (6 m away) near each boiler front row column.

TP. No.	Particular	Terminal Points
7.1.14	Service Water	At one point (6 m away) near each boiler front row column.
7.1.15	CBD & IBD drains	At nearest drain trench
7.1.16	Vents	One meter above the boiler house/ main plant building roof level
7.1.17	Waste water	Waste water- To nearest trench of plant drain drain system Oils,chemicals- At one point
7.1.18	Construction water supply	At one point inside the plant near construction area
7.1.19	Construction Power Supply	Tap off from existing 6.6 kV switchgear system
	<u>Electrical</u>	
7.1.20	Power Evacuation	Interconnection of 11kV Busduct to Generator Transformer.
7.1.21	Aux. Power system	Interconnection of 6.6kV Power Cable to Unit and Station Transformer.
7.1.22	Earthing system	Interconnection of BTG complete earthing system with the other package and switchyard earthing system.
7.1.23	Cable Tray System	Interconnection of BTG Package scope of cable tray with station cable tray system.
7.1.24	Station Power system	At outgoing terminal of 6.6kV Breaker of Station Switch board.
	<u>Control & Instrumentation</u>	
7.1.25	Instrumentation and control cables between MCC/Switchgear/ Starter panel and Cabinets/Panels	Terminal Point-At bidder's cabinets/Panels Except for the equipment/drives for which the MCC/Switchgear/Starter Panel are by others.
7.1.26	Instrumentation and control cables including special cables between Bidder supplied Systems & DCS	Terminal Point-At bidder's control system cabinets/Panels For equipment in bidders' scope which are controlled from DCS (by Bidder), all cables I&C /special cables etc upto control system are in bidders' s scope. Including corresponding cables, cable trays, conduits, etc

TP. No.	Particular	Terminal Points
7.1.27	Equipment's/Systems (by others) to be controlled by DCS	From Field termination cabinets by Cooling Tower vendor to Bidder's DCS. Including corresponding cables, cable trays, conduits, etc.
7.1.28	Communication between control system (microprocessor based/PLC) (by others) and bidder's DCS. Hardwired Signal between control system (by others) and bidder's DCS.	Terminal Point- Control system cabinet (by others) All corresponding cables, cable trays, conduits, etc.in Bidders scope
7.1.29	Time Synchronisation signals from Master Clock (by Bidder) to Control Systems by others as defined in, Annexure-1.	Terminal Point- At bidder's Master clock cabinet Bidder shall provide Time Synchronisation Signal (redundant) for each control system Microprocessor based). Accordingly, redundant receiver & cables to be considered by others. Type of signal required by other control systems shall be confirmed during detail engineering.
7.1.30	Bulk power supply feeders of UPS (redundant) & Non-UPS Supply (240 VAC 50 Hz)	PDB at one point. Including corresponding cables, cable trays, conduits, etc.

Notes:

- At all terminal points, whether at equipment or on pipelines, it is the BIDDER's responsibility to supply all the necessary jointing materials/gaskets and make the final connection at all terminal points.
- All necessary isolation valves / orifices / blind flanges for tap-off and interconnection points, as deemed necessary, shall be in BIDDER's scope.
- Exact position/elevation/location of terminal points shall be studied by BIDDER as per the proposed scheme & design by visiting site and indicate in the bid which subject to OWNER's acceptance.
- BIDDER to indicate the Instrument air and service air quantity / quality and pressure requirement at the terminal point.

3.8 EXCLUSIONS

The following equipment and services are excluded from EPC Bidder's scope of work and to be provided by the Owner:

- Land for setting up the unit

- (b) Supply of fuel, limestone, sand/bed material, startup oil
- (c) Firefighting system
- (d) Instrument air & service air compressors
- (e) Ash handling system beyond terminal points
- (f) Supply, Fabrication & Erection of all the structural works including foundation and associated RCC works for the TG Building, Service Building, Switchyard control building, ESP Control room buildings, Pipe & cable racks, Miscellaneous buildings etc. within the BTG island.
- (g) Design Engineering for foundations for all the structures / buildings, equipment etc. and other associated RCC work in the BTG area
- (h) Soil Investigation
- (i) Topographical Survey
- (j) Site Grading
- (k) Workshop and workshop equipment
- (l) Weigh bridge
- (m) Storm water runoff pond
- (n) Laboratory equipment & furniture
- (o) Generator Transformer, Unit Transformer and Station Transformer.
- (p) Fire Detection and alarm System.
- (q) Intercom and Public Address System
- (r) Station Power And Control Cable and cable tray.
- (s) Station illumination system
- (t) Supply and installation of Turbo Ventilator.

CHAPTER-4

GENERAL REQUIREMENTS

4.0 GENERAL REQUIREMENTS

4.1 LAYOUT & MAINTENANCE REQUIREMENTS

LAYOUT REQUIREMENTS

- General plot plan indicating the available area for the project and STG building general arrangement drawing are shown in the Attachment 2: Preliminary plot plan (Drawing No.

TCE.13833A-ME-MP-6001). The plot plan identifies the relative locations of various facilities within the plot. Bidder shall furnish their proposed main plant area layout along with the bid. All general arrangement and layout drawings shall be dimensioned in millimeters and generally drawn to scale in accordance with Good Industry Practices.

- Plot plan and detailed design of the plant shall meet all the requirements and norms of statutory authorities, electrical inspector, MOEF, local government/municipal authorities. IBR, Factory inspector, Fire inspector, Chief controller of explosives, Safety distance between various facilities and buildings and any other requirements under which the project comes under the purview.
- Bidder shall also ensure and provide the requirements of transportation, construction, erection, maintenance requirements and functional requirements while preparation of the plot plan. Adequate area and suitable hoists / trolleys shall be considered to facilitate maintenance.
- In order to prevent any vibration from the steam turbine generating sets from being transmitted to the turbine building and other equipment located inside the building, the turbo set shall be founded on an independent pedestal, isolated from all other foundations and superstructure by adequate clearances all around.
- All heavy equipment and heavy rotating machinery in particular as far as possible, should be located on ground floor. Their foundations should be clear of column foundations since such an arrangement will avoid vibrations being transmitted to the building from the rotating machinery.
- Free space for the rotor withdrawal, condenser tube removal and other areas reserved for such erection or maintenance activities shall be clearly identified in the drawing.
- All skids housing mechanical equipment shall be provided with a clear space of at least 1000 mm for proper operation and maintenance.
- As far as possible, equipment layout should follow the logic and sequence of the flow process. This will result in simple and convenient piping layouts. When flow takes place essentially by gravity, receiver vessels should be placed at a lower elevation than the source vessel.
- Adequate consideration should be given to the prevention and containment of fire. Necessary access shall be provided for the entry of firefighting personnel in the event of a fire break-out and also for the safe exit of operating personnel.
- Adequate ventilation and safety aspects should be considered while developing the layout of equipment handling explosive, hazardous, or toxic substances.
- When the noise generated by equipment and machinery is expected to be in excess of recommended limits specified, such machinery should be provided with acoustic hoods or isolated from general working area by locating inside a walled room.

- The arrangement of duct work shall be as required for various equipment/system design and to secure accessibility and maximum space utilization.
- The layout of piping shall ensure that all valves are located so as to be conveniently accessible. The overhead piping shall have a minimum working clearance of 2.1m over all walkways and working areas (even after considering movement of piping) and 7 metres above roadways unless otherwise approved by the Owner/Owner's Engineer. All valves, 100 NB and above shall have a clear approach space of 1m to facilitate its operation and maintenance.

All accessible areas shall be provided with minimum clear headroom as follows, unless otherwise specified:

Finished floors to ceiling (buildings)	: 3000 mm
Doors, Walkways, Platforms, Stairs etc.	: 2100 mm
False ceiling of office areas	: 2400 mm
Safety cage for ladders	: 2500 mm
Access for forklift trucks	: 2800 mm
Main roads/Railway crossings & crane access	: 9000 mm
Other plant roads and truck access	: 6000 mm
Cable & Pipe rack	: 3000 mm

(Except Road/Rail crossings)

- All piping shall be grouped wherever practicable and shall be routed to present a neat appearance. Drains shall be provided at all low points and vents at high points as per actual layout.
- All necessary auxiliary platforms and access stairways ladders for operation and maintenance of equipment, piping, valves, instruments, etc., shall be provided by the Bidder.
- One (1) no. passenger elevator of 800 kg for TG building and One (1) no. of 1500 kg capacity passenger-cum-goods elevator common for boiler area shall be considered.
- In case where two isolation valves are provided, one valve shall be near the tap off and the second valve at an accessible location. If any of the valves are not accessible, suitable access platform shall be provided by the Bidder. Necessary walkways with a minimum 1000 mm wide shall be provided.
- Pipe trenches for essential systems like condensate suction piping may be provided. If trench is provided, access to pump suction strainers and expansion joint shall be ensured and the trench width shall be adequate to enable assembly and disassembly of flange joints. While finalising the trenches, a minimum space of 300 mm shall be provided from the outer face of pipe. Clear space of 150 mm shall be provided below the pipe support for easy drainage. All trenches will be constructed with gentle slope in the bottom and with interconnected drains

leading to drain pit(s) of adequate capacity to ensure that water does not remain trapped in trenches. Proper pumping arrangement shall be provided for removing water from the drain pit(s).

- Unit control desk and I&C system cabinets shall be located in the control room. All the cabinets shall have the same height, depth and colour.
- Batteries shall be located in separate rooms. The battery charger and UPS equipment shall be located adjacent to battery room. The battery room shall have space provision for sink and accessory storage. Battery room shall be naturally ventilated with exhaust fans.
- Acid protection linings, platforms for the batteries, cable entry space & cross ventilations shall be provided in Battery Room.
- All electrical panel rooms of Sub-Station at least two (2) nos. fireproof doors of two (2) hours fire rating shall be considered.
- Access to the rooms and doors provided in various floors shall consider movement of panels during erection and also later for maintenance/ replacement. Monorail for panel lifting to be consider by BIDDER.
- The layout shall meet all the statutory requirements, relevant international standard / Loss Prevention Association (LPA) regulations and Boiler, Factory and Electrical Inspectorate requirements.
- The layout of the switchgears/PMCC/MCC/DB shall consider the following aspects:
 - a) Adequate space for movement of personnel with breaker/modules withdrawn.
 - b) Adequate movement & operation space around.
 - c) Separate maintenance space.
 - d) Space for cable trenches / racks. All the cable shall be laid in trench / racks only.
 - e) Minimum statutory clearance requirements.
 - f) Space for additional panels that may arise during engineering and O&M.
- Following shall be considered as minimum spacing for various switchboards (electrical panels)

(a)	6.6 kV switchgear facing 415V PCC/MCC/DB	2500 mm (min)
(b)	Two 415 V PMCC/MCC/UPSDB and other 415V Switchboards facing each other	2000 mm (main switchboard), 1500 mm (battery chargers, LDB, UPS, etc.)
(c)	415V LV PCC/MCC/DB or panel front facing the wall	2000 mm (main switchboard), 1500mm (battery chargers, LDB, UPS, etc.)
(d)	415 V PMCC/MCC/UPSDB and other 415V Switchboards back side to the obstructions like column, raceways, walls if single front	1000 mm or door opening space plus personnel movement whichever is higher

(e)	Space between the sides of two switchboard panels or switchboard panels and the wall.	1000 mm
(f)	From top of switchboard / panels to nearest obstruction	800 mm (min).
(g)	Between battery banks and battery bank to any obstruction / wall.	2000 mm

- Inserts on ceiling shall be provided for cable tray support work / electrical lighting fittings fixing for all constructed Area.
- Insulation mats to be consider by BIDDER in front of all Electrical panels.
- Arc flash study with boundary marking.
- Layout of transformer Yard/Bay shall be prepared considering the NFPA requirements. It shall consist of fire walls, covering shed, oil soak pit of adequate capacity, chain link fencing, gates etc. Transformer shall have all around free space of 1.25m(Min.).
- Electronic grounding shall be separate from station electrical grounding.
- Necessary platforms shall be provided for mounting and accessing the transmitter racks.
- All I&C equipment being supplied by the Bidder shall be supported adequately to prevent vibration and anchored sufficiently to prevent undue strains on the equipment served.
- Local panels shall be mounted near the equipment.
- Straight length requirement before and after control valves, flow element and de-superheater shall be provided as per latest applicable standards.
- All local control rooms housing PLC / DCS panel rooms shall be provided with false flooring & false ceiling so as enable bottom cable entry.
- Any specific recommendation regarding PLC, Analysers, etc. shall be taken care as per OEM's requirements.

4.2 MAINTENANCE REQUIREMENTS

- The Bidder shall provide facilities for carrying out on-load and off-load maintenance and should include adequate handling equipment, working space, platforms and safety devices.
- In order to carry out on-load maintenance, necessary arrangement for cooling the equipment and quick access shall be ensured.
- Access and cleanout doors shall be provided to permit access to the furnace, superheater, economiser, air-heater and any other areas requiring access.

- The operating/maintenance platforms around the furnace and equipment shall be very close to the furnace/equipment casing and the clear gap shall not exceed 150 mm between edge and furnace/equipment casings.
- Maintenance/access platforms for coal feeders, steam, water and oil piping and fittings and for dampers on air and flue gas ducts shall be provided.
- Material handling equipment consisting of monorails, cranes, hoists and trolleys with all other ancillaries including supporting structure as required, shall be provided as required for all areas for the maintenance of the equipment provided under this specification.
- For equipment, which weighs above two ton or lift more than 10m, electrically operated hoists with trolleys would be provided. For equipment weighing less than two ton or lift less than 10m, manually operated hoists and trolleys would be provided. All blowers/fans/motors, gear boxes, etc. shall be provided with hoists and trolleys for maintenance purposes.
- One set of all special tools and tackles shall be furnished and shipped with each piece of equipment for dismantling, maintenance, adjustment, and calibration of the equipment. The tools shall be shipped separately.
- Necessary mobile maintenance and access ladders shall be provided for access to roof of buildings not provided with staircase or for maintenance of inaccessible equipment (for e.g. light fittings)
- Ramps having a slope of 1:8 shall be provided in front of all doors provided with rolling shutters.
- The I&C system should be designed with extensive self-diagnostics and troubleshooting features. Facilities shall be provided for quick repair/maintenance and on-line replacement of faulty modules.
- Standardization concept shall be used in setting the components for the systems.

4.3 ERECTION REQUIREMENTS & SITE SERVICES

4.3.1 General

- Bidder shall be responsible for transporting the equipment from his/his sub-vendor's works to site. The Bidder shall also be responsible for unloading from carriers at site, unpacking, inspection of inventory including checking against invoices, repacking where required, submitting shortages/damages reports, equipment storage and erection insurance, lodging insurance claims against losses/damages etc.
- Providing storage of closed/semi-closed/open type for proper storage and maintenance of plant and equipment is the responsibility of the Bidder. The Bidder shall indicate his requirements of closed/ semi-closed/open storage areas in his Bid. He shall also indicate the space requirements for office, construction, fabrication & lay-down area and canteen in their offer.

- Transportation of materials to Bidder's stores and transportation of the same to erection site is in the scope of the Bidder.
- The Bidder shall submit well in advance, his schemes for movement, lifting and handling of heavy equipment / components indicating also the tools, tackles and equipment they proposes to employ for the same, for approval by the Owner/Owner's Engineer prior to actual undertaking of such works.
- Bidder shall carry out proper erection of all equipment under this contract including grouting of foundation bolts, base plates, embedded plates, pipe sleeves etc., touch up and finish painting as well as anticorrosive protection painting as specified and as required, including the supply of necessary paint of approved quality and colour.
- The works such as disassembly, cleaning and reassembly of equipment, where required, are covered in the Bidder's scope of work.
- The Bidder shall, at all times, keep the workplace and storage areas clean and free of loose or combustible materials and waste materials. Bidder shall provide adequate firefighting facilities and take necessary precautions. All waste/debris collected during work shall be removed promptly and site shall be handed over to the Owner in a clean and tidy condition on completion of work. The security and safety are the sole responsibility of the Bidder.
- Supply of adequate quantity of consumables required for the job, viz., welding electrodes, drill bits, tapes, scaffolding, welding gas, oil, grease, lubricants, cotton waste, etc. Up to handing over shall be in the scope of the Bidder.
- Supply and initial filling of various lubricants shall be arranged by the Bidder.
- The Bidder shall furnish all necessary approved / calibrated / tested erection tools, rigging, scaffolding, bending, framing, cutting, welding, stress relieving and testing equipment needed for the complete erection and testing including the services of all qualified and experienced personnel.
- All temporary piping, fittings, strainers, valves, dummy plates, spool pieces and other accessories required for cleaning, flushing, steam blowout and testing of the pipelines, valves and equipment shall be supplied by the Bidder. It shall also be the Bidder's responsibility to arrange for all pumps, tanks, instruments and other accessories that would be required for cleaning, flushing and testing operations. Bidder shall also supply the necessary hanger and support systems required for all temporary pipe work. After completion of these operations, the Bidder shall dismantle all temporary pipe works and restore the pipe work to the original design conditions.
- Work will involve preparation of certain hangers and supports for field run piping. All auxiliary steel brackets required for locating the hangers, will be prepared and installed by the Bidder. Hangers for pressure parts shall be tested with torsion wrench for even load distribution. The hot and cold settings of hangers shall be checked and recorded and any readjustments as required shall be done by the Bidder. Hanger rows shall be site-welded.

- All piping systems together with valves, specialities and instrument impulse piping up to instruments shall be internally cleaned and flushed by the Bidder after erection in a manner suited to the intended services.
- All impulse lines of joints shall be of Argonic welded type for steam services and high pressure services. For low pressure services like Service & Potable water and compressed air the same shall be threaded type. All threaded joints of the orifices shall be seal welded after the testing.
- Pipes installed but not connected, shall have ends closed with taps or plugs to prevent the entry of foreign material. All reasonable precautions shall be taken to prevent the entry of foreign materials in pipelines before and during erection. All drain points, after installation shall be sealed with caps.
- All instruments impulse pipe fittings and accessories, clamps, supports, stands (racks) required for installation and erection of instruments and their accessories shall be painted and meet approved painting specification.
- Erection and testing including calibration and commissioning of all instruments and control equipment supplied under this contract shall be executed by the Bidder. Hardware's required for erection of all instruments and control equipment covered under this contract shall be supplied by the Bidder
- Bidder shall provide temporary fencing for isolation of construction area, lighting, lightning, guarding, safety & security of persons & property at site, temporary roads, drains, firefighting equipment, waste disposal facilities, sanitary facilities and all other facilities for construction, commissioning & testing.
- Arranging for statutory inspections and clearances, as required shall be arranged by the Bidder and original certificates shall be furnished for Owner's record.
- Bidder shall set all spring hangers to the required loads and record all hanger settings and furnish the same to Owner for approval.
- Approach ways and platforms for maintenance shall be provided.
- The Bidder shall get prior approval of the Owner/ Owner's Engineer before any installation work starts. If any work is carried out by the Bidder before prior approval from Owner/ Owner's Engineer and modification is sought by Owner/Owner's Engineer later, then the work will be redone by the Bidder without any cost/material implications to the Owner/ Owner's Engineer.

4.3.2 Safety Requirements

- Refer Attachment-12 for General Safety Guidelines of HIL
- Refer Attachment-13 for Electrical Safety Guidelines of HIL

4.3.3 Tools & Tackles

- The Bidder shall furnish a comprehensive list of erection tools and tackles.
- If, in the opinion of the Owner/Owner's Engineer, the tools, tackles, construction equipment and aids provided by the Bidder are not adequate, the Bidder shall suitably augment the same as directed by the Owner/ Owner's Engineer. In the event of non-compliance by the Bidder, the Owner reserves the right to augment such facilities and back charge the Bidder all expenses incurred in this connection including the Owner's overheads.
- The Owner may require Bidder's equipment for use on hire basis. The hire charges for the Bidder's equipment shall be all inclusive, including the cost of consumables, operator's services, depreciation, wear and tear as well as the Bidder's overheads and profits. These rates will be payable by the Owner to the Bidder only if the Owner requires the use of these equipment for carrying out his own work outside the scope of this contract.

4.3.4 Coordination with Sub-Vendors

- Coordination with sub-vendors under this contract is the responsibility of Bidder. Owner / Owner's Engineer shall also reserve the right to coordinate with sub-vendor directly or through Bidder as required by them based on their discretion.

4.4 PAINTING & COATING REQUIREMENTS

Painting requirements of the equipment, structures, piping etc. present in the power plant are covered here . The painting system should ensure optimal protection of the installation with minimum need for maintenance, environmentally friendly & easy to apply. Statutory and Local regulations shall be strictly followed in selection and application of paint.

4.4.1 General

- a) All paints & paint material used shall be procured from approved manufacturers and applied as per their coating system data sheet.
- b) In general shop fabricated equipment will be delivered to the site coated with a shop applied system or the manufacturer's standard finish in accordance with the requirements of this specification.
- c) Necessary precautions shall be provided to all equipment, structures to protect other surfaces from abrasive blasting, coating over spray and spatter.
- d) The Contractor shall submit the recommended painting for the project, procedure for its application, for review and approval by the Customer. Contractor shall maintain proper painting records. Disposal of painting waste shall comply with applicable laws, regulations. Necessary safety precautions shall be implemented.

4.4.2 Paint Application

- a) Paints and other coating materials shall be applied in accordance with the paint manufacturer's instructions. A smooth uniform film shall be applied to the surfaces to be coated. Local regulations regarding spray and roller coating shall be observed.
- b) Painting shall be performed only when the appropriate conditions are prevailing viz, on surface temperature, relative humidity of the air etc. The measurement of these conditions is the responsibility of the Bidder.
- c) Handling & packing of painted material shall be appropriate to avoid damage to painting, such as the use of non-metallic slings, etc for handling and by minimizing handling after painting.
- d) All steel equipment shall be provided with priming or coating system to protect the steel surface during transport, storage, installation and construction. Appropriate method of applications viz, spray , brush , roller shall be adopted. Suitable coating materials shall be applied only after proper evaluation on aspects like its suitability for the intended purpose, corrosion protection, health & safety requirements etc.
- e) Coating systems are tabulated in ANNEXURE-PAINT and shall be pre-qualified in accordance with specification.
- f) Corrosivity of Environments

Corrosivity category		Mass loss per unit surface (per year of exposure)	
		Mass loss g/mm ²	Thickness loss μm
C2	Low	>10 to 100	>1.30 to 25
C3	Medium	200-400 g/m ²	(25-50μm)
C4	High	400-650 g/m ²	(50-80μm)
C5	Very High Industrial & marine	650-1500g/m ²	(80-200μm)

- g) PERFORMANCE TEST OF PAINT

SL. No.	TEST	ASTM TEST METHOD
1.	Abrasion Resistance: (topcoat only)	D4060
2.	Adhesion:	D4541
3.	Dry Heat Resistance:	D2485
4.	Flexibility: (topcoat only)	D522, 180° bend
5.	Pencil Hardness: (topcoat only)	D3363
6.	Salt Fog Resistance:	B117, 1000 hours
7.	Weather Resistance:	G23 Type D
8.	Density	D1475
9.	Dipping properties	D823
10.	Drying time	D1640
11.	Hardness	D3363
12.	DFT/Coat	As per SSPC Guidelines
13.	Storage Stability	D1849

SL. No.	TEST	ASTM TEST METHOD
14.	Resistance to	
	i) Humidity for 2000 hrs.	D2247
	ii) Salt Spray for 2000 hrs.	B117
	iii) Accelerated Weathering	D822

4.4.3 HEALTH AND SAFETY

- (a) All paints contain harmful or toxic components of various degrees. Exposure to concentrations above the maximum allowable limits shall be avoided. The storage, the method of application and the working conditions significantly affect the degree of toxicity of paints and varnishes.
- (b) Personnel shall be prohibited from eating, drinking and smoking at the workplace.
- (c) Wearing of personal protection clothing (gloves, helmet, screen, safety shoes, working clothes) shall be compulsory.
- (d) Efficient ventilation systems shall be designed and installed so that the atmosphere of the work place continuously remains healthy and the toxic and dangerous products are collected and discharged.
- (e) Disposal of painting waste resulting from painting, shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertains to the work and coating materials.
- (f) Health and Safety rules in effect on site or in the production unit shall be strictly followed by the Contractor's and/or its sub-contractor's personnel.

4.4.4 Inspection

- (a) Inspection will be performed by an inspector authorised by Purchaser / Engineer. The painting work shall be subjected to inspection by purchaser / engineer at all times. The vendor shall offer stage inspection on surface preparation, primer application, subsequent coats and paint qualification test.
- (b) Vendor shall provide the expert technical services of the paint manufactures as and when required by purchaser / engineer to ensure both the surface preparation and applications are carried out as per their recommendations.

4.4.5 Suggested Colour Codes for Painting

Colours for various equipment in power plant shall be as per IS-5. Vendor shall obtain written consent from the Purchaser on colours to be applied prior to its application.

ANNEXURE - PAINT

A. Painting scheme for C2 and C3 environment

Sl no	Description	Surface Preparation	Primer		Intermediate paint		Finish coat		Total DFT Min
			paint	no of coats	paint	no of coats	paint	no of coats	
1	Boiler Structure, uninsulated ducts, suspensions, hangers temperature < 120 °C	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	120µ	280µ
2	Indoor Structure	Sa 2 ½	HB Zn Phosphate	2	80 µ	HB MIO epoxy	1	120µ	200µ
3	Insulated parts exposed to temp > 120 °C	Sa 2 ½	In organic Zn silicate	2	60 µ				60 µ
4	Work Shop	Sa 2 ½	HB Zn Phosphate	2	80 µ	HB MIO epoxy	1	120µ	200µ
5	Water Treatment Plant (external)	Sa 2 ½	Zn rich epoxy	2	80µ	HB MIO epoxy	2	200µ	360µ
6	Coal Handling Plant	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	120µ	280µ
7	Fuel pipings	Sa 2	Ethyl Zn silicate	1	40µ				80 µ
8	Un insulated silencer/steel stacks > 120 °C	Sa 2 ½	Ethyl Zn silicate	1	40µ				80 µ
9	Above Ground piping	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	120µ	280µ
10	Buried Piping (External)	Sa 2 ½	Coal tar primer, coal tar enamel, inner wrap of fibre glass, final outer wrap of enamel impregnated fibre						4.0 mm
11	Buried Piping (Internal)	Sa 2 ½							500µ
12	storage Tanks External	Sa 2 ½	In organic Zn silicate	2	80 µ	HB MIO epoxy	1	120µ	280µ
13	storage tanks Internal	Sa 2 ½							400µ
14	DM water piping internal	Sa 2 ½							4.0 mm
15	DM water tank internal	Sa 2 ½	In organic Zn silicate	2	80 µ	HB coal tar epoxy	1	150µ	380µ
16	Fuel Oil Tanks internal	Sa 2 ½	In organic Zn silicate	2	80 µ	HB coal tar epoxy	1	150µ	380µ
17	Insulated parts continuously exposed to condensing water	Sa 2 ½	In organic Zn silicate	2	75 µ				75 µ
18	For insulated piping < 125 °C	Sa 2 ½	Polyamide cured epoxy coating	2	250 µ				250 µ
19	Electrical parts, control panels, valves, pumps & motors (indoor)*	Sa 2 ½	Zn phosphate epoxy	2	80 µ				160µ
20	Electrical parts, control panels, valves, pumps & motors (outdoor)*	Sa 2 ½	Zn phosphate epoxy	2	80 µ				180µ
21	Switch Yard, floor grills, walk ways	Sa 2 ½							80µ

* Note: Manufacturer to specify details of painting system capable of withstanding environmental conditions for a period of 10 years before first maintenance

A. Painting scheme for C4 and C5 environment

Sl no	Description	Surface Preparation	Primer		Intermediate paint		Finish coat		Total DFT
			paint	no of coats	paint	no of coats	paint	no of coats	
1	Boiler Structure, uninsulated ducts, suspensions, hangers temperature < 120 °C	Sa 2 ½	HB Zn Phosphate	2	HB MIO epoxy	2	epoxy PU HB	2	360µ
2	Indoor Structure	Sa 2 ½	HB Zn Phosphate	2	HB MIO epoxy	1	poly urethane	2	260µ
3	Insulated parts exposed to temp > 120 °C	Sa 2 ½	In organic Zn silicate	2					60 µ
4	Work Shop	Sa 2 ½	HB Zn Phosphate	2	HB MIO epoxy	1	poly urethane	2	260µ
5	Water Treatment Plant (external)	Sa 2 ½	Zn rich epoxy	2	HB MIO epoxy	2	epoxy PU HB	2	360µ
6	Coal Handling Plant	Sa 2 ½	HB Zn Phosphate	2	HB MIO epoxy	2	poly urethane	2	340µ
7	Coal Fuel pipings	Sa 2	Ethyl Zn silicate	1			HR aluminium paint	2	80 µ
8	Un insulated silencer, steel stacks > 120 °C	Sa 2 ½	Ethyl Zn silicate	1			HR silicone aluminium paint	2	80 µ
9	Above Ground piping	Sa 2 ½	In organic Zn silicate	2	HB MIO epoxy	1	poly urethane	2	260µ
10	Buried Piping (External)	Sa 2 ½	Coal tar primer, coal tar enamel, inner wrap of fibre glass, final outer wrap of enamel						4.0mm
11	Buried Piping (Internal)	Sa 2 ½	solid rigid poly urethane 500µ						500µ
12	storage Tanks External	Sa 2 ½	In organic Zn silicate	2	HB MIO epoxy	2	poly urethane	2	340µ
13	storage tanks Internal	Sa 2 ½			3 coats of amine adducts				400µ
14	DM water piping internal	Sa 2 ½			hard rubber lining min 4 mm thickness				4.0 mm
15	DM water tank internal	Sa 2 ½	In organic Zn silicate	2	HB coal tar epoxy	1	HB coal tar epoxy	1	380µ
16	Fuel Oil Tanks Internal	Sa 2 ½	In organic Zn silicate	2	HB coal tar epoxy	1	HB coal tar epoxy	1	380µ
17	Insulated parts continuously exposed to condensing water	Sa 2 ½	In organic Zn silicate	2					75 µ
18	For insulated piping < 125 °C	Sa 2 ½	Polyamide cured epoxy coating	2					250 µ
19	Electrical parts, control panels, valves, pumps & motors (indoor)*	Sa 2 ½	Zn phosphate epoxy	2			Chlorinated rubber	2	160µ
20	Electrical parts, control panels, valves, pumps & motors (outdoor)*	Sa 2 ½	Zn phosphate epoxy	2			Chlorinated rubber	2	180µ
21	Switch Yard, floor grills, walk ways	Sa 2 ½			hot dip galvanising coating Wt.610 gms/M ² (coating thickness of 80 µ)				80µ

* Note: Manufacturer to specify details of painting system capable of withstanding environmental conditions for a period of 10 years before first maintenance

4.5 SPARES, SPECIAL TOOLS & TACKLES

Spares for the total plant shall be divided into two categories namely, a) Start-up and Commissioning Spares; b) Recommended Spares. All spares supplied under this contract shall be strictly interchangeable with the parts for

which they are intended to be replacements. The spares shall be treated and packed for long storage under climatic conditions prevailing at the site.

Start-up and Commissioning Spares

- Start-up and Commissioning spares are those which would be required during plant or equipment testing, start-up and commissioning. All spares used until the plant is finally handed over by the Bidder to the Owner come under this category. All start-up and commissioning spares as required shall be provided by the Bidder without any additional cost to the Owner.
- Bidder shall be responsible for the ready and timely availability for all the start-up and commissioning spares as required during various stages of testing, cleaning and commissioning up to handing over of the total plant.
- An adequate stock of start-up spares shall be available at the site such that the start-up and commissioning of the equipment/systems, performance testing and handing over the equipment/ systems to the Owner will be carried out without hindrance and delay.

Recommended Spares

- In addition to the spares mentioned above, the Bidder shall also furnish recommended list of operation & maintenance spares parts with unit prices other than the mandatory spare part as listed in Attachment-8. These spares shall be those considered necessary by the original equipment manufacturer for two (2) years trouble-free operation. The unit price of each spares shall be indicated separately and shall not be included in the quoted base price. The price indicated for the recommended spares shall not be considered for the purpose of evaluation.
- The Owner reserves the right to buy any of the spare parts as considered necessary.
- Bidder shall indicate the service expectancy periods for all the spare parts in terms of hours of operation under normal operating conditions after which replacement will become necessary.
- The price of the operation & maintenance spares shall be kept firm up to twenty four (24) months from the expiry of the validity of the offer. Purchase of these spare parts will be covered by a separate order or an amendment to the contract.

Special Tools and Tackles

- The Bidder shall include all necessary special tools & tackles required for maintenance of the plant being supplied. A comprehensive list of special tools and tackles is to be furnished in the bid. Total price of all these tools and tackles shall be included in the quoted lump sum price. The price furnished by the Bidder shall be considered for the purpose of evaluation.
- The Bidder shall supply under this contract all tools for each piece of equipment / system and it shall be boxed separately, and the boxes shall be appropriately marked for shipment and identification of contents. A weather-proof itemised list of the contents shall also be attached to the outside of each container.

- Bidder shall note that if any other tools and tackles are found to be necessary during engineering or erection, testing, commissioning up to take-over of plant and same is not specifically not included in the list of Special Maintenance Tools and Tackles submitted in the bid, the same will be deemed to have been already included by the Bidder in his scope and no price implication due to same would be accepted.
- Special maintenance and tools and tackles like module puller, optic fibre cable splicer, optic fibre cable tester, etc., as required for the I&C equipment shall be included in Bidder's scope. These tools shall also include necessary Testing equipment to facilitate ease of maintenance.

4.6 QUALITY ASSURANCE & CONTROL

The minimum Quality Assurance / Quality Control (QA/QC) requirements and the services the Bidder is expected to provide to assure 'Quality Assurance' are described in this section. 'Quality Assurance' is defined as the entire programme adopted by the Bidder during engineering, manufacture, procurement, construction and commissioning to assure conformity with the contract specifications and relevant codes and standards indicated in the specifications. Quality Assurance/Quality Control procedures followed by the Bidder shall address the QA/QC requirements during the following phases of the project:

- a. Engineering
- b. Procurement
- c. Construction including testing and commissioning.

Bidder shall submit documents to demonstrate that the Bidder and his sub-vendors possess, QA/QC procedures meeting the requirements set forth in this section. Bidder shall submit the quality assurance plans for all other equipments under this contract along with his bid. These quality plans and reference documents/standards etc. shall be subject to Owner's approval without which manufacture shall not proceed. In the approved Quality Plans, the Owner/Owner's Engineer shall identify the Customer Hold Points. A Customer Hold Point signifies a stage in any item of work which requires documented proof of approval based on tests/checks which shall be carried out in presence of the Owner or his Owner's Engineer and beyond which the work shall not proceed without consent of the Owner/Owner's Engineer in writing.

4.2 Engineering

The Bidder shall prepare and submit a project Quality Assurance Procedure that covers the engineering phase of the Works. The procedure shall be designed for this project and shall address the specifics of how the Bidder will control, monitor and verify the requirements contained in this section. The Bidder shall utilise all of his QA/QC resources, manuals and procedures when preparing the plan. Owner / Owner's Engineer will review the plan prior to utilization and upon issue the plan will become the basis by which Owner / Owner's Engineer will evaluate the Bidder's engineering QA/QC activities as they relate to this project.

Owner / Owner's Engineer Participation

The Owner / Owner's Engineer reserves the right to audit and verify procedures set forth in the Engineering Quality Plan. This audit right in no way relieves the Bidder from performing the control verification procedures outlined in the plan.

Engineering Quality Assurance and Quality Control Requirements

Following are the minimum Quality Assurance and Quality Control requirements for the project. The Bidder's Engineering Quality Plan shall set forth in detail the procedures to satisfy these QA/QC requirements:

a. Design control

The Bidder will define, document and advise the appropriate handling of the following design controls:

- Establish internal as well as external discipline relationships
- Qualifications of personnel assigned for each task
- Establish audit procedures to ensure that the design conforms to the requirements
- Define and outline the number of multidiscipline design reviews
- Establish procedures for handling design changes
- Establish guidelines to handle all issues in pre-award, award and pre-fabrication with Manufacturer's and Sub-vendors.

b. Document control

The Bidder shall include in his QA/QC-procedures the document control methodology defining:

- Authorized use of documents
- Receipt, logging and distribution of documents
- Methodology for updating and implementation of additions and revisions
- Methodology for document transmittal to Owner / Owner's Engineer representative.

c. Audits

All documents shall be audited by the Bidder for conformance with the QA/QC procedures.

The Owner / Owner's Engineer reserves the right to review design details, either directly or through their consultants. The Owner / Owner's Engineer may audit detailed design including steam turbine generator, steam generator and auxiliaries related design, structural designs/piping design and other areas.

d. Engineering Sub-vendor

The subcontracting of detailed engineering to third parties does not relieve the Bidder of his responsibility for Engineering Quality Assurance.

4.3 Procurement

a. Source quality control

It is the Owner / Owner's Engineer's intent that the Bidder deal only with Sub-vendors and Manufacturers (Vendors) who have established and demonstrated effective quality assurance and quality control procedures. Owner / Owner's Engineer does require, however, that the Bidder perform such normal inspection of equipment manufactured in his own manufacturing unit or at the works of his Sub-vendors/ Vendors, 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.

Prior to finalization of the contract, the Bidder shall prepare and submit a Project Quality Assurance Plan that covers Procurement and requirements for procured items for the complete Works.

b. After Award of Subcontract

Once Sub-vendors and manufacturers are established, Owner / Owner's Engineer and the Bidder shall review item by item all major engineered equipment and systems and to reach an agreement on the need for pre-fabrication/pre-inspection and any additional quality plans needed to ensure the required quality.

c. Owner / Owner's Engineer / Third Party Inspector appointed by Owner Participation

The Owner / Owner's Engineer/Third Party Inspector appointed by Owner reserves the right to audit the performance of the Sub-vendors/Manufacturers and the Bidders inspection effort. This is normally accomplished by visiting the Sub-vendors/Manufacturers with the Bidders' Inspector at pre-selected points during manufacture. Bidder will identify notification points so that the Owner's / Owner's Engineer's representative(s)/Third Party Inspector appointed by Owner can be present at particularly important stages of fabrication should the Owner / Owner's Engineer wish to attend. The notification points are not hold points unless specifically identified as such. Should Owner / Owner's Engineer/ Third Party Inspector appointed by Owner elect not to or fail to attend, the Work shall proceed without interruption. However, wherever customer hold points are indicated and mutually agreed upon, the Bidder shall not proceed further unless the hold is cleared/waived. The Owner / Owner's Engineer/ Third Party Inspector appointed by Owner reserves the right, however, to make announced spot-checks to facilitate evaluation of the Sub-vendor and/or the Bidder's inspection effort. Owner / Owner's Engineer/ Third Party Inspector appointed by Owner may wish to hold technical meetings with the Sub-vendor during the design and fabrication of the machinery. Should Owner / Owner's Engineer/ Third Party Inspector appointed by Owner desire to hold technical meetings, the Bidder will be advised at a reasonable notice.

During audit visits to fabricator shops, Owner / Owner's Engineer/ Third Party Inspector appointed by Owner may elect to spot-check base materials and welds to verify proper metallurgy using whatever methods Owner / Owner's Engineer may wish to utilise, but only in

the presence of Bidder's Inspector unless otherwise agreed. Some of these requirements have been identified in the minimum inspection requirements listed in this section.

d. Communication

- Direct, timely communication between the Bidder's Inspectors and Owner's auditing Inspectors is mandatory, especially in customer hold 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 Owner, his duly Owner's Engineer and/or an outside inspection agency acting on behalf of the Owner shall have access at all reasonable times to inspect and examine the materials and workmanship of the works during manufacture or erection and at the Contractor's or his sub-contractor's works/premises. The Contractor shall accompany the Owner/Owner's Engineer during such inspection. The Contractor shall give the Owner/Inspector fifteen (15) days written notice of any material being ready for inspection/ testing. Such tests shall be to the Contractor's account except for the expenses of the Inspector.
- When the factory tests have been completed at the Contractor's or sub-contractor's works, the Owner/Inspector shall issue a certificate to this effect within fifteen (15) days after completion of tests. But if the tests are not witnessed by the Owner/Inspector, the waiver shall be issued by the Owner/ Inspector within fifteen (15) days of the receipt of the Contractor's test certificate. Failure of the Owner/Inspector to issue such a waiver shall not prevent the Contractor from proceeding with the works. The completion of these tests or the issue of the waiver shall not bind the Owner to accept the equipment should it, on further tests after erection be found not to comply with the Contract. However, in case of waiver, the Contractor shall ensure to carry out the testing as per approved quality plans and specification requirements and send two copies of all the test results to the Owner for his review and approval.

PROCUREMENT QA/QC REQUIREMENTS

a. Inspection plan

Inspection plans with detailed instructions for the Inspector's guidance shall be provided for each item. The Bidder shall prepare a list of all relevant major equipment / systems, prepare quality plans for these equipment / systems. The Bidder's Procurement Inspection function will begin with the Letter of Award (LOA) of the purchase order and conclude when the Inspector (including inspection by client's inspector wherever applicable) has duly released the equipment in the Sub-vendor's shop.

b. Inspection Co-ordination and Responsibility

The Bidder shall have the overall coordination responsibility for inspection activities. The Bidder's responsibilities shall include, but not be limited to the following:

- Issue assignments for source inspection

- Issue specific inspection instructions when required to the assigned source inspector
- Indicate the required type of report forms
- Coordinate and respond to questions of a technical nature
- Monitor inspection reports to determine if inspections are being performed as per written instructions
- Forward all related order correspondence to the assigned source Inspector
- Receive inspection reports from the source Inspector and make distribution as required
- Ensure that comprehensive files are maintained for each job.

c. Inspectors' qualifications

The Bidder shall submit with their QA/QC Manual resumes of Bidder's inspectors detailing their experience, education and qualifications for Owner / Consultants review / approval. The Inspectors shall have sufficient prior experience and qualifications for the equipment assigned.

d. Inspector's responsibilities

After receiving the assignment from the Bidder, 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 / Owner's Engineer.

e. Inspection reports

- i. Inspection reports for interim inspection visits shall be consecutively numbered and identify non-conformance and exceptions found/ corrected at that time. Final checklists should indicate all items inspected during interim inspections.
- ii. 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.
- iii. Inspection release certificate shall be issued by the assigned Inspector only after all the requirements of the purchase order is met and the rectifications mentioned in the inspection report/s are satisfactorily completed. The inspection release certificate issued by the inspector, is an authorisation to the Sub-vendor to present final billing to the Bidder. A copy of the release note shall be attached to the packing list to serve as notification to the job site about the inspection approval.

4.4 Construction

Owner / Owner's Engineer's Participation

Owner / Owner's Engineer will have a Quality Assurance/Quality Control organization to audit the Bidder's QC effort. The assigned Owner / Owner's Engineer's personnel will provide assurance to

Owner / Owner's Engineer's management that the Work meets specifications, however, the basic inspection and quality control responsibility is vested with Bidder. The purchaser/Owner's Engineer will have access to the Bidder's/Sub-vendor's/site premises/site office/site stores to check the quality of materials at any point of time during construction/commissioning stage.

Owner / Owner's Engineer's auditing may include spot checks of materials including their testing in the field to ensure that inadvertent substitutions have not been made in the fabrication shops or mixing point or in field ordered materials. Owner / Owner's Engineer's auditing shall also include testing of concrete, cement mortar, etc.

Communication

Direct, informal communication between the Bidder's field Inspectors and Owner / Owner's Engineer's auditing Inspectors is mandatory. Further Owner / Owner's Engineer shall be advised when major problems related to design or fabrication are uncovered.

Bidder's in-progress inspection reports, follow up/punch out sheets, records of radiograph inspections, etc. shall be available to Owner / Owner's Engineer's auditing Inspectors during the course of the Work.

At the end of the Work, Bidder's standard inspection reports, check off sheets, radiographs, master copy of loop diagrams, electrical test data sheets, etc. shall be handed over to Owner / Owner's Engineer in an organised, agreed upon format. Bidder shall verify that all of the required documentation of the equipment has been received and placed in the equipment files. The Bidder is responsible for obtaining any outstanding documentation from the suppliers.

Construction QA/QC requirements

It is the Owner / Owner's Engineer's intent that the Bidder (and any Sub-vendors employed) provide sufficient qualified Inspectors to assure that facilities are installed in accordance with the plans and Owner / Owner's Engineer's specifications and intents and that the level of quality called for therein is obtained. Prior to finalization of Contract award, the Bidder shall submit a detailed Field Quality Assurance Program for Owner / Owner's Engineer'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 Bidder shall provide a full time, dedicated Quality Assurance Organization. As a minimum the Bidder'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 Engineer Representative for approval.

b. Organization, authority and responsibility

Delineate the Bidder's Quality Control organization, responsibility and authority for performance of QC functions by discipline.

c. Inspector qualifications

The Bidder's Construction Assurance organization will consist of people with requisite qualifications. The field QA organization will be a fulltime organization, with no other construction related duties. As with engineering and procurement, Owner / Owner's Engineer 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 Bidder are properly labelled by the Sub-vendor 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. Bidder/Sub-vendor non-conformance

This shall provide for documentation and disposition of non-conformances resulting from Bidder/Sub-vendor 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.

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, any field definition agreed to shall be included. Some of the inspections are listed below:

- (a) Performing random dimensional check and visual material verification of field fabricated pressure equipment and of any piping, vessel, electrical and instrument installation.
- (b) Internal checking of all vessels for:
 - i.) Cleanliness
 - ii.) Proper internals. This involves opening the vessel manways and removal of internals.

- (c) 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, megger 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.
 - xv.) Ensure that the refractory material used for the lining, the process of lining, curing and final testing of the lining meets the boiler manufacturer's recommended specification requirements.
- (d) Final checking of installed facilities, completing check out forms, and signing on behalf of the Bidder documents attesting completion of the Work, as called for in the Contract documents.
- (e) Monitoring or inspecting the work of Sub-vendors This requires pre-award and pre-field start meetings for major subcontracts with Bidder's / Sub-vendor/ Owner / Owner's Engineer/ Third Party Inspector appointed by 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:
 - (i) Foundations
 - (ii) Field fabricated vessel
 - (iii) Tanks
 - (iv) Piping
 - (v) Electrical

- (vi) Instrumentation
- (vii) Insulation
- (viii) Painting/coating
- (ix) Cooling tower protective coating
- (x) Epoxy coating for structural steel
- (f) Execute Bidder's standard quality tracking program
- (g) Perform final check of installed facilities with Owner / Owner's Engineer'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.
- (h) See that proper protective procedures are employed and maintained for early installed equipment and equipment stored in offsite staging areas.

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.

Calibration of test equipment

Calibration of tools, gauges, instruments and other measuring and testing devices shall be included.

QA personnel qualification and certification

The qualification required of QA/QC personnel shall be outlined.

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.

Interface with statutory authorities

Participation of statutory authorities, which require testing, witnessing and inspection shall be provided.

Audits

Requirements for audits to verify implementation of the QA/QC program on a regular basis shall be included.

Mechanical completion acceptance

Bidder shall perform final inspection of the Work in accordance with the Contract documents. Periodic reporting of QA/QC activities (once a month or earlier) as required shall be submitted.

Quality Assurance/Quality Control Plan

Bidder shall furnish a detailed Quality Assurance/Quality Control Plan (QA/QC) for each equipment / system covered under this specification for Purchaser/Owner's Engineer's review and approval.

The QAP shall be subject to Purchaser's approval. Bidder shall follow the approved QAP without any price or time implication.

4.7 DRAWINGS AND MANUALS REQUIREMENTS

- 4.7.1** Contractor shall prepare drawings for all system based on tender specification and submit the same for Owner /Owner's Engineer approval. Construction shall be carried out as per approved construction drawings/ specifications issued/ approved by the Owner's Engineer/Owner during the course of execution of work. Where the Contractor has to prepare drawings, Contractor shall submit the drawings to Owner's Engineer/Owner and the approval in writing of the Owner /Owner's Engineer shall be obtained before commencing fabrication.
- 4.7.2** After each job completion, Contractor shall prepare 'As-Built' drawings. Final certified 'As- Built' drawings shall be submitted by the contractor to Owner /Owner's Engineer.

4.8 SITE SAFETY, ENVIRONMENT & HEALTH REQUIREMENTS

The Bidder shall always comply with Owner's Health and Safety Policy while performing the works as indicated in Attachment-12 and Attachment-13. In addition, the Bidder's Organisation shall have a written health and safety policy issued by the Chief Executive of the Organisation, appropriate to the scale and nature of the risks involved in the contract works. A copy of the Policy shall be made available to the Owner before signing the contract agreement as evidence of Bidder's commitment to management of employee's health and safety and compliance to Statutory and regulatory requirements. The Policy along with its Component operation procedures shall be evidenced as working document publicised among Bidder's and his Subcontractors' employees through appropriate language/s. All Bidder's employees shall be familiar with the Safety Policy and their role and obligations in its implementation.

The Bidder will develop a site-specific health and safety plan and a site-specific construction environmental control plan, both in accordance with project requirements, Federal, State and Local regulations and OSHA 1910 General Industry Regulations and 1926 Construction Industry Regulations. The Bidder will provide access to all safety documentation to the Owner. Bidder shall prepare a comprehensive site safety, environment and health plan consistent with the Owner's existing plan at site and submit for Owner Approval prior to mobilization to site. This site safety, environment and health plan should include detailed work instructions for safety inspection, checklist, personnel protection equipment, deep excavation precautions, precautions for heavy haul operation, rigging and lifting operations etc. Bidder shall appoint a Safety Representative (SR) meeting statutory competence requirement and approved by the Owner based on his qualification and experience.

Bidder shall develop and submit a comprehensive safety plan to ensure safety of equipment, systems and all operating and maintenance personal at site during the commissioning activities. Prior to commencement of any commissioning activities, a joint audit team represented by Owner, Engineer and Contractor shall do a detailed check of the system to ensure mechanical completion.

Commissioning activities should be taken up only after the equipment or system is found fit for safe operation by the joint audit team.

4.9 SHOP INSPECTION AND TEST PROCEDURE.

4.9.1 GENERAL

The Plant and Equipment covered by this Contract shall be subjected to inspection and testing. The VENDOR shall provide all services to establish and maintain quality of workmanship in his Works and that of his SUB-VENDORS to ensure the mechanical accuracy of components, compliance with approved drawings, identification and acceptability of all materials, parts and Equipment.

For supply of systems, VENDOR shall, at the start of the 'Contract', furnish a total list of items in their scope of work. This list, giving a brief description of the item, quantity, names of probable SUB-VENDORS, and a blank column for agency for final approval of drawings / data sheets, shall be submitted for approval by Owner's Engineer. (The blank column shall be filled by Owner's Engineer.) The list shall be submitted within two weeks from the date of LOI.

For systems and major items such as pressure/load bearing items, machineries etc., the VENDOR shall furnish quality plan giving details of checks / tests to be conducted by them on material, process, sub-assembly and assembly. These shall include requirements as prescribed in the applicable specifications, codes and statutory requirements. The quality plan shall be reviewed by the Owner / Owner's Engineer and the stages to be witnessed and verified shall be indicated by the Owner /Owner's Engineer in the quality plan and approved.

The VENDOR shall give the Owner's Engineer written notice of any material being ready for testing as per format enclosed. The clear notice period shall be seven (7) days for local inspection and fifteen (15) days for outstation inspection. Such tests shall be to the VENDOR'S account except for the expenses of the Owner's Engineer. The Owner's Engineer, unless the inspection of the tests is virtually waived, shall fix a date for inspection with the VENDOR and attend such tests within fifteen (15) days of the date on which the Equipment is notified as being ready for test / inspection failing which, the VENDOR may proceed with the tests and shall forthwith forward to the Owner's Engineer duly certified copies of tests in triplicate. If the VENDOR fails to offer the Equipment for inspection as per the agreed date, he is liable to pay for the time and expenses for the infructuous visit of the Owner's Engineer.

In all cases where inspection and tests are required whether at the premises or Works of the VENDOR or of any SUB-VENDOR or at laboratory, the VENDOR, except where otherwise specified, shall provide free of charge all facilities such as labour, materials, electricity, fuel, water, stores, test bed, apparatus and instruments, laboratory tests etc. as may be required by the Owner's Engineer or his authorised representative to carry out effectively such tests of the Equipment in accordance with the 'Contract' and shall give facilities to the Owner's Engineer or to his authorised representative to accomplish testing.

The Owner or the Owner's Engineer shall at all working hours have access to all parts of the VENDOR'S and his SUB-VENDOR'S factory where the items of the Plant are being prepared, for carrying out inspection activities as deemed necessary. A set of the relevant latest approved drawings with approval marking of the Owner's Engineer and drawings for proprietary items shall be made available by the VENDOR to the Owner or the Owner's Engineer, for reference during inspection.

In the case of stage inspection hold points, the VENDOR shall proceed from one stage to another only after the component is inspected by the Owner or his representative and written permission given to proceed further. The same procedure shall be adopted for any rectifications / repairs suggested by the Owner or the Owner's Engineer.

The Owner or the Owner's Engineer shall have the right to inspect any machinery, material, structures, Equipment or workmanship furnished or used by the VENDOR and may reject any which is defective or unsuitable for the use and purpose intended, or which is not in accordance with the intent of the Contract. The VENDOR, upon demand by the Owner or the Owner's Engineer, shall remedy or replace at the VENDOR'S expense such defective or unsuitable items of the Plant, or the Owner or the Owner's Engineer may, at the expense of the VENDOR, remedy or replace such defective or unsuitable items of the Plant.

All principal mill test reports, vendor inspection / tests reports, test certificates and test curves shall be supplied for all inspection / tests carried out including other records such as stress relieving charts, radiographic charts and other non-destructive testing records in accordance with the provisions of the Contract, duly certified by the main VENDOR. The Owner or the Owner's Engineer shall reserve the right to call for certificates of origin and test certificates for all raw material and Equipment at any stage of manufacture.

The Owner's Engineer shall within fifteen (15) days from the date of inspection as defined herein give notice in writing to the VENDOR of any non-conformance pertaining to all or any Equipment and workmanship which in his opinion is not in accordance with the 'Contract'. The VENDOR shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the said objections or shall confirm in writing to the Owner's Engineer giving reasons therein that no modifications are necessary to comply with the 'Contract'.

When the factory tests and documentation have been satisfactorily completed at the VENDOR'S or SUB-VENDOR'S Works, the Owner's Engineer shall issue acceptance note / shipping release note / certificate to this effect within fifteen (15) days after completion, but if the tests are not witnessed by the Owner's Engineer, the certificate or comments thereof shall be issued within fifteen (15) days of the receipt of the VENDOR'S test certificate by the Owner's Engineer. Failure of the Owner's Engineer to take such an action shall not prevent the VENDOR from proceeding with the Work. The completion of these tests or the issue of the certificates shall not bind the Owner to accept the Equipment should it, on further tests after erection, be found not to comply with the 'Contract'.

None of the Plant and the Equipment to be furnished or used in connection with the Contract shall be despatched until shop inspection, satisfactory to the Owner or the Owner's Engineer has been

made. However, such shop inspection and/or certification shall not relieve the VENDOR of his responsibility for furnishing the Plant and the Equipment conforming to the requirements of the Contract nor prejudice any claim, right or privilege which the Owner or the Owner's Engineer may have because of the use of defective or unsatisfactory items. Should the Owner or the Owner's Engineer waive the right to inspect any item, such waiver shall not relieve the VENDOR in any way from his obligation under the Contract. In the event of the Owner or the Owner's Engineer's inspection revealing poor quality of goods, the Owner or the Owner's Engineer shall be at liberty to specify additional inspection procedures, if required, to ascertain the VENDOR'S compliance with the Equipment Specifications.

4.9.2 SUB-ORDERS

In order to facilitate the inspection of bought-out materials and Plant, the VENDOR shall submit for approval, three (3) copies of all sub-orders placed by him as soon as they are issued. Copies of any drawings referred to in the sub-order shall also be submitted, unless otherwise agreed by the Owner or the Owner's Engineer.

The sub orders and drawings referred to above shall include all components which are subjected to electrical and mechanical pressure or stress when the Plant is in operation, and also auxiliaries and spares which are to be directly despatched to Site from the SUB-VENDOR'S Works.

All sub-orders of the main VENDOR and SUB-VENDORS shall clearly be marked with the main VENDOR'S name and the Owner'S name and 'Contract' reference. They shall include the following statement:

"The Plant or the Equipment which is the subject of this order shall comply in every respect with the requirements of the Owner's Engineer'S technical specifications and shall be subject to inspection and tests to the satisfaction of the Owner's Engineer and ourselves".

For the purpose of this clause, inter-works orders shall also be treated as sub-orders. It is obligatory on the VENDOR that he advises his SUB-VENDOR of the pertinent clauses in this Specification when ordering bought-out Plant, Equipment or materials. In particular, the VENDOR shall advise very SUB-VENDOR that he is required to supply design calculations, drawings, inspection reports and test certificates strictly in accordance with this Specification and technical information for inclusion in the Instruction Manual as specified in Section-E. The SUB-VENDORS should also be reminded that they shall include with their offer all tools and appliances necessary for proper maintenance and all spare parts in accordance with Section-E of the Specification. Itemised prices of the recommended spare parts shall be submitted together with the appropriate part numbers and drawings.

Sub-ordering / sub-contracting for major items such as pressure / load bearing items, machinery etc. can be done only with the approval of the Owner / Owner's Engineer.

4.9.3 MATERIAL TESTS

In the event of the Owner or the Owner's Engineer being supplied with the certified particulars of tests which have been carried out for the VENDOR by the supplier of material, the Owner or the Owner's Engineer may, at his own discretion, accept the same as proper evidence of compliance with the requirements of appropriate specifications for the materials.

The VENDOR is to provide test pieces as required by the Owner's Engineer to enable him to determine the quality of material supplied under the 'Contract'. If any test piece fails to comply with the requirements, the Owner's Engineer may reject the entire lot of material represented by the test piece.

Critical materials used in manufacture of the Equipment and construction of the Plant covered by the 'Contract' may also be subjected to one or more of the non-destructive tests (NDT) as called for in the Specification or as mutually agreed. Salvaging of material due to unacceptable defect is to be attempted by the VENDOR only after getting specific concurrence from the Owner or the Owner's Engineer and according to the approved procedures.

4.9.4 WELDING

All welding involved in construction and fabrication of the Plant and items covered under the 'Contract' shall be carried out in accordance with procurement specifications and applicable codes.

Welding procedures and welders' qualifications shall be approved by the Owner's Engineer. Where applicable, welders shall be tested as detailed in codes specified for pipe welding, vessel welding and structural welding and appropriate to the corresponding weld position using test pieces of appropriate parent metal to be used on the job. The Owner's Engineer shall have the right to have any welder re-tested at any time during the 'Contract'.

Recommendations of applicable codes shall be followed for non-destructive tests, wherever applicable.

Copies of all welding procedures, procedure qualification records, welders' performance qualification certificates, post-heating / stress relieving records, NDT records and other test results shall be made available upon request of the Owner's Engineer.

4.9.5 FABRICATION/INSPECTION

Fabrication / Inspection procedures for vessels, heat exchangers, pipes, tubes, valves, etc. shall be in accordance with procurement specifications, quality plan, applicable codes or any other approved equivalent.

4.9.6 TESTS AT MANUFACTURER'S WORKS

General

The tests at Works shall include electrical, mechanical and hydraulic tests in accordance with the appropriate clauses of Statutory Regulation, relevant codes and standards and approved drawings

/ specifications and in addition any test called for by the Owner or the Owner's Engineer to ensure that the Plant being supplied fulfils the requirements of the Specifications. The VENDOR shall carry out all the shop tests and inspections specified under individual items of the Equipment in Section-D, in addition to those normally required as per codes / standards. For items not covered by any code or specifically mentioned in the Specifications, the tests are to be agreed with by the Owner's Engineer. If considered necessary by the Owner or the Owner's Engineer, multi-part assemblies shall be fully erected and tested in the Works prior to packing and despatch to the Site.

Test Certificates

Test certificates including test records, performance curves and balancing certificates shall be supplied according to the Distribution Schedule. All the tests shall be carried out in accordance with the provisions of the 'Contract'.

All test certificates must be endorsed with sufficient information to identify the material or the Equipment to which the certificates refer, and must carry at the top right hand corner the identification of the Owner and the 'Contract'.

Calibration

All instruments used for critical measurement such as pressure gauges for leak tests, instruments for measuring performance parameters, instruments for precision dimension measurements shall have valid calibration certificates traceable to national standards. This means that the calibrating agency engaged by the VENDOR shall use instruments which are in turn calibrated by Government approved agencies and such information shall be recorded in the calibration certificate issued by the calibrating agency by giving the certificate number, date and date of validity of the certificate given by the Government approved agency.

4.10 STORAGE OF EQUIPMENT AT SITE

4.10.1 SCOPE

This specification details the general guidelines for storage of mechanical and electrical equipment at site from the date equipment are taken over by the Contractor until the same are erected and handed over to the Owner.

4.10.2 STORAGE CLASSIFICATION

The types of storage are broadly classified under the following heads:

- (a) Special storage – Air conditioned
- (b) Closed storage
- (c) Semi-closed storage
- (d) Open storage

The equipment covered under this specification shall be stored in the type of storage as recommended by the Manufacturer / Owner / Owner's Engineer.

4.10.3 CONSTRUCTION OF STORES

Normally, the Owner makes available the space, at terms specified elsewhere, for the Contractor to construct the necessary stores as specified.

To the extent feasible, materials should be stored near the point of erection. The storage areas should have adequate unloading and handling facilities with adequate passage space for movement of material handling equipment such as cranes, fork lift trucks, etc. The storage of materials shall be properly planned to minimise wasteful handling during retrieval of items required for erection.

The outdoor storage areas as well as semi-closed stores shall be provided with adequate drainage facilities to prevent water logging. The Contractor shall check the satisfactoriness of these facilities prior to monsoon.

The stores sheds shall be built in conformity with fire safety requirements. The stores shall be provided with adequate lights and fire extinguishers. 'No smoking' signs shall be placed at strategic locations. Safety precautions shall be strictly enforced.

In case of storage of certain equipment / materials, it may be necessary to maintain specified temperature ranges. In such cases, it is the responsibility of the Contractor to provide adequate heating / air conditioning facilities on round the clock basis. The Contractor shall check that space heaters, heating bulbs and air conditioners are kept energised continuously as applicable. In the event there is a prolonged failure of electric power, rendering such air conditioners / space heaters inoperative, the Contractor shall make alternative arrangements to ensure that items under storage do not suffer any damage / deterioration on this account.

Adequate lighting facility shall be provided by the Contractor in storage areas and storage sheds and security personnel positioned to ensure enforcement of security measures to prevent theft and loss of materials entrusted to him by the Owner. The Contractor shall carry out regular inventory of materials received, issued and erected and notify the Owner of any loss when noticed.

The Contractor shall provide adequate number of competent stores personnel including store-keepers, clerical staff, inspection engineers, watchmen and security staff to efficiently store and maintain the equipment / material entrusted to him.

Where necessary, the Contractor shall provide necessary space heating and other protective care to equipment in case it will take a long time to haul them to the stores. Any equipment left in the open under such conditions shall be, if required, covered with tarpaulin.

All inflammable items should be stored in separate location with proper fencing with adequate safety demarcation & precautions.

4.10.4 MAINTENANCE DURING STORAGE

Where unloading from the carriers and transport to warehouses is excluded from the Contractor's scope, the Contractor shall take over the materials from the Owner's storage area / sheds.

Where materials is unloaded by the Owner before the Contractor arrives at site or even when the Contractor is already at site, the Owner can hand over the material to the Contractor and thereupon it will be the responsibility of the Contractor to store and maintain these material in a proper and approved manner.

While taking over the materials, the Contractor shall carry out inventory and inspection of the same and submit a report of his observations to the Owner. After taking over of the equipment / materials, the Contractor is solely responsible for the same until handing over to the Owner the erected plant and surplus materials, if any. The Contractor is responsible for maintenance of the equipment / materials in storage, during erection and until commissioning including protection of the same against theft, elements of nature and corrosion damages. In case commissioning of the equipment is delayed, the Contractor shall be responsible for maintenance of the erected plant and equipment as directed by Owner / Owner's Engineer.

The Contractor shall repack the equipment after inspection and store the same in an orderly manner, preserving their identification slips, tags and instruction booklets, etc., required during erection. The storage of materials shall be equipment-wise. Loose parts shall be stored in sheds on racks, preserving the identification marks and tags in good condition. The group codes shall be displayed on the racks.

The Contractor shall carry out frequent inspection of materials stored and also extend necessary facilities to the Owner / Owner's Engineer to carry out such inspection, when considered necessary. The Contractor shall implement the suggestions of the Owner / Owner's Engineer in this connection.

At no time shall any materials be stored directly on ground. All materials shall be stored minimum 200 mm above the ground on proper platform made up of RCC/MS channels/wooden sleepers to avoid water contact with equipment during heavy rainfall.

Welded and cast units shall be stored in such manner that there is no danger of distortion.

All the storing area should be monitored regularly or protected for damages created by Rats/ or any other reason.

All special measures to prevent corrosion shall be taken by the Contractor.

Materials which carry protective coating shall not be wrapped in paper, cloth, etc., as these are liable to absorb and retain moisture. The materials without coating should be packed in VCI bags to avoid rust. The Contractor shall inspect the materials and in case of signs of wear or damages to protective coating, that portion shall be cleaned with carbon tetra chloride or any other approved solution and coated with an approved protective paint. In case of VCI, damaged one should be

changed immediately after notice. Complete record of all such observations and protective measures taken shall be maintained.

The grease recommended for protection of surfaces against rusting is refined from petroleum oil with approved additives, grease shall be only in traces.

The protection offered by grease does not last more than six to twelve months.

The rust preventive oil for application on machined / fabricated components shall meet the following requirements.

- Kinematic viscosity at 50°C is 400 CST.
- Flash point in open vessel is 240°C Minimum.
- Acidity number 2 mg.
- Maximum percentage of water 0.08.
- Protection offered normally does not last more than six to twelve months.

While handling the equipment, no dragging on the ground is permitted. The Contractor shall submit his scheme for handling major pieces of equipment for approval by the Owner / Owner's Engineer prior to actual handling of the same. In cases where a scheme is recommended by the Owner / Manufacturer, it shall be strictly adhered to.

The Contractor shall periodically inspect materials with specific reference to -

- Ingress of moisture and corrosion damages.
- Damage to protective coating.
- Open ends in pipes, vessels and equipment
- In case any open ends are noticed, the Contractor shall get them capped.
- Insulation of electrical equipment.

Regular insulation checks are essential and these values shall be properly logged.

- Any damages to equipment / materials.

In case of any damages, these shall be promptly notified to the Owner. In all cases, the repairs / rectification shall be carried out strictly as directed by the Owner / Owner's Engineer.

If such repairs / rectification is necessitated due to causes attributable to the Contractor, such repairs / rectification shall be carried out at no extra cost to the Owner. In other cases, compensation for such repair / rectification works will be as mutually agreed to.

In case such damages are attributable to the Contractor and if, in the opinion of the Owner / Owner's Engineer, the Contractor is not competent to carry out necessary repairs / rectification, the Owner shall get this done by any other agency and recover the expenditure incurred by him from the Contractor.

4.10.5 **MODES OF STORAGE**

Given below are the general guidelines for storage of various equipment under the broad storage classifications listed in clause 2.0 above. Wherever the specific recommendations of the Manufacturer / Owner / Owner's Engineer are at variance with what is indicated below, the former shall prevail.

Special Storage – Air Conditioned

The following materials are normally stored in air conditioned storage.

- **Welding Electrodes**
These deteriorate under adverse conditions of storage and are preferably stored in air-conditioned storage. As an alternative, if approved, these can also be stored in hot boxes / ovens. It is essential to regularly inspect the conditions of electrodes and ensure that temperature is always maintained within specified range.
- **Ball, needle and roller bearings:**
These shall be stored in their original packing.
- **Photographic materials and films.**
These shall be stored in their original moisture vapour proof packages.
- **Rubber Goods:**
These shall be protected against sunlight and artificial light as well as high humidity conditions.
- **Electronic instruments and components.**
These shall be stored in sealed packages. Bidder shall arrange racks and proper storage for sensitive instruments like transmitters, analyser sensors and for electronic components (if any)

Closed storage

The following materials are normally stored in closed storage.

- Cement bags.
- All small parts / components liable to be misplaced / lost. These shall include the following:
 - a. Small structural cleats, bolts, nuts, washers, etc.
High tensile bolts and nuts shall be stored in separate sealed boxes with proper identification to avoid mix up with other items.
 - b. Pipe hangers, spring hangers, etc.
The identification numbers on spring hangers shall be carefully preserved during storage.
Stainless steel and copper tubes, pipe fittings, etc.
 - c. Electrical clamps, cable boxes, cable glands, ferrules, fuses, control cables, copper cables and grounding strips, push button switches, etc.
 - d. Pilot valves, pull rods, keys, control valves. These shall be greased, wrapped in paraffin paper and stored in packing boxes.

- Boiler fine fittings, soot blowers (if applicable), fan bearings, hangers and couplings.
- Drive units of tubular air heaters, fans, motors, pumps, including those supplied disassembled.
- All indoor switch gear equipment.
- Bus ducts, exciters, excitation system equipment, voltage regulators, circuit breakers, potential and current transformers, lightning arrestors, bushings, storage batteries and cells.
- All instrument parts such as measuring instruments, controllers and regulators, interlock system, control drive units, gauges, instrument valves, thermocouples and leads.
- Thermal and insulation materials.
- Mineral wool, glass wool, castable refractories, fire bricks, asbestos, etc.
- Synthetic paints. Normally in separate stores.

Semi-Closed Storage

The following materials are normally stored in semi-closed storage.

- Dust collector elements in boxes.
- Boiler dampers, manhole doors, mountings, casing frames, buck stays
- Air pre-heater frames tubes, baskets.
- Burner panels and burners.
- Fan impellers, large assembled pumps, , pulleys and idlers, bearings, outdoor motors, etc.
- Large C. I. Valves, butterfly valves, stop and control valves, expansion joints.
- Outdoor switch gears and panels, small transformers, cable tray parts, etc.
- Crane rope drums, hoists, trolleys.
- Wire ropes in drums covered with tarpaulin.
- Bearing stands

Open Storage

The following materials are normally stored in open storage.

- Fabricated and un-fabricated structural steel members.

Chimney steel, stairways and hand rails.

Gallery steel

Crane bridges and steel members.

Reinforcement steel

- Coarse aggregates and sand.
- Un-fabricated pipes and fabricated pipe assemblies, Concrete and hume pipes. Large diameter conduits / pipes in boxes.
- Boiler, drum, tubes, tube panels and headers.
- Air pre-heater tube plates.
- Pressure vessels, reaction towers and columns.
- Fabricated vessels and tanks shall have their openings firmly blanked.
- Cable drums.
- Large power transformers.

4.10.6 SPECIFIC GUIDELINES FOR STORAGE

Given below are the guidelines for certain other major equipment / materials. These are broad guidelines only and storage shall be strictly as directed by the Manufacturer / Owner / Owner's Engineer.

Rotating Equipment such as Pumps

These are normally stored in assembled condition in closed / semi-closed storage. When stored in semi-closed storage, they shall be covered with tarpaulin and bed plates shall rest fully on sleepers.

The Contractor is responsible for proper lubrication of these equipment as directed.

The gear boxes and oil sumps shall be kept filled with recommended lubricating gear oil. The couplings and bearings shall be covered with approved grease and nozzle flanges screwed with caps or suitably plugged.

The shaft and internals shall be, if so directed, given a fresh coat of approved protective paint.

Pumps, if delivered in non-assembled condition, shall be stored with the parts properly greased and wrapped in VCI bags. Smaller parts are to be stored on racks whereas larger parts on sleepers in closed storage. Occasional flushing with hot lubricating oil may have to be carried out, if so directed, in the cases of equipment such as boiler feed pump.

The shafts of rotating equipment shall be turned by 90°C every week to avoid rotor journals from rusting and to ensure that shaft is free to rotate.

The Contractor shall maintain record of lubrication with details of lubricants used as well as protective measures carried out.

Piping and Valves

All pipes shall be stored on sleeper beds with open ends securely capped. The bevelled ends shall be protected with a coating of approved grease. If so directed, inside surfaces of piping shall be coated with approved protective solution.

Pipes shall be neatly arranged and stacked for easy identification and retrieval.

Pipes shall be blown with air prior to installation and it shall be ensured that there is no obstruction.

Valves shall be stored with the discs screwed down on the seat so that packing surfaces are not exposed to dust. All machined surfaces shall be covered with grease. Preservation of identification tags is essential to avoid installation in a wrong service. Smaller valves shall be stored in closed storage whereas large CI valves may be stored in semi-closed storage.

Pipe fittings shall be stored on racks in closed storage in packed condition, with openings suitably capped.

Switch gear & Control Panels

Depending on whether these are of indoor or outdoor design, these shall be stored in closed / semi-closed storage.

The spaced heaters, where provided, shall be kept connected with power supply irrespective of mode of storage where space heaters are not provided, use of adequate number of heating bulbs is recommended.

Insulation resistance shall be measured at regular intervals and megger values properly logged.

Transformers

It is advisable to assemble and set the transformer filled with oil in its permanent location soon after receipt even if it is not likely to be put in service for a while. In case of gas filled transformers, a positive pressure should be maintained during storage as recommended by the Manufacturer. If transformer is to be stored partially or fully dis-assembled, it shall be protected against moisture ingress / absorption by keeping them immersed in transformer oil or as recommended by the Manufacture / Owner / Owner's Engineer.

Prior to charging any transformer, it is essential to check the satisfactoriness of insulation values and di-electric strength of oil.

Cells, Accumulators, Batteries

These shall be stored in a dry and well ventilated place and protected from extreme cold. Internal parts of large cells are loose and the cells should be handled with care to avoid displacement of internals. Saw dust shall never be used for packing batteries as it is hygroscopic.

Cables

Cable drums if stored indoors, shall be in dry, ventilated stores. Cables are normally supplied with ends sealed. When a length is cut, the end should be resealed. The drums shall be stored with adequate spacing between them for better air circulation.

Motors

Besides general procedures such as regular inspection and recording of insulation resistances, in the case of LT motors, if so recommended, low voltage current flow through the windings may be maintained during storage.

Instruments

These are stored on racks in closed storage and in air conditioned storage if so recommended. These shall be stored in their packages in dry condition and shall be handled with extreme care.

Instrument flanges and nozzles, if directed, shall be coated with technical Vaseline.

In the case of fragile instruments, the storage shall be in a separate zone away from where heavy materials are stored to minimise danger of damage.

Steel

Reinforcement steel: Reinforcement steel shall not be kept in direct contact with the ground but stacked on top of an arrangement of timber sleepers or the like. If stored for long periods, these may be coated with cement wash before stacking to prevent loose scales and rust. Fabricated reinforcement shall be carefully stored to prevent damage, distortion, corrosion and deterioration.

Structural steel: Structural steel could safely be stored in open storage but with sufficient space in between for handling and crane movement. All steel shall be stored 300 mm above ground on suitable packing to avoid damage. It should be stored according to sizes and sections preferably in the order required for erection. The area for open storage should be properly graded to avoid water logging in the storage area. Steel shall not be stored in the vicinity of areas where excavation or grading will be done. Scratched or abraded steel shall be given a coat of primer for protection after unloading and handling prior to erection. All milled and machined surfaces shall be properly protected from rust / corrosion by suitable coating.

Cement

Cement shall be stored in bags in a separate shed away from where mechanical and electrical equipment are stored to minimise the possibility of cement dust settling on the equipment.

The storage shed where cement is stored shall be absolutely water tight. The flooring shall be a 15 mm thick concrete slab laid on a dry course soling or as recommended. The ground shall be drained away from the shed to prevent accumulation of water in its vicinity.

The bags shall be neatly stacked with adequate passage in between for easy retrieval. The cement shall be issued on 'First-In-First-Out' basis.

In case different grades of cement are stored in the same shed, each grade shall be stacked separately to avoid mix up and clear indication boards shall be provided to identify different grades.

Synthetic Paints

These have limited life and as a safeguard against possible deterioration, the drums shall be inverted at regular intervals as specified to minimise risk of hard settling of pigments.

Slings & Wire Ropes

All slings and wire ropes shall be coated with approved grease and hung from racks in rolled condition.

4.2 DOCUMENTATION

The Contractor's store-keeping function will include maintaining various records as required by the Owner / Owner's Engineer. These records shall include but not be limited to:

Supplier wise record of equipment / material received stored and issued for erection as well as stock position.

Record of inspection and repairs carried out, protective measures and lubrication of equipment in storage as well as erected until the same are taken over by the Owner.



Client – Hindalco Industries Ltd

Project – 2X30 MW CGPP

TCE.13833A-ME-6002-6001, Rev-R0



TATA CONSULTING ENGINEERS LIMITED

TECHNICAL SPECIFICATION FOR MAIN PLANT SYSTEM

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CHAPTER-5

MECHANICAL DESIGN REQUIREMENT & EQUIPMENT SPECIFICATION

5.0 MECHANICAL DESIGN REQUIREMENTS & EQUIPMENT SPECIFICATION

5.1 GENERAL

- 5.1.1 Each steam generator and turbine generator unit shall be designed to produce maximum continuous output power of 30 MW with steam parameters of 66 kg/cm² (a) pressure and 485°C temperature at the turbine inlet. Two units shall be designed to operate independently having interconnection with each other so that any turbine can be operated by any of the boilers. Also, provision shall be kept in the entire system to integrate another unit of similar capacity in future with minimum retrofitting works.
- 5.1.2 The unit shall be designed to operate as a base load station. However, continuous operation under cyclic modes during certain periods of a day is also envisaged. The design should cover adequate provision for quick startup and loading of the unit to full load at a fast rate and apart from constant pressure operation would also have the facility for sliding pressure operation. The design of the equipment and control system would permit participation of the machine in automatic load frequency control.
- 5.1.3 The CGPP shall be designed to generate its rated power while maintaining the MP and LP steam supply to refinery at rated parameters while meeting its internal consumption of steam and power during normal operating hours. Also, it shall be capable of supplying MP and LP process steam during peak operation of refinery. The steam and power demand during normal and peak hours of each unit is indicated below:

SI No	Type	Pressure (bara)			Temperature (°C)			Refinery Demand	
		Min	Max	Minimum Mechanical Design	Min	Max	Minimum Mechanical design	Normal	Peak
1	MP (Medium Pressure)	12	14	15.4	190	220	230	75 TPH	90 TPH
2	LP (Low Pressure)	4.3	6.5	7	160	190	200	115 TPH	140 TPH
3	Refinery Power Requirement							19.8 MW	21.8 MW

Notes:

- The steam and power requirement is solely demand of refinery and shall be supplied at CGPP boundary. Bidder to consider consumption of auxiliary steam and power for CGPP and design the system accordingly.
- The MP and LP steam parameters to be made available at plant boundary.

- 5.1.4 The boiler, turbine- generator and associated equipment and systems shall be of proven design, using proven materials with well established physical and chemical properties and as appropriate to the service as intended.

- 5.1.5 The unit and the auxiliaries shall be designed for maximum reliability and availability, operability and maintainability. The bidder shall specifically state the design features incorporated to achieve the high degree of reliability and availability.
- 5.1.6 The unit shall be suitably designed and provided with necessary instrumentation for rapid starting, loading and unloading without causing undue vibration, distortion, differential expansion or producing excessive thermal stresses. The design of the control system and relevant equipment shall adhere to the fail safe operation at all system conditions. The fail safe operation signifies that loss of signal/air/power supply, loss of excitation or failure of any component will not cause hazardous conditions and at the same time prevent occurrence of false trips.
- 5.1.7 The work falling under the purview of Indian Boiler Regulations (IBR) shall completely meet or exceed all the requirements of the latest edition of IBR. Any other standard acceptable to IBR can also be considered, provided the requirements of that standard are equivalent or exceed IBR requirements.

5.2 BOILER AND ACCESSORIES

- 5.2.1 Boiler and auxiliaries shall be complete with necessary equipment, structural, foundation bolts, piping, valves, fittings and painting, instrumentation and control equipment with installation hardware, ducting, cabling, electrical system/equipment and all other associated items for safe and reliable operation of the plant.
- 5.2.2 Each steam generator unit shall be rated to deliver for conditions specified in Attachment 1: Technical data sheet. The steam purity shall be ensured as per the requirement of steam turbine and other operating auxiliary plant over the entire load range.
- 5.2.3 The steam generator shall be of CFBC technology, sub-critical, single drum, natural circulation and non-reheat type. The boiler shall have capability to fire 100% Indian coal, 100% Indonesian Coal and 100% South African Coal or any combination of coals specified in this specification and utilize Low Diesel Oil (LDO) or Bio-Diesel as start-up fuel and during low load operation. Also, the steam generator shall be suitable to fire biomass (Max 10%) along with coal.
- 5.2.4 The steam generator shall consist of combustion chamber, cyclone/dust collectors, Siphon seal/seal pot. Bidder may consider hot cyclone or cold cyclone or internal recirculation / U-beam technology as per their standard manufacturing practice. The similar design should be in satisfactory operation for minimum two years.
- 5.2.5 Bidder shall design the combustion chamber for staged combustion for better combustor temperature control and also to limit the formation of nitrogen oxides.
- 5.2.6 All pressure part tubes and headers shall be of seamless type. Welded tubes are not acceptable.
- 5.2.7 Suitable number of safety valves in drum, superheater and start up vent along with silencers shall be provided.
- 5.2.8 A nitrogen based inerting system shall be provided for preservation of steam generator during shut down.

- 5.2.9 The boiler structure shall be designed to support all loads located on the structure. In addition, other loadings may be introduced on the structure from piping, enclosures, adjacent structures and equipment. Loading due to wind and seismic conditions shall be considered in the design.

COMBUSTION CHAMBER

- 5.2.10 The combustion chamber assembly shall be arranged for natural circulation of water/steam. The combustion chamber shall be a gas tight enclosure. The areas where a reducing atmosphere, erosion are expected, the same shall be refractory lined and protected. The combustion chamber design shall be suitable to provide pressure withstanding capacity as per guideline of NFPA 85.
- 5.2.11 The combustion temperature shall be uniform in the entire volume of the furnace and shall be in the range of 830-870°C and shall be optimum considering sorbent dosing in the boiler. The particle velocity in the combustor shall be maximum 5 m/sec. The same shall not cause any explosion in any of the fuel path.
- 5.2.12 The circulation system shall ensure adequate circulation ratio during rapid start-ups and load changes to prevent overheating of the water wall tubes with maximum possible heat flux in the furnace.
- 5.2.13 Heat transfer surfaces in furnace region shall be avoided as far as possible. If any heat transfer section is placed in the combustor, suitable measures shall be provided to protect from erosion problems for the same. The placement of heat transfer sections in the combustor by provision of suitable vertical panels, horizontal panels or wing walls would be acceptable provided, Bidder has supplied such designs and such units are in successful operation for a period of not less than five years.
- 5.2.14 Suitable allowance shall be provided for the water wall, economizer tubes and in-furnace super heater to counter the erosion conditions. Bidder shall clearly bring out in his offer the proven preventive measures provided for the water walls and in furnace heat transfer sections to counter erosion.

CASING

- 5.2.15 A gas tight enclosure shall be designed for the entire boiler from the lower furnace to the ID fan suction considering explosion/implosion forces developed due to furnace pressure excursions. The combustor shall be of membrane type water wall construction. In other areas where welded wall construction is used, no skin casing is required, but skin casing of steel plates shall be used for all enclosures and behind all wide spaced tubes where refractory is used.

CYCLONES

- 5.2.16 The cyclones shall be designed to provide a high recycle rate in order to ensure a uniform temperature in the furnace. The inlet and outlet temperature difference in cyclone shall be as minimum as possible and, in any case, shall not exceed +10 Deg C.

- 5.2.17 The cyclones offered by bidder should be water / steam cooled. If the water/steam cyclone is having refractory liner, the refractory shall be suitable to withstand the temperature applications and shall be capable of withstanding thermal expansion and thermal shocks. The cyclone design shall ensure that there shall not be any choking / slagging in cyclone bottom outlet and seal pot zones.
- 5.2.18 If other designs of separators such as non-cooled or refractory cyclones are proposed by bidder, the same shall be supported by suitable justification with good operating experience for more than two years.
- 5.2.19 If any alternative solid collecting technology other than cyclone is proposed, the Bidder shall indicate the same with design details along with their experience of the same in a boiler of similar capacity in successful operation for more than two years.

SIPHON SEAL/SEAL POT

- 5.2.20 The Bidder shall provide proven siphon seal box/pot design. The siphon seal shall be designed to allow free solids flow from low-pressure region (cyclone outlet) to the higher-pressure condition (combustor/furnace) without air locks and moving parts. Air purges at strategic locations on return leg in seal box shall be provided to assist solids flow to the combustor.
- 5.2.21 Other solid re-injection device is also acceptable provided, Bidder has already supplied such designs of similar capacity and the same are in successful operation for a period of not less than two years.

STEAM DRUM

- 5.2.22 The drum internals system will comprise cyclone separators and steam washers or scrubbers/moisture separators, baffles, hood, internal feed piping and sampling connections. The design of the drum steam/water separator ensures that the steam quality leaving the drum is as per the requirement of steam turbine generator over the entire load range. The drum dished ends at both ends shall be provided with properly sized hinged manhole doors.
- 5.2.23 All nozzles shall be of the long body type so that this will extend through the steam generator lagging. The ends of nozzles smaller than 50 mm shall have plain ends for butt welding. The nozzles 50 mm and larger shall have bevelled ends for butt-welding. All nozzles shall be of full penetration welds and shall be ground flush with the inner diameter of the drum.

SUPERHEATER

- 5.2.24 The super heater shall be of proven design and shall be designed to maintain superheat steam temperatures at super heater outlet over the entire steam temperature control range (i.e. from 50% BMCR to 100% BMCR rating) under the following conditions:
- With the steam generator heat absorption surface condition varying from clean to normally expected and permissible fouling limits;

- With minimum possible use of desuperheating spray;
- With permissible and normally expected unbalance or stratification in flue gas flow;
- With all specified mode of fuel burning;

- 5.2.25 Bidder shall provide necessary measures to prevent erosion of super heater tubes. Interstage desuperheater shall be installed at one or more points in super heater sections to ensure rapid temperature/control response.
- 5.2.26 Complete superheater temperature control system with necessary attemperators, piping, block, control, isolation, drain, vent, check valves and instrumentation & controls shall be provided.
- 5.2.27 The super heater supports or hangers exposed to hot gases within the setting shall be of a heat-resisting material suitable for long life under the service condition.
- 5.2.28 All SH tubes shall have an allowance of minimum 1 mm towards erosion over and above the designed wall thickness.
- 5.2.29 The maximum flue gas velocity in the convection zone shall be limited to 12 m/sec so as to limit erosion problems.
- 5.2.30 The maximum tube metal temperature (skin temperature) shall be below the oxidation limit as applicable to the material.

ECONOMIZER

- 5.2.31 The economiser shall be of non-steaming type and shall have provision for recirculation of water while starting the unit. The economiser tube banks shall be of in-line design with bare tubes. Anti vibration baffles/ plates shall be properly located for gas distribution.
- 5.2.32 Suitable SS shields shall be provided on tubes connecting to headers inside the flue gas path.
- 5.2.33 All economizer tubes shall have an additional wall thickness of minimum 1 mm as erosion allowance in addition to the calculated design thickness.
- 5.2.34 The heating surfaces shall be readily accessible for inspection, cleaning and maintenance and replacement. Drains and vents shall be provided to ensure that complete venting during a fill and draining during shutdown is achieved.

5.3 AIR AND FLUE GAS SYSTEM

- (a) The air and flue gas system shall be designed to meet the requirements of 100% BMCR conditions and with the specified fuels. Ducts, flues and wind boxes shall be capable of

withstanding a minimum continuous operating and transient design pressure as per guideline of NFPA 85.

- (b) The air and flue gas system shall consist of 2 x 70% Primary air fans, 2 x 70% Secondary air fans and 2 x 70% Induced draft fans. In each type of fans, 20% margin on flow will be provided i.e. both fans operating together will be able to meet 140% of BMCR requirement. This margin will be considered based on worst coal firing, frequency of 50 Hz, temperature of maximum ambient plus 5 deg C for PA fans & SA fans and maximum flue gas temperature plus 15 deg C for ID fans. Silencers shall be provided for fans.
- (c) Forced oil lubrication system for each of the fans and blowers shall be provided consisting of 2 x 100% oil pumps each with motor, 2 x 100% oil coolers and filters; one (1) oil tank associated valves, piping etc. Bidder can also offer splash type oil lubrication system as per their standard practice.
- (d) Annubar type flow meter shall be provided for the measurement of air flow of PA & SA fans at individual limbs and total air flow after air-preheater.
- (e) PA, SA, and ID fans shall be provided with vibration isolation system (spring mounted) or conventional block/frame type RCC foundation. The fans shall be provided with vibration monitoring equipment.
- (f) The system shall also consist of blowers / fans meant for seal and purge air, ash coolers, seal pots/loop seals. The number of blowers / fans shall be selected keeping 100% standby for each of the above system provided with necessary interconnections.
- (g) Adequate number of interconnecting, isolating and control dampers with drives shall be provided in air & flue gas ducts to permit proper operations. The control dampers shall be pneumatically operated and isolation dampers shall be electrically operated.
- (h) All gas and air ducts shall be designed to ensure uniform distribution of gas and air flow to the various portions of the unit. These ducts shall consist of turning vanes / baffle plates, stiffening devices, metallic/non-metallic expansion joints, bracings, access doors and brackets, support structures and hangers as necessary.
- (i) All the fans and blowers shall be provided with electrically operated hoists both on fan and motor side.

5.4 TUBULAR AIR PREHEATER (TAPH)

- (j) Bidder shall include tubular air pre-heater for preheating the air. Air-preheaters shall be designed in such a way that cold end elements/tubes should not get affected due to acid dew point corrosion of flue gas. Suitable material or preventive measures shall be provided.
- (k) Air-side bypass shall be provided for primary and secondary air to avoid cold end corrosion during start-up and low load operation.

5.5 FUEL FEEDING SYSTEM

- (a) The coal burning system shall be designed to meet the requirement of steam generator at 100% BMCR condition for the range of coals specified.
- (b) Three no. coal bunker for each boiler with total storage capacity of 24 hours shall be provided. Also, provision to be given to fill biomass in one of the bunkers within 1/3rd of its volume. Isolation gates shall be provided at each bunker outlet. The gates shall be dust proof, rack and self cleaning type pinion. The gates shall be provided with chains for manual operation. Suitable bunker emptying arrangement shall be provided.
- (c) The coal and biomass density of 1600 kg/m³ shall be considered for structural design of bunker. The storage capacity of bunker shall be selected considering coal density of 800 kg/m³ and 150 kg/m³ for biomass. All bracing and stiffening shall be on external side of hopper.
- (d) Suitable dust extraction / bunker ventilation system shall be provided bunkers. Minimum two (2) number of Radar type level measuring instrument for each bunker shall be provided.
- (e) Gravimetric feeders shall be provided to extract coal /biomass from bunker outlet and also for controlling feed rate of fuel depending on the load requirement of boiler. Proper sealing of feeders shall be ensured during operation. Air required for sealing can be taken from cold air side of secondary air system. Variable frequency drive shall be provided for gravimetric feeders.
- (f) Coal /biomass from gravimetric feeders shall be fed into the furnace through drag link conveyors either directly or through the return legs of the siphon seals as per standard practice of Bidder. Preventive measures shall be provided for sealing of fuel feeding system from the combustor and for proper distribution of coal inside combustor.
- (g) The feeders shall be designed with adequate wide range of capacity as well as reserve capacity to allow for variation in size, quality and moisture content.
- (h) The Bidder shall choose the number of feeders suitably. The capacity of the feeders shall be so selected that 100% BMCR requirement shall be met with N-1 feeders in operation for any fuel firing conditions.
- (i) Feeders shall be capable of reverse rotation also to facilitate bunker emptying through feeders.
- (j) All surfaces in contact with coal shall be made of corrosion and erosion resistant stainless steel unless otherwise specified elsewhere in this specification.
- (k) At each coal feeder port, compressed air shall be provided to assist coal feeding. Access doors shall be provided at appropriate location on each feeder. Suitable sight glasses shall be provided on feeder casing for visual inspection of coal.
- (l) All surfaces in contact with coal shall be made of corrosion and erosion resistant stainless steel unless otherwise specified in this specification.

5.6 LIMESTONE FEEDING SYSTEM

- (a) The powdered limestone feeding system shall be complete with bunkers, suitable feeding system, isolation gates, chutes and etc to meet the required emission specifications when firing the range of coals specified.
- (b) One (1) no. limestone bunker for each boiler shall be considered with 24 hours storage requirement for maximum sulphur capture under firing the design range of fuel. The powdered limestone bunker shall be provided with pneumatic fluidising arrangements to ensure uninterrupted flow of powdered limestone from the bunker. The dry air required for the above shall be from the service air system.
- (c) Isolation gates shall be provided at each powdered limestone bunker outlet. The gates shall be of dust-proof, rack and self cleaning type pinion. The gates shall be provided with chains for hand operation also.
- (d) Suitable dust extraction / bunker ventilation system shall be provided for each bunker. Minimum two (2) no's of Radar type level measuring instrument for each bunker shall be provided.
- (e) The selection of number of feeders shall be such that with N-1 feeders in operation, it shall meet the requirement of maximum sulphur capture under any fuel firing condition.
- (f) Rotary air lock feeders or any other suitable arrangement (based on standard practice of the bidder) shall be provided in each feed stream to act as a pressure seal between combustion chamber and feed system.
- (g) The downstream of rotary air lock feeders shall have motor operated isolating gate valves for maintenance works with air poking arrangements with dry service air.
- (h) Bidder shall provide a suitable powdered limestone feeding system vent arrangement to ensure good feeder stability.

5.7 BED MATERIAL FEEDING SYSTEM

- (a) For the first start-up of the CFBC steam generator and/or after a shutdown, in which bed material is required to be fed to the combustor, Bidder shall offer one bed material bunker of minimum capacity equal to thrice the bed material quantity required for initial start-up operation, along with conveying system to the combustor. Regular makeup to the combustor during normal operation shall be fed from bed material bunker for solid inventory. Bed material bunker shall be provided with vent filters.
- (b) The downstream of the bed material bunker shall have rotary air lock feeder with necessary air sealing arrangements and dry service air for poking/cleaning. Rotary air lock feeders shall be used to feed and control bed material to the combustor either directly or through drag link conveyors.

- (c) The downstream of the rotary air lock feeder shall have motor operated isolating gate valves for maintenance works with air poking arrangements using seal and purge air.
- (d) Minimum two (2) number of Radar type level measuring instrument for the bunker shall be provided. The initial supply of bed material (crushed refractory or sand) up to plant acceptance is in the scope of the Bidder.

5.8 BED ASH REMOVAL SYSTEM

- (a) The total bed ash shall be based on maximum ash generated as well as gypsum inert and unreacted lime under different combination of fuel firing as specified elsewhere for 100% BMCR. Bidder shall indicate the percentage of total ash for which the bed ash system is designed and shall furnish the basis for the same.
- (b) Adequate redundancy shall be provided for ash drain lines to drain the bed ash from combustor. The gate of the drains shall be pneumatically operated.
- (c) The bed ash drained from the combustor shall be cooled to a maximum temperature of 150°C at bed ash cooler. The bed ash cooler shall be water cooled type. Bidder shall offer bed ash collection and cooling system with standard ash cooler & knife gate valve (KGV). The bed ash removal system (bed ash cooler, ash cooling fan / blower for air cooled type and other associated systems) shall be designed with N+1 redundancy for 100% BMCR under entire range of fuel, wherein N is number of operating streams. Bidder may also use the air from fluidizing fans with suitable controls. Bidder shall explore the feasibility to recover the heat from bed in process.

5.9 FLY ASH REMOVAL SYSTEM

- (a) The total ash shall be based on the maximum ash generated firing design range of fuel as specified to achieve 100% BMCR. Bidder shall indicate in his bid the percentage of total ash for which the fly ash system is designed and shall furnish the basis for the same.
- (b) The ash hoppers shall be designed for an ash density of 1760 kg/m³ structurally and shall provide 8 hours ash storage firing entire design range of fuel with ash density of 800 kg/m³. The hopper material thickness shall be minimum 6.00 mm. All bracing and stiffening shall be on external side of hopper. The hoppers shall be suitably insulated on the exterior.
- (c) The hoppers shall be of pyramid shape with plate angle of at least 70° with the horizontal with an access door on each side of baffle. Ash hoppers for bag filter shall be provided with heating elements on all sides of hopper. One man hole per hopper and approach to the access doors shall be provided.
- (d) Each ash hopper shall be provided with a dust tight sealed hinged inspection door and an access door of approximately 450 mm x 450 mm size. The hoppers shall be provided with the required outlet connections.

5.10 INSULATION AND REFRACTORY

- (a) The Bidder shall provide thermal insulation and lagging for entire boiler, flue gas / air ducting, etc. The thickness of insulation shall be such that the surface temperature of the lagging shall not exceed 50°C for ambient temperature of 30°C & still air condition.
- (b) The following specific areas of CFBC steam generators, but not limited to shall be provided with protective refractory :
 - i. Combustor
 - ii. Cyclones and connecting ducts to convective pass and from combustor
 - iii. Ash coolers
 - iv. Ducts and transfer lines
 - v. Fuel inlet, Bed material and powdered limestone entry point
 - vi. Loop seals
- (c) In addition to the above if the bidder requires protective refractory in any other region, the same shall also be included.
- (d) All refractory required for furnace wall, cyclone and other areas shall be of good operating history and from reputed supplier who has supplied the same refractory material for the services indicated above in a boiler of similar capacity or higher and has undergone successful operation for a period of not less than two years in one CFBC boiler.
- (e) For all refractory the materials, are to be inspected and cleared at the manufacturing works by the CFBC refractory specialist or Third Party Inspection (TPI) and the entire refractory application is to be carried out in his presence along with refractory manufacturer supervision at site.

5.11 START UP OIL AND IGNITION SYSTEM

- (a) Low Diesel Oil (LDO) or Bio-diesel shall be used as start-up/support oil system to bring the furnace of the CFB steam generator up to the required operating temperature during start-up. The Fuel oil system shall be designed to cater to maximum of 30% BMCR requirement. Fuel burners shall have High Energy arc (HEA) igniters for flame initiation.
- (b) Two (2) no fuel oil tank shall be provided for main plant area. Each tank shall be sized considering 8 hours storage requirement for Boiler and all diesel generators.
- (c) The fuel oil supply system shall consist of Three (3) 100% capacity fuel oil (1 working for each unit + 1 common standby) pressurising pumps, suction strainers, compressed air atomised burners, fuel oil and air piping, fuel oil safety and burner shut off valves, fuel oil pressure and

temperature control valves, fuel oil metering units, valves and fittings, instrumentation, safety and control systems.

- (d) Drain oil connection and pumping system shall be provided in steam generator area.
- (e) Minimum turn down ratio of 4:1 shall be provided. Adequate number of position indicating contacts for integration into burner management system (BMS) shall be provided.
- (f) The air fuel ratios around the burners shall ensure low NO_x emission. The Bidder shall furnish details of the system proposed to be adopted by him for NO_x emission control.

5.12 BLOW DOWN SYSTEM

- (a) The blow down system shall consist of continuous blow-down (CBD) tank and intermittent blow down (IBD) tank, all piping, headers, valves, supports and hangers, insulation, level control system and instrumentation etc.
- (b) CBD tank shall be connected to IBD tank with CBD tank level control system complete with auto level drain control valve. The steam space of CBD shall be connected to the deaerator with NRV & isolation valves.
- (c) Safety relief valve shall be provided on the CBD tank. Anti erosion compensating wearing plates shall be provided at the inlet of each tank. The tanks shall be provided with manhole openings of suitable size with bolted and hinged doors. The vent of IBD tank shall be led to a safe location.
- (d) All drain lines in steam & water side leading to the respective drain headers/IBD shall be provided with two valves and the second valve shall be motor operated.
- (e) The continuous blow down line shall be provided with motorised isolation valve and motorized inching type blow down valve. The intermittent and emergency blow down lines shall also be provided with motorised isolation valve and motorized inching type blow down valve.

5.13 SOOT BLOWING SYSTEM (IF PROVIDED)

- (a) Fully automatic, sequentially controlled, microprocessor based steam soot blowing system would be provided. The system would have short retractable rotary wall blowers for the furnace and long retractable rotary blowers for the super heater, economizer and air preheater.
- (b) The soot blowing system consist of motor operated steam soot blowers of the rotary and retractable type, with drives, pressure reducing, isolation and relief valves, steam traps, thermal drain valves, complete piping, support and hangers, insulation, motor control centres and soot blower instrumentation and control system. The system is of self-draining type.

- (c) The auxiliary steam for soot blowing including pressure reducing & de-superheating station, piping, valves, fittings, instrumentation etc. shall be arranged by Bidder within their battery limit.

5.14 HIGH PRESSURE CHEMICAL DOSING SYSTEM

- (a) The phosphate dosing system shall be supplied for boiler unit to maintain the drum water chemistry.
- (b) The system shall be complete with phosphate preparation/metering tank, 2 x 100% dosing plunger pumps complete with suction / discharge valves, Y-type strainers, instrumentation, dosing pump discharge header sectionalising valves and complete piping with isolating and non-return valves, safety eye washers etc.
- (c) Complete system for High Pressure chemical dosing shall be skid mounted only and proper spaces for the O & M shall be provided in & around the skid.

5.15 LOW PRESSURE CHEMICAL DOSING SYSTEM

- (a) The LP dosing system (O₂ scavenger and Ammonia) shall be supplied to maintain the feed water chemistry.
- (b) Each system shall be complete with preparation/metering tank, 2 x 100% dosing plunger pumps complete with suction / discharge valves, Y-type strainers, instrumentation, dosing pump discharge header sectionalising valves and complete piping with isolating and non-return valves, safety eye washers etc.
- (c) Complete system for Low Pressure chemical dosing shall be skid mounted only and proper spaces for the O&M shall be provided in & around the skid.

5.16 AUXILIARY COOLING WATER SYSTEM

- (a) The auxiliary cooling water system shall be supplied at one point to each Boiler. The further distribution of auxiliary cooling water shall be in the Bidder's scope. The system shall consist of complete piping to all equipment requiring cooling water. Each cooler / bearing shall be supplied with isolating valves at the inlet and throttling type valves at the outlet. Flow measurement of suitable range shall be provided for every equipment. Local drains at outlet side shall be provided near all the equipment. An air vent shall be provided at the top most point in the boiler side. Adequate number of Pressure and temperature indicators shall be provided.

5.17 STEAM TURBINE GENERATOR & AUXILIARIES

- 5.17.1 The steam turbine shall be of a proven design for the specified duty conditions. The steam turbine shall meet the design criteria specified in IEC-45 standard (latest Edition).
- 5.17.2 The steam turbine and accessories shall operate satisfactorily in the entire design frequency range specified in Attachment 1: Technical data sheet, without exceeding the safe vibration limits and acceptable noise level under all operating conditions.
- 5.17.3 The steam turbine and auxiliaries would be designed to operate as a base load station (2x30 MW) as also it shall be capable to operate at cyclic load variations. The turbine design will cover adequate provisions for quick start-up and loading of the units to full load at a faster rate. In case of sudden reduction in demand (load throw off), the unit should get safely unloaded and stabilized for operation at house load. During disturbances in the sub-station, the unit shall be capable of operating in an islanded mode catering to its own house load (about 5 to 6%). These disturbances shall not cause tripping of steam generator.
- 5.17.4 The steam Turbine shall also be designed to operate continuously with turbine under VWO condition (i.e., output of 105% TGMCR).
- 5.17.5 The steam turbine generator shall be capable of safely operating and continuously delivering rated output, under following operating conditions:
- a) With a frequency variation of $\pm 5\%$ over the rated system frequency of 50 Hz.
 - b) Within $\pm 10\%$ of voltage variation of the rated generator voltage at maximum and minimum of rated frequency range.
- 5.17.6 Each steam turbine unit shall include the equipment, base/sole plates, foundation bolts, embedment's, instrumentation and control equipment, electrical hardware and accessories, heat resistant and special shielded cables where required, all piping, fittings, valves and specialties, hangers and supports, thermal and acoustic insulations etc. as specified and as required to make the system complete and in line with the technical requirements of this specification.
- 5.17.7 Each steam turbine shall be complete with steam strainers, turbine emergency stop and control valves, interconnecting piping between emergency stop valve (steam strainer integral to ESV) and turbine casing, Blow out kit for steam blowing, turbine governing and protection system, solenoid valve for remote tripping.
- 5.17.8 Each turbine will have two no internally controlled automatic extraction facility and quick closing non-return valve as well as isolation valve shall be provided in the extraction piping. Adequate safety relief valves and vent valves shall be provided in the extraction and exhaust piping. The safety valve and vent valve outlet shall be led to a safe location.

5.18 TURNING GEAR

The turning gear shall be electric motor driven and with auto-engage & auto disengage arrangement. A hand operated mechanical barring gear shall also be provided in addition to motor driven turning gear which can be used in the event of an emergency.

5.19 STEAM TURBINE GLAND AND GLAND STEAM SEALING SYSTEM

- a) Each cylinder shall be provided with efficient shaft glands of the steam sealed multistage labyrinth metallic type. Design shall permit examination and replacement if necessary, of the glands without lifting the upper half of the turbine casings.
- b) The system shall automatically control the pressure of the gland sealing steam under all operating conditions through a set of control valves. During normal operation, the source of sealing steam to be from the turbine. During start-up and low loads, an alternative source of sealing steam to be provided from the main steam line or from the auxiliary steam header. Necessary pressure reducing and desuperheating station also to be provided. The switchover from the start-up/low load source to the main source (from steam turbine) to be automatically achieved above a certain set value of the load. Alternatively, Bidder may consider external sealing steam from auxiliary steam header at all load regimes as per their standard design.
- c) A gland steam condenser with stainless steel tubing and an evacuation system consisting of two full capacity AC motor-driven fans/blowers for handling gland leak-off to be provided.
- d) An alternative path to discharge gland steam to atmosphere outside turbine building to be provided for use during outage of the gland steam condenser.

5.20 STEAM TURBINE LUBRICATING OIL AND CONTROL OIL SYSTEM

- a) The turbine lube oil system for each unit shall comprise of One (1) no. main lube oil tank, One (1) no. Shaft driven or AC motor driven main oil pump, One (1) no. AC motor driven (screw type) auxiliary oil pump, One (1) no. DC motor driven (gear type) emergency oil pump for safe coasting down, One(1) no. AC motor driven and one (1) no. DC motor driven Jacking Oil pump (if necessary as per manufacturer's standard Two (2) nos. 100% duty AC motor driven vapour extractors, Two (2) nos. 100% duty lube oil cooler, Two (2) nos. 100% duplex filter, One (1) no. centrifuge type oil purifier of capacity 1000 LPH, One (1) no. emergency overhead lube oil tank, accumulators, piping, valves, fittings, instrumentation etc.
- b) The main oil tank and overhead lube oil tank shall be of stainless-steel material. The entire lube oil supply & return piping shall also be of stainless-steel material.
- c) For each steam turbine - The control oil system shall be separate with lube oil system. The separate control oil system shall be comprising One (1) no. control oil tank with two (2) x 100 % AC motor driven vapour extractors, Two (2) nos. AC motor driven (screw type) control oil pumps, common filters for lube oil and control oil system, Two (2) nos. 100% duty cooler (shell & tube type with removable tube bundles), accumulators, piping, valves, fittings, instrumentation etc. The grade of oil to be used with complete specification for both control system and lube oil system shall be indicated by the Manufacturer.
- d) The control oil equipment and piping system shall also be of SS316L material. Safety Block with trip solenoid valve shall be offered which shall be interlocked with tripping circuit. Local Gauge Board with governing oil system instruments and other hydraulic components is not required/offered. Necessary instruments required for governing oil shall be as per OEM

standard. One (1) number open type local gauge panel shall be offered with below measurement:

- Main Steam Pressure & Temperature (local gauge)
- Exhaust Pressure & Temperature (local gauge)
- Lube Oil Pressure (local gauge)
- Control Oil Pressure (local gauge)
- Speed Signal (Digital Indicator)

5.21 STEAM TURBINE GOVERNING AND PROTECTION SYSTEM

- (a) The steam turbine generator unit shall be equipped with an governing system capable of controlling and regulating the speed of steam turbine in conformity with performance characteristics specified. It shall include necessary speed / load / pressure / frequency controllers, load limiter, speed / load changer. A mechanical hydraulic control (MHC) system with continuous tracking arrangement also to be provided. In case mechanical hydraulic backup is not provided, adequate redundancies in the governing system shall be included to ensure reliable and safe operation.
- (b) Each Steam turbine shall be equipped with separately actuated overspeed device called quick acting emergency governor to trip the unit at 110% of rated speed in case speed governor fails to limit the turbine overspeed. Means for testing the operation of emergency governor when the machine is on load without exceeding the rated speed of the unit.
- (c) All critical trip functions as per recommendation of OEM shall have separate triplicated initiating contacts and logic processing shall be carried out by two independent channels of electronic logic circuits.
- (d) Fire Protection for Lube oil and control oil shall be provided.
- (e) Any other protection required as per OEM recommendation shall be provided.

5.22 STEAM TURBINE SUPERVISORY EQUIPMENT

- (a) The steam turbine supervisory equipment to be provided to indicate and record the behavior of the steam turbine under varying conditions and provide adequate warning of the development of potentially dangerous steam turbine conditions.
- (b) The supervisory equipment for each unit shall include detection and recording of, but not be limited to the following: -
 - Shaft vibration - Relative shaft vibration in both X & Y direction for steam turbine and generator (16 Nos - XY radial shaft vibrations)
 - Turbine speed
 - Turbine load
 - Emergency stop and governing valve position (As per OEM Design)
 - Inlet steam pressure & temperature

- Extraction & Exhaust steam pressure & temperature
- Casing metal temperature differentials
- Bearing metal temperature (For Turbine, gear box & Generator), axial shift / displacement (For Turbine rotor) and drain oil temperature at common return header.
- Keyphasor

5.23 PRESSURE REDUCING DESUPERHEATING SYSTEM (PRDS)

Following Pressure reducing desuperheating system (PRDS) and desuperheaters

- De-superheater- Medium Pressure Extraction steam to process from turbine extraction.
- De-superheater- Low Pressure Extraction steam to process from turbine extraction.
- Pressure reducing desuperheating system (MP PRDS)- Medium pressure steam to process from main steam with 100% redundancy
- Pressure reducing desuperheating system (LP PRDS)- Low pressure steam to process from MP steam with 100% redundancy

Above are the minimum PRDS & Desuperheater requirement. Bidder shall include additional PRDS & Desuperheaters (if any) based on final HMBD.

- (a) The PRDS station shall be sized to meet maximum MP and LP steam at rated parameters mentioned in this specification. The complete upstream and downstream piping, fitting and accessories for the bypass arrangement shall be part of the system. Spray water supply line from BFP discharge outlet along with the spray water control valve shall also provided.

5.24 AUXILIARY STEAM SYSTEM

- (a) One (1) nos. PRDS for auxiliary steam requirement during startup and normal unit operation shall be provided as part of auxiliary system. One (1) nos. pressure reducing station requirement for gland sealing.
- (b) The following auxiliary steam consumers are envisaged as a minimum:
 - I. Turbine gland sealing
 - II. Steam jet air ejector hogging
 - III. Steam jet air ejector holding
 - IV. Vapour absorption machines for Air conditioning
 - V. Any other, if required
- (c) The auxiliary PRDS shall be designed based on the above requirement in line with the final HBD from the turbine OEM. Flow capacity shall meet the gland sealing, hogging /holding ejector requirement during start-up.
- (d) Deaerator pegging steam shall be taken from LP process steam header.

5.25 SURFACE CONDENSER AND ACCESSORIES

- 5.25.1 The Condenser shall be designed for 5% margin above the heat load at the condition of 10 MW gross power output of turbine with zero process steam requirement. Also, 5% tube plugging margin with cleanliness factor of 90% to be considered for condenser design. The condenser shall be designed for a temperature rise of 5°C with a design cooling water temperature of 34.6 °C. The condenser shall be provided with a neck to connect the turbine exhaust opening. The condenser unit shall be capable of condensing all the steam from the associated turbine over the entire load range with all drains being dumped into the condenser, with the design cooling water inlet temperature specified. The condensate temperature shall not be less than the saturation temperature corresponding to condenser backpressure.
- 5.25.2 The condenser shall be such that the condenser pressure, corresponding to sudden load throw-off without bypass system at maximum condenser cooling water inlet temperature does not exceed the turbine trip value for the condenser pressure. Further, the selected condenser shall not cause unit capability loss at the maximum condenser inlet cooling water temperature.
- 5.25.3 The location and design of steam and water dumps to the condenser shall be in accordance with ASME Standard TDP-1, Part-1.
- 5.25.4 The velocity of water in the condenser tubes shall not exceed 2.0 m/s. Adequate arrangement and space shall be provided at the rear of the condenser to facilitate the removal of condenser tubes. Also, turbine foundation columns shall be suitably placed to enable easy operation of rear water box door.
- 5.25.5 Hinged quick opening manhole covers shall be provided for easy access to the interior of water boxes for inspection or maintenance. At least two manholes shall be provided in each water box/reverse chamber. Suitable lifting lugs shall be provided for the water boxes.
- 5.25.6 Each waterbox shall be provided with a drain valve of adequate size at the bottom to enable the front and rear waterbox and tubes to be emptied of water in not more than 30 minutes. Also, each water box shall be provided with adequately sized vent line with two valves. One valve, immediately after the tapping and the second valve at an accessible area near vent termination for frequent operation.
- 5.25.7 Access manholes of adequate size shall be provided, one in each of the hotwell sections. Hotwell connections to suction of condensate extraction pumps shall have anti-vortex baffling and the screen mesh shall be made of SS 304.
- 5.25.8 A suitable means of access shall be provided into the condenser to permit inspection and cleaning of confined areas. For this purpose, an access manhole of 600 mm x 600 mm size minimum shall be provided on the shell above tubes.
- 5.25.9 The condenser hotwell shall be sized for minimum of three (3) minutes storage retention at maximum flow. The above storage shall be from normal level to the low-low level of the hotwell.

The low - low level shall be 150 mm above the bottom of hot well. Connections shall be provided to empty the hotwell and the emptying time from the normal operating level (to the station drains) shall be about one hour or less.

5.25.10 The tube material shall be as per datasheet in Attachment-1, manufactured and tested in accordance with the approved standard. All tubes shall be of tested quality and the Bidder shall have to submit the test certificate of the tubes. Each tube shall be eddy current tested for soundness. The tubes shall be roller expanded. The extent of tube expansion shall be established by mock-up test and all expansion shall be done to the measured extent.

5.25.11 The tube support plates shall be arranged suitably so that no periodic vibration of tubes may be induced by the running of the Turbine and the maximum span shall be limited such that vibration induced by steam flow may not occur. Edges of tube holes with support plates shall be chamfered and deburred to prevent tube damage.

5.26 Condenser Air Removal System (Steam Jet air Ejectors)

- a. The air removal system functions under two regimes: One during normal operation and the other when raising vacuum on the turbine during start up.
- b. The condenser air removal system shall primarily consist of one (1) start up (hogging) ejector and two (2x100%) main running ejectors with inter and after condenser.
- c. The start-up ejector shall be designed to lowest possible parameters to achieve vacuum as quickly as possible during start up.
- d. The outlet piping of startup ejector shall be provided with a silencer and the piping shall be terminated outside the building at a safe elevation.
- e. The ejector unit shall be designed, constructed and tested in conformance with the latest edition of HEI standards. Each element shall be designed to handle the capacity recommended in the latest edition of HEI standard to suit steam surface condenser.
- f. All necessary pipes, fittings, valves, flanges and instruments shall be provided by the Bidder to complete the system.

5.27 Condensate Extraction Pumps and Accessories

- a. 3x50% condensate extraction pumps of vertical canister type shall be provided for each unit to pump the condensate from the condenser hotwell through the steam jet air ejector, gland steam condenser, to condensate make up water storage tank.
- b. In order to ensure an acceptable availability between planned maintenance periods, components of pumps shall not be made of materials which are degradable and/or which will wear and need replacing within 40,000 hours with the exception of mechanical shaft seal materials, which shall be capable of operating for not less than 15,000 hours.
- c. The pump characteristic curve tolerances shall be limited to:

Sl. No.	Description	Plus(%)	Minus(%)
1.	Flow at guarantee point	0	0
2.	Head at guarantee point	3	0
3.	Efficiency at guarantee point	Unlimited	0
4.	Shut-off head	5	0

These tolerances shall be the permissible variations between the conditions as proposed initially by the Bidder and the design parameters demonstrated during acceptance tests.

- d. When pumps operate in parallel, the load sharing deviation between them be limited to 5% at flow capacities from the design flow down to the minimum flow.
- e. The pump motor rating shall not be less than larger of the following:
 - i. Sufficient to drive the pump through the entire range of run-out flow to shut-off conditions.
 - ii. 110% of pump design point rating.
 - iii. 115% of maximum power requirement of the pump.
- f. The suction specific speed for the pump shall be selected so as to ensure that pump is completely protected against low flow recirculation and consequential cavitation and without exceeding specified vibration level over the entire operating range. Pump with suction specific speed value higher than 11000 US units, not proven in practice, may be rejected.
- g. The construction shall be such as to allow removal of pump shaft and impeller without disturbing the canister.
- h. The suction side vent of each canister shall be individually connected to the condenser. The discharge side vent of each condensate extraction pump shall have its own solenoid valve operated, together with break down orifice and be connected individually to the condenser.
- i. The initial sealing water for the condensate extraction pumps shall be from the hotwell make-up system, and during normal operation from the condensate extraction pump discharge. The transfer from one sealing water source to another shall be automatic.
- j. The minimum recirculation system of the condensate extraction pump shall also meet the minimum flow requirements of gland steam condenser.
- k. Pump shaft coupling shall be of flexible type and the thrust bearing shall be provided in the pump. Pumps shall be fitted throughout with renewable wearing parts such as wearing rings, shaft sleeves, stage sealing rings, etc.
- l. The suction valves shall be suitably sealed to avoid ingress of air into the condensate.
- m. The impeller shall be cast in one piece finished all over and carefully balanced both statically and dynamically. Individual impeller shall be balanced in single plane. Entire rotor shall be balanced in two planes. The assembled rotor shall also be dynamically balanced.

- n. Suitable automatic starting devices shall be provided to bring the stand-by pump into operation in case of failure of operating pump or when the condensate header pressure drops below a predetermined value. The following protections shall be provided for the Condensate Extraction Pump (CEP) as a minimum
 - i. Condenser Hot well level 'Low-Low'
 - ii. Discharge pressure before Non Return Valve on the CEP pump discharge is less than pre-set value
 - iii. CEP drive motor protections actuated

The above-listed protections are a minimum and additional protections if required shall be provided to make the system complete during detailed engineering phase.

5.28 Make up water storage tanks and pumps

One (1) no make up water storage tank for each unit shall be provided to store the TG cycle condensate, return condensate from refinery plant and shall be used as buffer storage tanks. Return condensate shall be supplied at plant boundary with the quality indicated in this specification. Suitable arrangements to be made to drain the return condensate at nearest drain pit in the event of bad quality return condensate is received. DM water shall be used as cycle make up with level control station at each tank inlet. Suitable heating arrangements to be provided on the tanks for preheating the condensate before transferring to deaerators. The pegging steam shall be taken from auxiliary steam header. 2x100% Makeup water pumps shall be provided to transfer the condensate to deaerators.

5.29 FEED CYCLE EQUIPMENT AND ACCESSORIES

Deaerating Feed Water Heater

- a. One (1) no spray cum tray type constant pressure deaerator for each unit shall be considered. The constant pressure deaerator shall be capable of satisfactory operation under boiler MCR conditions, normal operation, condition of turbine trip, no condensate return from process and steam bypass operation (full open) and lowest condenser pressure. Minimum condenser pressure shall not affect deaerator performance in any manner. The pegging steam to the deaerator shall be taken from auxiliary steam header.
- b. Deaerator and storage tank shall be designed and constructed ASME Section VIII Div I code (latest edition) for unfired pressure vessels. The tray supports shall be rigid enough to withstand severe vibrations that would be caused due to water. All materials used inside the deaerator such as trays, fasteners, support rods, nozzles shall be of SS. The sprayer shall be spring controlled spray valves (variable flow area) which ensures fine atomization of condensate at all loads. The sprayer device shall provide a self-regulated system in which disc/piston opening adopts automatically to the changing hydraulic loads.
- c. Heating steam shall be introduced into the water stored in the feed water tank through a rake of sparger steam pipes below the minimum water level. The rake shall be suitably supported to

prevent vibration. Suitable means shall be provided to prevent back flow of water into steam pipes in case there is any sudden drop in steam pressure. A separate heating steam rake to supply heating steam during start-up shall be provided. These heating steam pipes shall be suitably supported to avoid excessive vibration during start-up, normal operation and transients. Steam pipe configuration shall be such as to prevent entrainment of any heating steam into boiler feed pump suction lines.

- d. Deaerator safety valve shall be provided on deaerator. The safety valve should of adequate relieving capacity. The disc and spindles of the safety valve shall be made of 13% Cr. stainless steel.
- e. Manholes of minimum 500mm on deaerator and storage tank for access to and removal of internals including trays shall be provided.
- f. The outlet pipes from the feed water storage tank shall be provided with a vortex breaker and project a minimum of 75 mm above the bottom of the storage tank so as to prevent sludge from getting into the suction pipes of the boiler feed pumps. The feed water storage tank shall be provided with two manholes of minimum 500 mm size. In case of spray-tray type deaerator an additional manhole with hinge shall be provided at a suitable location in the deaerator section.
- g. Low load recirculation flow and balancing device leak off flow systems from the boiler feed pumps shall be led to the feed water storage tank.
- h. The vent from the continuous blow down tank (CBDT) shall also be led to the deaerator.
- i. The deaerator level shall be controlled by controlling the condensate inlet flow into deaerator during normal conditions. The feed water storage tank shall have a minimum of 10 minutes storage capacity of 100% BMCR between normal operating level and low-low level. The overflow and drain from deaerator shall be led to the condenser through flash tank.
- j. The sprayer shall be designed to ensure fine atomization of condensate at all loads upto 110% of the design flow.
- k. The maximum oxygen content of the feed water discharge from the Deaerator without chemical dosing shall not exceed 7ppb at all loads and including the rated capacity. The carbon dioxide content of the feed water discharge shall be nil.
- l. The deaerator shall be capable of deaerating all the incoming steam and condensate, HP heater drain and DM make up water even when there is no condensate return from process at a rate to provide boiler feed to match the boiler MCR requirements continuously. It shall be designed to avoid any stagnation pockets of non-condensable gases.
- m. The operation of deaerator shall be stable and free from vibration, water hammer when subjected to pressure decay which may occur at full load trip out condition of the TG and during the interval required for change over to the alternative steam source.
- n. Relief valves to be designed to relieve the largest capacity resulting from one of the following conditions:

- a. Extraction steam entering deaerator
 - b. Condensate entering Deaerator
 - c. Pegging steam quantity.
 - d. Other flows entering deaerator.
- o. The deaerator shell and storage tank may go under vacuum during certain abnormal conditions and deaerator and storage tank shall be designed accordingly. The storage tank shall have one support leg fixed and other of sliding type to take care of expansion. The Deaerator shall be provided with drain connection on the storage tank with manual valve and drainpipe to the basement level, Initial fill line with NRV, motor operated valve, gate valve etc. Vacuum breaker valve shall be provided for deaerator.
- p. The vent from the continuous blow down tank (CBDT) will also be led to the deaerator. The deaerator level shall be controlled by controlling the make up water into deaerator during normal conditions. The overflow and drain from deaerator shall be led to IBD.
- q. Maintenance platforms, ladder, strainer assembly for sprayers, approach stair and lugs for attaching platforms and walkway around equipment shall be provided and should be hot dip galvanized.
- r. The Deaerator shall also be provided with thermometer pockets and thermometers on the storage tank, deaerating section, condensate inlet, feed water outlet from the deaerator water storage tank, steam inlet, etc. Pressure gauge and relief valves to conform with the code requirements, air release valves, Water level gauge illuminated / two (2) nos., level transmitters / level controllers and other instruments mounted on separate standpipes with isolating valves and provision for initial filling, vent and drain connection. For initiating alarms, protective actions, level indication and level control functions, the following shall be provided as a minimum on the Deaerator Feed water storage tank
- i. LOW level
 - ii. 'LOW –LOW ' level
 - iii. 'HIGH' level
 - iv. 'HIGH –HIGH 'level
- s. The above listed are a minimum and additional provisions if required during detailed engineering phase shall be provided to make the system complete.

5.30 Boiler Feed Pumps

- a. The boiler feed pump group shall consist of 2 x 100% duty boiler feed pump sets for each unit. There shall be common suction header and common discharge header for all the BFPs of both Units. The suction for the BFP pump shall be taken through strainers for the individual pump from deaerating feed water heater. A boiler feed pump (BFP) set shall comprise of a main pump,

lubricating system comprising oil pumps, working and lube oil coolers, duplex filter, oil tank, connected pipes, valves, etc. for the entire BFP system.

- b. The boiler feed pumps shall be of horizontal, multistage, constant speed centrifugal pump. A design with both suction and discharge nozzles on top, pointing upwards shall be preferred.
- c. Location of deaerating feed water heater and offset of suction piping from pumps shall be such that the margins on net positive suction head (NPSH) required by pump during normal and transient conditions, would be as per Data Sheet and flashing/steaming in suction lines is avoided under all operating modes.
- d. If required, a pump warm-up system shall be included in case Bidder's pump required the same. In case Bidder does not recommend provision of same, the same shall be substantiated by proven experience. However rapid start-up of pump set shall be possible from any operational condition i.e. cold or partially warmed-up.
- e. The Bidder shall furnish calculations to justify the acceptability of the location of the deaerating feed water heater with respect to margins over the required NPSH by the pump during normal and transient conditions. The transient condition would be during a turbine trip with the boiler trip condition or any other condition. The calculations shall have to be approved by Owner / Owner's representative.
- f. During normal operation the discharge valve of standby BFP set would be kept normally open. Each BFP set as a whole shall be capable of withstanding the reverse rotational speeds which would result from non-return valve failure under the most severe condition (i.e., remaining normally working pump operating at full speed) and provided with a suitable instrumentation to detect reverse rotation of pumps due to backflow of water after motor is tripped. It is not recommended for the pump to be rotated in reversed direction for longer duration (discharge valve to be closed immediately). However, the offered pump shall be suitable for reverse rotation and same shall not be allowed to start or run during reverse rotation. Bidder shall provide reverse rotation detection system to close discharge valve on detection of same.

Pump characteristic curve test tolerances shall be limited to:

Sl. No.	Description	Plus(%)	Minus(%)
1.	Flow at guarantee point	0	0
2.	Head at guarantee point	3	0
3.	Efficiency at guarantee point	Unlimited	0
4.	Shut-off head	5	0

These tolerances shall be the permissible variations between the conditions as proposed initially by the Bidder and the design parameters demonstrated during acceptance tests.

- g. The suction specific speed for the pump shall be selected so as to ensure that the pump is completely protected against low flow recirculation and consequential cavitation. The suction

specific speed shall not exceed the value specified in data sheet. The specified vibration level shall not be exceeded over the entire operating range. The vibration level of the offered pump shall be as per ISO 10816-7 zone A. The Bidder shall indicate a reference list of installations where he has supplied similar capacity pumps with the suction specific speed value equal or higher than that offered by him. The impeller shall be designed for a minimum 40,000 hours operation.

- h. In the event the normal sound level exceeds the allowable level specified, acoustical treatment features, subject to the Owner's review and acceptance, shall be in the basic scope to achieve the specified sound level.
- i. Dry running of the BFP is not recommended however, in case of power failure the pump and motor shall be suitable till the coasting down of the pump to stand still condition. Also, suitable dry run protection features to be implemented for BFP operation.
- j. However, the pump shall preferably be capable of running under vapor locked condition for a sufficient duration without any damage during transient reduction in suction pressure well below that required for cavitation free operation.
- k. The pump motor rating shall not be less than the larger of the following:
 - i. Sufficient to drive the pump through the entire range of run-out flow to shut-off conditions.
 - ii. 110% of pump design point rating.
 - iii. 115% of maximum power requirement of the pump.
- l. Pump suction and discharge nozzles shall be provided with flange connections to standard ANSI B 16.5. Pump casing vent and drain connections with plugs and valves shall be provided, as required.
- m. All bearings shall be provided with a forced lubrication from a common oil system. The thrust bearings shall be of tilting pad type and suitable arrangement shall be provided to adjust the clearances. Also, the design of lubricating oil system should take into account the oil requirements of the motor wherever thrust bearings are fitted. Bearings shall be easily accessible without disturbing the pump. Each bearing housing shall have a drain plug. The bearing housing shall be cooled with passivated DM water.
- n. A suitable axial thrust balancing arrangement preferably balancing drum & segmental pad type thrust bearing shall be provided. The balance drum leak-off shall be lead back to pump suction. No axial thrust shall be transferred to the electric motor at any condition of operation.
- o. Adequate space shall be provided between pump drain connections and base plate for installation of minimum 15 mm drain piping. Pumps shall be supplied with suitable drainpipes or drain rim type base plates with tapped drain connections.
- p. All BFP sets shall have individual lubrication system. The lubrication system shall include, but not necessarily be limited to, a shaft driven oil pump, a spare full capacity electric motor driven oil pump, all piping valves, return flow sight gauges, relief valves, oil coolers, pressure and temperature switches, duplex or two simplex filters, pressure gauges, flow control devices, oil level indicators,

supply thermometers and return oil thermometers for each bearing and an oil reservoir. All oil piping, valves and fittings shall be of carbon steel and shop fabricated.

- q. The pump shall be supported in such a manner as to permit free expansion both axially and radially whilst maintaining alignment. The boiler feed pump shall be subjected to reasonable forces and moments from main pipe work. Therefore, the terminal connections of pump shall be designed accordingly.
- r. Required electrical interlock shall be provided for safe and continuous operation of the lubricating oil system, including supply of pressure transmitters for automatic pump start, trip and alarm interlocks. The following protections shall be provided as a minimum but not limited to: -
 - i. Deaerator level low – low
 - ii. BFP suction pressure very low
 - iii. BFP suction flow very low
 - iv. BFP suction flow very high
 - v. Feed water temp. at BFP discharge very high
 - vi. Differential temp. of feed water across BFP discharge and suction very high
 - vii. BFP motor protections actuated
 - viii. Balancing drum leak off pressure high
 - ix. Lube Oil header pressure very low
 - x. Lube Oil temp. after oil cooler very high
 - xi. Bearing metal temp very high
 - xii. Very high vibration
- s. The above listed protections are a minimum and additional protections, if required shall be provided to make the system complete during detailed engineering phase.
- t. The pumps shall have top suction and discharge nozzles with raised face flanged ends for suction and welded connection for discharge with appropriate pressure class and provided with necessary reinforcements, to withstand the forces and moments transmitted from connected pipes and arrangements to eliminate leakage.
- u. A minimum flow recirculation arrangement shall be provided along with each pump. Capacity of the devices shall be adequate such that even under closed condition of the pump discharge valve the temperature rise of the pump and flow induced vibrations are within acceptable limits.
- v. All local instruments necessary for safe operation of the pump set shall be supplied and arranged in a local gauge board.
- w. Mechanical seals shall be selected on the basis of proven long term operating experience in a BFP environment. The mechanical seals shall have a life expectancy of atleast 15,000 hours.

- x. Bidder shall provide On-line monitoring system for vibration monitoring. All necessary protection required to protect the BFP, even if not included above shall be part of scope of supply.

5.31 DUST PRECIPITATION AND COLLECTION SYSTEM

- a. Each boiler shall have two (2) flue gas streams and one electrostatic precipitator (ESP) shall be provided for each stream of steam generator. The electrostatic precipitator shall be designed to limit dust concentration to less than 30 mg/Nm³ with (N-1) [where N = total number of fields] fields in service for the complete load range of steam generator under all fuel firing conditions and as per the analysis specified in this specification. The ESP casing design pressure shall be compatible with combustor design pressure. ESP shall be complete with supporting structural frames, collecting and discharge electrodes, shaft insulators, bush insulators, independent rapping system for collecting and discharge electrodes with automatic rapping controls, high voltage transformers, rectifiers, bus sections with sectionalising and grounding switches and controls, fly ash collecting hoppers with accessories etc. Bidder to implement High Frequency Transformer Rectifier (HFTR) and micropulse technology in ESPs for better efficiency. Bidder to elaborate in the Bid other energy efficiency measures adopted for ESP.
- b. Access doors and platforms and corresponding interior walkways shall be provided on each side of the casing before and after each of the fields in series at the bottom and midpoint elevations of the collecting electrodes in order to facilitate maintenance and inspection of each of the fields. Interior walkways shall be a minimum of 1200 mm wide.
- c. The staircases shall be located in between both the streams of ESP, towards the Steam Generator side. Staircase shall extend from zero meter floor.
- d. For personnel protection, key interlocks shall be provided to prevent the opening of any inspection and/or access doors until after de-energising of all high voltage equipment that can be reached and/or made contact with, through the inspection and/or access door.
- e. Each hopper shall be provided with a conveniently located 150 mm (6 inch) pipe nipple fitted with a quick removable hinged cap located near hopper outlets to facilitate emergency poking. ESP casing shall rest on specially designed bearings which will rest on supporting structures to allow thermal expansion and other load variations.
- f. Penthouse/weather enclosures shall be ventilated by electric motor driven fans. The temperature of transformer rectifier sets, controls etc., must be maintained within acceptable limits under all operating conditions with maximum ambient temperature. The fans shall be wall mounted, exhaust from inside the penthouse to the outside and be protected with rain louvers.
- g. The hoist to permit easy removal of each transformer-rectifier from its operating position to grade level shall be provided.
- h. The rapping system shall be designed for selective remote automatic or manual operation at adjustable intervals. Necessary rapping arrangement with controls shall be provided for perforated

gas distribution plate at inlet to and outlet from the ESP. Heating elements with auto cut provision and vibrating pads shall be provided for ESP hoppers on all four sides for smooth flow of ash through the hopper. Knife Gate Valve at the outlet of ESP hopper flange shall be provided by the Bidder.

- i. If necessary, SS liners shall be provided for ensuring smooth flow of ash.
- j. Guillotine Dampers shall be provided at the inlet and outlet of each stream of ESP for isolation.

5.32 TRANSFORMER RECTIFIER EQUIPMENT

- a. High Frequency Transformer Rectifier (HFTR) and micro-pulse transformer shall be provided by Bidder. Primary taps shall be included on the transformer. Transformer shall have electrostatic shielding between primary and secondary windings and shall have suitable shielding of the high voltage coil to accomplish proper voltage division in the transformer when unit is subjected to surge conditions encountered in electrostatic fly ash precipitator application.
- b. Each output leg of each transformer-rectifier set shall serve one bus section and both bus sections served by each transformer-rectifier set shall be in the same field.
- c. Transformer rectifier assemblies shall be mounted in a heavy gauge welded steel tank designed for a minimum of 0.5 kg/cm² test pressure and full vacuum
- d. All silicon rectifier cells shall be conservatively rated for compatibility with maximum circuit load and demands requirements.
- e. In the event of arcing, the filter voltage shall be switched off for several half cycles to ensure a satisfactory extinction of the arc. If dust bridging or metal short circuits occur in the precipitator, the precipitator short circuit current shall be limited to the rated current of the installation and disconnected completely after the expiration of a given time.
- f. Supports and shafts shall be provided with heating elements with auto cut provision. Supporting insulators shall be located in heated compartments that are maintained above the dew point of the flue gas. They shall be located out of the dirty gas stream. These shall be protected from weather by either a common top housing or individual compartments. A steel shroud below the insulator may be provided which will further inhibit dust diffusion. Each compartment shall be pressurised and ventilated by heated filtered air furnished by one motor driven blower.

5.33 CONTROL CUBICLES

Automatic control cubicles shall be furnished for indoor mounting. The automatic controls shall have full control from 10% of the power set rating to full rating.

The control system should be capable of:

- i. Evaluating sparking by intensity and wave shape.
- ii. Regulate power at the threshold of sparking.
- iii. Break a power arc within around ten- (10) milli sec of its occurrence.

- iv. Automatically control the arc response so that power is restored within around one hundred twenty (120) milli secs. And
- v. Modify the current wave shape permitting greater power input prior to reaching spark over threshold.

Adequate numbers of indicating instruments and alarms shall be provided on the control cubicles.

Rapper control system for each bus section or pairs of bus sections served by a single transformer-rectifier shall :

- a) Provide manual adjustments of the timing and frequency of operation and the rapping intensity from the control cabinets,
- b) Provide rapper diagnostic system including miniature indicating lights, digital indicators, etc.

5.34 ESP Motors

Drive motors of the rapping mechanism for collecting and discharge electrodes and fans shall comprise 415V, 3 phase, 50 Hz, rated direct-on-line induction motors with IP-65 enclosure.

In general, motors shall conform to Specification as specified elsewhere in this specification.

The storm water drain piping shall be provided up to the grade levels for ESP.

6.34.1 DAMPERS

- a. All necessary regulating and isolating dampers shall be provided for the efficient and convenient operation of the steam generator. The Bidder shall furnish a list of all dampers, their purpose and torque rating etc. together with the details of actuators and accessories for remote control. Powered dampers shall also have provisions for manual operation during emergency / maintenance along with graduated local position indicator.
- b. The dampers shall be capable of effectively stopping the flow in the closed position and while in full open position shall cause minimum pressure drop. Special attention shall be given to the design of sealing arrangement of isolating dampers to ensure that they provide a positive shut off when closed. Open and Close positions shall be clearly marked on each damper.
- c. The dampers in flue-gas paths shall be so located that the build-up of grit behind the damper blades is reduced to a minimum.
- d. The attachment of all louvers to the damper spindles shall be by means of key fitting. All bearings for spindles or damper operating gear shall unless approved to the contrary, be arranged for efficient grease lubrication. Grease lines of copper/steel shall be run from all greasing points on each damper to a convenient and easily accessible location adjacent to the respective damper and terminated with suitable clamps and grease nipples on a steel frame to facilitate easy lubrication.
- e. All dampers shall be arranged to facilitate local manual operation from a gallery or floor level. The operating gear shall be fitted with a graduated indicator and shall be designed such that the damper may be retained in any position. The isolating dampers shall, in addition be fitted with locking devices to permit locking in the fully open and shut positions.

- f. Power operated gas tight isolation dampers along with their drives shall be provided at locations required for carrying out internal repair and maintenance.
- g. The above dampers shall have guaranteed gas tightness efficiency (on flow) of 100%. The actual number, location and the scheme for the same shall be to Purchaser's approval. Bidder shall provide guillotine type dampers at the following:
 - (i) before and after each ESP
 - (ii) before and after each ID fan
- h. The inlet dampers shall be located in horizontal duct to avoid fly ash build up when in closed position.
- i. The damper shafts shall be rigid and shall have side bearing plates. Horizontal shafts shall be supplied wherever possible.
- j. Double gland type stuffing boxes with graphite impregnated asbestos packing material of equal acceptable to the Purchaser shall be used to prevent hot air or gases from escaping around damper shafts.
- k. Manual damper operation by the Purchaser shall be accomplished by hand-wheels accessible from platforms attached to the ductwork support steel.
- l. If grease lubrication is required grease connection shall be accessible.
- m. Bolted plates or other positive closures shall be supplied in order to permit pressure testing of the steam generator setting.

5.35 CRANES AND HOISTS

6.35.1 GENERAL

- a) Cranes and hoists shall be complete with its accessories, associated drives, motors, supporting structure, power supply, safety devices, and controls and shall conform to local statutory rules and regulations.
- b) All lifting and handling equipment to facilitate the handling of all equipment during erection/ maintenance/ overhaul during the plant's lifetime shall be in Bidder's scope. Bidder to furnish the required lifting arrangement for the following:
 - Turbine generator building shall be provided with electric overhead travelling (EOT) cranes. Crane shall be provided with main and auxiliary hook.
 - Hoists with monorails and chain pulley blocks shall be provided for all buildings as required for the entire plant.

- c) Crane /Hoists shall be rated for the heaviest component to be handled with the auxiliary hoist rated for 20% of main hook capacity. Subsequently, the required capacity of EOTs shall be in multiples of 5 metric tons.

6.35.2 CRANE DESIGN CONSIDERATION:

- a) The turbine generator building EOT crane shall be rated for the heaviest component to be handled. The generator stator shall be erected using jacking method or using mobile cranes. The main crane is used for maintenance of steam turbines and electric generators, generator coolers, lube oil units and the boiler feed water pumps. The auxiliary hoist is used to handle smaller components more rapidly.
- b) The height of lift for the Turbine Building EOT crane shall be based on lifting the tallest piece from the operating floor to grade, with consideration of sufficient clearances for lifting over other equipment on operating floor.
- c) The EOT cranes shall of the plate box girder construction. The crane structure shall be designed in accordance with IS 807. Box girders shall be designed as not to permit accumulation of water or oil inside them.
- d) The turbine building EOT crane shall be able to be operated both from cabin located on the crane and pendant push button station hanging from the crane. Air conditioning with one no. 4.5 kg CO2 type fire extinguisher shall be provided in Cabin.
- e) 10% of main speed shall be the creep speed and shall be provided for all motions.
- f) Access walkway with safety handrails shall be provided along the full span length of the Turbine Building crane.
- g) The turbine generator building EOT crane main hook shall be of Ramshorn type. The auxiliary hoist hook shall be of the shank type.
- h) The EOT cranes shall be designed to operate under overload test with 125% of rated load without any permanent deformation. The EOT cranes are designed with a maximum deflection of 1/900 of crane span at rated load.
- i) Incoming cable will be terminated at the isolating junction. The isolating junction box shall be located 1000 mm above the ground on one of the building columns below the runway conductors.
- j) The scope of supply shall include the minimum of the following:
 - i. Crane steel structure frame complete with end carriage with travelling machineries.
 - ii. Runway rails with associated fixtures comprising of fixing clamps, bolts nuts, etc.,
 - iii. Access ladders, stairs, walkways, platform and handrails.
 - iv. Hoist mounted on a trolley including brakes, hooks, load blocks, wire ropes, electric overload devices with flexible bumpers, slings and all necessary accessories including end stoppers, track sweeps, buffers, etc.

- v. High tensile wire ropes and rope guides
 - vi. Limit switches for all motions.
 - vii. Lube oil or grease for initial charge/filling
 - viii. All electrical accessories to make the equipment complete in all respects.
- a) Bridge Girders : The crane structure shall be designed in accordance with IS 807. The
 - b) main girders of the bridge shall be either box type construction or solid
 - c) web construction. The bridge girder shall have enough strength to carry
 - d) the rated load without causing undue stress or deflection.
 - e) 4.2.2 Box girders shall be designed as not to permit accumulation of water or
 - f) oil inside them. Hand holes or manholes shall be provided for ease of
 - g) inspection and cleaning.

6.35.3 **HOIST DESIGN CONSIDERATION:**

- a) For the equipment weighing above 1000kg or with a lift >10mtr, electrically operated type of hoists would be provided. For the equipment weighing < 1000 kg or with a lift <10mtr, manually operated hoists and trolleys would be provided.
- b) Design and construction throughout shall be based on ample safety factors to guard against injurious strains and distortions. All hoist parts shall be designed with a minimum safety factor of 5. All parts shall be readily accessible for inspection, adjustment, and repair.
- c) Non-spinning wire rope shall be used on all hoists where the load is suspended by a single rope.
- d) Hooks shall be of forged steel supported on a ball or roller bearing. They shall rotate freely within this bearing.
- e) All gears shall be forged, rolled or welded steel with cut teeth. All gearing shall be enclosed in dust tight housing. All gearing shall operate in grease lubricant or oil as appropriate.
- f) Bearings shall be grease lubricated. Bearings shall be sealed to prevent leakage and all bearings shall be protected against entry of dust. Bearings shall be grease tight. The equipment should be arranged so that all points of lubrication are easily and safely accessible.
- g) The scope of supply shall include the minimum of the following:
 - i. Hoist mounted on a trolley including brakes, single/plain forged steel hook supported on a ball or roller bearing with catches/latches, load blocks, wire ropes, electric overload devices with condition monitoring system, buffers and all necessary accessories including end stoppers and buffers.
 - ii. Limit switches for all motions.
 - iii. Complete motorized trolley.

- iv. Monorail with all accessories including clamps, hanger rods, bolts/nuts, washers, end stoppers, track sweeps, safety grips, pads, etc.
- v. High tensile wire ropes and rope guides
- vi. One (1) No. isolating switch shall be provided for each electric hoist with rising cable enclosed in conduit.
- vii. Lube oil or grease for initial charge/filling.
- viii. All electrical accessories to make the equipment complete in all respects.

6.35.4 Chain Pulley block design consideration:

- a) The chain pulley block shall be a complete unit with travelling trolley, load chain, load chain wheel, hand chain, hand chain wheel, necessary gearing, brakes for hoisting, hook, and other accessories to make the equipment complete in all respects. The chain pulley block shall be of worm or spur gear type and shall have minimum factor of safety as five (5).
- b) The hand chains for the hoisting and traverse mechanism shall hang well clear of the hook and both the chains shall be on the same side. The length of the hand chain shall be such that the lowest point of the suspended loop shall hang 400 mm above the operating floor level. The hand chain wheels shall be provided with roller type guarding to prevent snagging and fouling of the chain.
- c) Gears shall be cut from solid cast or forged steel blanks or shall be of stress-relieved welded steel construction or built-up from steel billets and welded together to form a one-piece gear section. Gears shall have proper lubrication arrangement and shall preferably be of totally enclosed type.
- d) Shafts and axles shall be of forged steel and shall have ample strength, rigidity and adequate bearing surface for intended duties. Shafts and axles shall be accurately machined and properly supported.
- e) Brakes shall be of automatic type that shall stop and hold the load when hand-chain pull is released and shall permit controlled lowering of the load when hand-chain pull is applied for lowering the load.
- f) Ratchet and Pawl mechanism shall be provided to arrest the full load from lowering due to gravity. The ratchet and pawl shall be of steel, hardened and tempered so as to attain required wear resistance and toughness.
- g) The lifting hook shall be single hook type, forged, heat treated, rugged construction and provided with a standard depress type safety latch. Lifting hook shall have swivels and operate on ball or roller thrust bearings with hardened races.

5.36 AIR CONDITIONING AND VENTILATION SYSTEM

6.36.1 GENERAL

This section consists of the technical write up of Heating Ventilation and Air conditioning (HVAC) system for BTG Package of Hindalco 2X30 MW Cogeneration Power Plant.

6.36.2 DESIGN BASIS

AIR-CONDITIONING SYSTEM

- i. The areas to be air conditioned are mentioned in Table 1 of this section.
- ii. The following Input data shall be considered in the Design of Air-conditioning system:

(a) Outside design conditions:

Season	Dry bulb Temperature(°C)	Wet bulb Temperature(°C)
Summer	46.6	25.55
Monsoon	30.55	27.77
Winter	12.22	6.66

- (b) Inside Design Conditions: Air-conditioned areas will have inside design conditions as per Table 1 of this section.
- (c) Heat Load Data: Occupancy, Equipment heat load, fresh air, fresh air heat load, solar heat gain and other necessary factors shall be considered as per latest ISHRAE /ASHRAE standards or as actual.

6.36.3 VENTILATION SYSTEM

- i. The areas to be ventilated and the type of ventilation system to be provided shall be as per Table 2 of this section.

The following Input data shall be considered in the Design of Ventilation system:

Outside Design Conditions:

Season	Dry bulb Temperature(°C)	Wet bulb Temperature(°C)
Summer	46.6	25.55
Monsoon	30.55	27.77
Winter	12.22	6.66

6.36.4 NOISE AND VIBRATION

- i. The design of Air-Conditioning & Ventilation (AC & V) equipment and accessories will ensure of noise and vibration levels within the limits as per latest codes and standards. The noise level will not exceed 85 dB (A) at 1.0 meter from any rotating equipment.
- ii. All connections between air handling unit (AHU)/ packaged AC / fans and ductwork will be properly aligned and executed using flexible material (Rubber and canvas or lead impregnated PVC). Also chilling unit, AHU, cooling tower and pumps will be connected to piping through flexible connections (Resilient vibration isolating materials).

6.36.5 **CODES & STANDARDS**

Following standards in their latest year of publication along with latest addenda shall be followed as applicable.

IS 659 / IS 660	Safety code for air-conditioning / mechanical refrigeration
IS 277	Galvanized Steel Sheets
IS 325	Three phase induction motors
IS 655	Metal Air ducts
IS 732	Code of practice of Electrical wiring and fittings for buildings
IS 900	Code of practice for installation and maintenance of induction motors
IS 996	Single-phase small AC and universal motors.
IS 1239	Mild steel tubes, tubular and other wrought steel fittings
IS 1248	Direct acting electrical indicating instruments
IS 1554	PVC insulated (Heavy duty) electric cables for working voltage up to (Part I) and including 1100 volts
IS 7613	Method of testing panel type air-filters for air-conditioning and Ventilation process.
IS 13947	Motor starters of voltage not exceeding 1000 volts
IS 2208	HRC cartridge fuse links up to 650 volts.
IS 13947	AC circuit breakers
IS 13947	Heavy-duty air break switches and composite units of air break switches and fuses for voltages not exceeding 1000 volts.
IS 520	Standard for positive displacement refrigeration compressor and condensing units.
IS 5111	Code of practice and measurement for testing refrigeration compressor.
IS 4671	Expanded polystyrene for thermal insulation purposes.
IS 702	Industrial bitumen

IS 8183	Bonded mineral wool
IS 8148	Packaged air-conditioners
IS 2312	Propeller type AC ventilation fans
IS 3588	Electric axial fans
IS 4894	Centrifugal fans
UL 555	Fire dampers
ARI 410-91	Method of Testing for Air cooling coils, heating coils
ISHRAE	Indian Society for Heating, Refrigeration & Air Conditioning Engineers
ASHRAE	American Society for Heating, Refrigeration & Air Conditioning Engineers
SMACNA	Sheet Metal and Air Conditioning National Associations (Duct Design)
ANSI	American National Standard Institute
ASTM	American Society for Testing Material
ARI-210	Standard for Unitary Air Conditioning Equipment
ARI 270	Standard for Application, Installation and Servicing of Unitary Air Conditioning Equipment
ARI 520	Standard for Positive Displacement Refrigerant Compressor & Condensing Units.
AMCA 210	Test Code for Air Movement Device.
NFPA-90A	Standard for Installation of Air Conditioning & Ventilation System.
NEC	National Electrical Code
NBC	National building code of India 2016
NEMA	National Electrical Manufactures Association.
IS-3963	Standard for roof extractors
IS-5120	Standard for Technical requirements for Rotodynamic Special Purpose Pumps

NOTE: All other relevant codes, standards and industrial standard practices shall also be followed if not mentioned in the above codes.

6.36.6 **DESCRIPTION OF SYSTEM**

AIR-CONDITIONING SYSTEM

Main Plant Control room area in TG building and AC areas in Operation & Maintenance building shall be air conditioned by centralized chilled water system using Vapor absorption chiller. CEMS room shall be air conditioned using Non ductable split air conditioner.

Bidder to submit heat load calculations for Summer, Monsoon and Winter along with heaters and humidifier calculations for selection of air conditioning equipment.

5.7.4.1 CHILLED WATER PLANT (AC PLANT)

In AC plant water chilling units, comprising of Vapour absorption machine (VAM) with chiller, water cooled condensers, absorber, heat exchanger, complete interconnecting refrigerant and absorbent piping, refrigerant pump, solution pump, insulation, purge unit, protective device, microcomputer/microprocessor control center and fully wired electrical panel etc. mounted on a common structural frame and 1 Nos. water cooled screw chiller as a standby to form (N working+1 standby) configuration with electric motor driven screw compressor, chiller, condenser, sub-cooler, economizer, expansion device, complete interconnected refrigerant piping, oil cooler, oil separator, microcomputer/microprocessor control center, fully wired electrical panel and protective device etc. mounted on a common structural frame.

Condenser water and chilled water pump set and associated equipment would be located at ground floor of Switchgear building. Chilled water from chilling units would be supplied to air handling units (AHU) located above and adjacent to the area to be air conditioned. Chilled water from the air handling unit, after picking up the heat load will be returned to the chiller units for cooling and recirculated to the air handling units. Each AHU will consist of casing, fan impeller section, cooling coil (chilled water type). Casing of AHU shall be of double skin construction, AHU shall have DIDW type centrifugal fan with backward curved blade.

The cooling tower and expansion tank for the air-conditioning plant would be located at the terrace of Switchgear building.

5.7.4.2 SPLIT AIR CONDITIONER

Non ductable Air cooled Split air conditioners are provided to cater the Air conditioning requirement of CEMS room.

Air cooled Split air conditioners with R134A/ R410A /R407C/ R32 CFC free refrigerant shall be provided and would be located inside the area to be air conditioned. The refrigerant after picking up the heat load from the air-conditioned area is passed on to the condenser which is placed outdoor for heat rejection. The refrigerant after heat rejection is then recirculated to the units and the cycle repeats.

Split unit would essentially comprise of the following:

- a) Indoor unit complete with fans, filters, cooling coils, expansion valves etc.

- b) Outdoor unit complete with outdoor fans, condenser coils etc.
- c) Refrigerant piping between the indoor and outdoor units, insulation for suction line.
- d) Necessary drain piping with insulation up to the nearest floor drain.

5.7.4.3 VENTILATION SYSTEM

TG building Ground floor, Mezzanine floor, Operating floor, Switchgear room and cable Vault shall be Ventilated by evaporating cooling.

Swas room, LAVT&NGR Panel room 1&2, I&C Battery room ,Tool room for turbine, Toilet area etc. Shall be ventilated by Mechanical dry ventilation system.

Bidder to submit Mechanical Ventilation and evaporative cooling system calculation for selection of Ventilation system equipment.

5.7.4.4 EVAPORATIVE COOLING SYSTEM

The evaporative cooling system is adopted with Air Washer Units (AWU). All Air Washer Units are of sheet metal enclosure type. Each air washer unit (evaporative system) will consist of the various sections such as Air Washer chamber/ casing, tank, distribution plates, set of metallic/ fabric filters at suction, suction louvers, bird screens, water headers, spray nozzle, piping, valves etc, drift eliminators, spray pumps, fans, necessary controls & instrumentation, and all other required accessories. The Air washer fan shall be of DIDW type.

Water spray system shall be double bank spray type with saturation efficiency 90%.

Cooled and filtered air from Air Washer Units is distributed by means of ducting. Part of the hot air (70% of the supply air) is exhausted by means of Turbo Ventilator mounted on the roof of TG hall. The quantity of air exhausted will be kept lower than the quantity of air supplied to maintain an overpressure with respect to the outside atmosphere. Inside temperature in evaporative cooled areas shall be 3°C less than design ambient temperature. Ventilation air requirement shall be calculated based on minimum air changes per hour or heat dissipation method, whichever is higher.

5.7.4.5 MECHANICAL VENTILATION SYSTEM

Mechanical Ventilation system with supply air fan/louvers and Exhaust fan/gravity damper is provided. The ambient Mechanical ventilation system will be designed based on maintaining inside temperature not exceeding 3°C above outside dry bulb temperature. Ventilation air requirement shall be calculated based on air changes per hour or heat dissipation method, whichever is higher.

7 DESIGN REQUIREMENT:

- 5.7.5.1 The air conditioning and ventilation equipment and accessories shall be designed for 24 hours operation continuously.
- 5.7.5.2 Vapour absorption chiller /split AC to be consider for the Air-conditioned areas as per heat load calculation.
- 5.7.5.3 Supply Air ducting for AC system shall be designed based on equal friction method at friction rate not exceeding 0.8 Pa/m and maximum initial velocity of 7.5 m/sec.
- 5.7.5.4 Return air ducting for AC system shall be designed based on equal friction method at a friction rate not exceeding 0.66 Pa/m and maximum initial velocity of 6 m/sec.
- 5.7.5.5 Ventilation ducting shall be designed based on equal friction method at friction rate not exceeding 0.8 Pa/m and maximum initial Velocity of 10m/sec.
- 5.7.5.6 For water pipe sizing design up to 50 mm dia pipe, maximum velocity 1.2 m/sec and pressure drop not exceeding 250 Pa/m and for pipe greater than 50 mm maximum velocity 2.4 m/sec and pressure drop not exceeding 400 Pa/m.
- 5.7.5.7 Air conditioning and Ventilation system equipment shall be interlocked with gas/ smoke detection and firefighting system.
- 5.7.5.8 The underside of exposed roof of all air-conditioned areas shall be insulated by 50 mm thick standard material by civil contractor.
- 5.7.5.9 All exposed windows of the air-conditioned areas shall be provided with light colored venetian blinds by others.
- 5.7.5.10 All refrigerants used in AC system shall be CFC free only.
- 5.7.5.11 For Rectangular Ducts, Aspect ratio shall not exceed 1:4.
- 5.7.5.12 Maximum neck velocity for supply air diffusers shall be 2.5 m/s.
- 5.7.5.13 Maximum neck velocity for return air diffusers shall be 2.5 m/s.
- 5.7.5.14 Maximum face velocity for supply air grills shall be 2.5 m/s.
- 5.7.5.15 Maximum velocity across louvers shall be 2.5 m/s.
- 5.7.5.16 Occupancy level, heat gain from occupancy, overall heat transfer co - efficient (U value)for walls, roofs, floors, partitions, false ceilings, windows etc. shall be as per latest ISHRAE standard.
- 5.7.5.17 For Air-conditioned area, Indoor air pressure relative to ambient shall be +1mm WC.
- 5.7.5.18 Percentage design safety margin shall be 10.0% on room sensible heat to take care of duct leakage, fan and duct heat gain and safety factor.
- 5.7.5.19 Percentage design safety margin on room latent heat shall be 10.0% to take care of duct leakage,

and safety factor.

- 5.7.5.20 Percentage design safety margin on Grand total heat shall be 5.0%.
- 5.7.5.21 10 % margin in equipment capacity over peak heat load calculated considering solar load and all internal loads due to equipment, lighting ,fresh air occupants etc. have to be considered.
- 5.7.5.22 For air-conditioned areas, fresh air Number of air change per hour shall be minimum 1.5 or 35 m³/h per person whichever is higher.
- 5.7.5.23 The speed of the fan shall not exceed for 960 RPM for fan for impeller diameter above 450 mm and 1440 RPM for fan with impeller diameter 450 mm and less.
- 5.7.5.24 All battery room fans shall be spark proof with flame proof motors.
- 5.7.5.25 For Positive pressurized area quantity of air exhausted shall be 70 % of the quantity of air supplied. Areas shall be provided with a minimum of 3 mm positive pressure.
- 5.7.5.26 Air quantity of TG building and Electrical room/MCC room is considered shall be calculated based on Air change per hr or heat load basis whichever is higher.
- 5.7.5.27 For mechanical ventilation, the dry bulb temperature shall be maintained maximum 3 Deg C above design ambient temperature.

8 PERFORMANCE GUARANTEES

- 5.7.6.1 Inside design conditions for AC areas will be maintained as per Table 1.
- 5.7.6.2 All applicable codes and standards for all equipment will be as per Indian / International (Local if any) only.
- 5.7.6.3 Performance curves and selection charts for fans, filters, etc. and selection charts and calculation for chiller,cooling coil and heating coil to be provided by Bidder.
- 5.7.6.4 The specified inside design conditions shall be guaranteed by the Bidder.
- 5.7.6.5 After completion of the installation, Bidder shall balance the system and make necessary adjustments for all equipment until all guaranteed performance requirements are satisfied. After completing the adjustments, Bidder shall conduct acceptance tests of the installation in the presence of Owner/Engineer during which the installation shall meet the guaranteed performance requirements to the satisfaction of Owner/Engineers and all inside design conditions specified shall be maintained, within the specified tolerances.

- 5.7.6.6 If the performance is not achieved by the Bidder, Bidder shall be given the option of making adjustments after which the tests shall be repeated at the Bidder's expense. The repeat test shall be carried out within the stipulated time.
- 5.7.6.7 All instruments and services required for the above tests shall be provided by Bidder. The test reports shall be submitted for Owner's approval before handing over the plant.
- 5.7.6.8 Bidder shall ensure that all instruments installed in the air conditioning systems as well as all instruments required for conducting acceptance tests shall be only calibrated instruments.
- 5.7.6.9 Bidder shall ensure that calibration of all instruments shall be carried out by any certified laboratory having traceability to international standards. Bidder shall submit such calibration certificates meeting the above requirements to Owner/ Engineers for approval prior to installations/ conducting of acceptance tests.

Table 1: Indoor design conditions – Air conditioning system

Sl. No	Area/Room	Inside design condition		Type of system	Redundancy	Inside pressure compared to atmosphere
		DBT °C	RH%			
1	TG Building					
1.1	Control Room	23±1	55±5	Vapor absorption chiller with chilled water coil AHU.	NW+1S	Positive
1.2	Central equipment room	23±1	55±5			Positive
1.3	Service building/Workshop area	23±1	55±5			Positive
1.4	Shift incharge room	23±1	55±5			Positive
1.5	Air lock room	23±1	55±5			Positive
1.6	SWAS Room (Dry Panel area)	23±1	55±5			Positive
1.7	Instrument room	23±1	55±5			Positive
1.8	Engineering room	23±1	55±5			Positive
1.9	Library room	23±1	55±5	Vapor absorption chiller with chilled water coil AHU.		Positive
1.10	Clerk and record room	23±1	55±5			Positive
1.11	Conference room	23±1	55±5			Positive

Table 1: Indoor design conditions – Air conditioning system

Sl. No	Area/Room	Inside design condition		Type of system	Redundancy	Inside pressure compared to atmosphere
		DBT °C	RH%			
1.12	Pantry	23±1	55±5		NW+1S	Positive
1.13	AHU room	23±1	55±5			Positive
2	Operation & Maintenance building	23±1	55±5			Positive
3	CEMS Room	23±1	Less than 60 % RH	Non ductable split air conditioner	NW+1S	Positive

Note: - Any area not listed above and required Air conditioning based on final building layout same shall be consider by bidder.

Table 2: Indoor design conditions – Ventilation system

Table 2: Indoor design conditions – Ventilation system									
Sl.No	Area/Room	Inside design condition		Supply air system	Exhaust air system	Minimu m ACPH	Numbers	Inside pressure compared to atmosphere	Maximum Noise level dB(A) one meter from fans
		DBT ° C	RH%						
1	TG Building								
1.1	TG Building Ground floor	Design Ambient -3º C	NC	Air washer unit	Turbo Ventilator	8	NW+OS	Positive	85
1.2	TG Building Mezzanine floor	Design Ambient -3º C	NC	Air washer unit	Turbo Ventilator	8	NW+OS	Positive	85
1.3	TG Building Operating floor	Design Ambient -3º C	NC	Air washer unit	Turbo Ventilator	8	NW+OS	Positive	85
1.4	Switchgear Room	Design Ambient -3º C	NC	Air washer unit	Gravity Damper	8	NW+OS	Positive	85
1.5	Cable Vault	Design Ambient -3º C	NC	Air washer unit	Gravity Damper	8	NW+OS	Positive	85
1.6	SWAS Room (Wet panel area)	Design Ambient + 3º C	NC	Tube Axial fan with filter	Gravity Damper	15	NW+OS	Positive	85
1.7	LAVT & NGTR Panel room -1	Design Ambient + 3º C	NC	Tube Axial fan with filter	Gravity damper	15	NW+OS	Positive	85

Table 2: Indoor design conditions – Ventilation system

Sl.No	Area/Room	Inside design condition		Supply air system	Exhaust air system	Minimum ACPH	Numbers	Inside pressure compared to atmosphere	Maximum Noise level dB(A) one meter from fans
		DBT °C	RH%						
1.8	LAVT & NGTR Panel room -2	Design Ambient + 3° C	NC	Tube Axial fan with filter	Gravity damper	15	NW+OS	Positive	85
1.9	I&C Battery room	Design Ambient + 3° C	NC	Supply air louver	Tube Axial fan with spark proof motor	20	NW+1S	Negative	85
1.10	Tool room for turbine	Design Ambient + 3° C	NC	Supply air louver	Tube Axial fan	15	NW+OS	Negative	85
1.11	Male toilet	NC	NC	Door grill	Propellor fan	15	NW+OS	Negative	85
1.12	Female toilet	NC	NC	Door grill	Propellor fan	15	NW+OS	Negative	85

Note:1 - Any area not listed above and required Ventilation based on final building layout same shall be consider by bidder.

Note:2- Design and engineering of Turbo Ventilator shall be in bidder scope, however supply and erection of Turbo Ventilator is excluded from bidder scope.

9 PIPING SYSTEM

This covers line sizing, material selection, flexibility analysis requirements, Inspection, testing, painting & underground protection for the following systems:

- High pressure (HP) piping system covering the Critical and Power cycle systems.

- b) Low pressure (LP) piping systems covering Sea water, Service water, Potable water, Service air, Instrument air, Fuel oil, etc.,
- c) Valves and specialities for Piping systems.
- d) Thermal insulation of hot surfaces for Piping systems.

The Bidders shall carryout basic and detailed engineering of entire piping system of co-generation power plant, conforming to ASME 31.1.

5.8.1 LINE SIZING

Sizes of pipelines shall be selected such that the velocity of fluid in pipes does not exceed the following limits under conditions of maximum possible volumetric flow:

<u>Fluid</u>	<u>Recommended velocity range (m/s)</u>
<u>Steam</u>	
Superheated steam	40 to 75 m/s
Saturated steam	20 to 40 m/s
Wet steam/Exhaust steam	20 to 30 m/s
<u>Water</u>	
Pump suction	0.5 to 1.5 m/s
Pump delivery	1.5 to 3.0 m/s
Boiler feed pump discharge	3 to 6.0 m/s
<u>Oil</u>	
Pump suction	1.0 to 2.0 m/s
Pump delivery	1.0 to 2.0 m/s
<u>Air</u>	
Compressed air	5 to 15 m/s
<u>Vacuum</u>	100 to 200 m/s

Lower values of velocities than those stated above shall be used to determine line size if dictated by considerations of pressure drop, NPSH, surges, water hammer, etc.

The design flows considered in line sizing shall not be less than the rated capacities of equipment to which the piping is connected such as pumps, blowers, compressors, valves, flow limiting orifices, etc., or, the system heat and/or mass balance diagrams.

Sizes of Boiler feed pump suction piping shall be selected to meet the NPSH requirements of the pumps under transient conditions prevailing on loss of steam supply to feed water tank. Similarly, for all pumps, NPSH requirements shall be satisfied in line sizing.

Wherever strainer pressure drops are considered, the same shall be for the 50% clogged condition of the strainers. Pressure drops across equipment shall correspond to unclean condition of the equipment.

Cascade drain piping systems of feed water heaters shall also be designed to handle the additional flows that are likely to occur due to tube rupture in the heaters besides other operating conditions stipulated elsewhere. The minimum additional flow to be considered shall be either 10 percent of tube side flow at Maximum Continuous Rating (MCR) conditions or the flow that can result from the complete rupture of one tube with two open ends, whichever is greater.

All overflows shall be designed for a capacity not less than the maximum possible difference between inlet and outlet flows under all operating conditions normal and abnormal, including mal operation.

5.8.2 WALL THICKNESS

The calculation of wall thickness required for pipelines subject to internal and/or external pressure shall be based on the formulae and recommendations as given in ASME B 31.1 / applicable codes. Adequate allowances shall be made towards thinning due to bending, weakening at branch connections, threading, commercial tolerances on pipe wall thickness, corrosion and erosion, etc. and the same shall be subject to approval by Owner's Engineer. In any case a minimum corrosion allowance of 1.6mm for CS & Alloy Steel piping shall be considered while selecting the thickness irrespective of grade of pipe material chosen. For pipes used for sea water application, a minimum of 3 mm shall be used as corrosion allowance.

In no case shall the thickness of pipe be less than Sch. 80 for sizes NB 50 & below, Sch. 40 for NB 65 to NB 250 and Sch. STD for pipe sizes NB 300 & above. However for SS piping which is NB 65 & above, Sch. 10s can be selected as minimum.

Pipe sizes 32 NB (1 ¼") and 125 NB (5") shall not be used in the piping systems.

5.8.3 FLEXIBILITY ANALYSIS

Formal flexibility analysis calculations shall be carried out in case of pipelines subjected to restrained thermal expansions or contractions. The following piping systems shall be analyzed:

- a) Pipelines with Design temperature equal to or greater than 100°C
- b) Regardless of their operating temperatures, all pipelines connected to sensitive rotating equipment such as turbines, feed pumps etc. for which limiting values of pipe reaction have been specified by the equipment manufacturer
- c) Any other pipeline which in the opinion of the Owner/Engineer requires a formal analysis.

- d) All drain lines from critical lines like main steam, Gland steam, bypass lines etc shall be analyzed irrespective of line size.

Analysis results shall satisfy the following:

- a) Calculated stresses in the piping system shall be within allowable limits stipulated in ASME B 31.1 for piping.
- b) Calculated forces and moments on equipment nozzles/TP are not more than the allowable loading provided by respective equipment manufacturer(s)/ Bidders. The deflection values at all support location in all directions (translational and rotational) shall also be calculated to enable design and selection of hanger/support system.
- c) Besides the flexibility analysis, steam hammer analysis/dynamic analysis shall also be performed wherever required to study the effects of fast closure of steam admission valves. For safety valve blowing, requirement of additional restraints/snubbers shall be reviewed and provided by the Bidder. The Bidder shall also analyze the effects of seismic & wind loads and provide adequate supports to take care of the same.

5.8.4 DIMENSIONAL STANDARDS

Uniform dimensional standards for all piping components shall be employed to ensure compatibility with each other.

Nominal pipes sizes and pipe outside diameters shall generally be as per ASME B36.10 for all carbon and alloy steel pipes and ASME B36.19 for stainless steel pipes. In case of deviation, prior approval shall be taken stating reasons for the deviation.

5.8.5 LAYOUT AND DETAILING

It is the Bidder's responsibility to plan and finalize all piping layouts in accordance with the flow diagrams and general arrangement drawings. Bidder shall prepare fabrication and isometric drawings as well as composite piping drawings. The Bidder shall plan the layout of pipelines in such a way as to avoid interference with other pipes and their hangers and supports, structures, equipment, electrical conduits, cable trays, ventilation ducts, etc. Should any interference occur during erection of piping at site, the Bidder shall modify the piping suitably to clear the same at no extra cost to the Owner. The pipe routing shall also take into account the availability of structures/structural members for providing suitable supports and hangers.

In case of pipes at working temperature above the ambient, the Bidder shall ensure that the layout finalized has adequate flexibility to absorb thermal expansion without causing undue stress in the pipelines. Further Bidder shall carry out exhaustive stress analysis studies as per

internationally accepted procedure and present the results to the Owner's representative for approval. Bidder shall also furnish a write-up furnishing all details regarding methodology adopted for analysis, computer programs employed along with input/ output list.

Piping shall generally be routed above ground but where specifically indicated or approved by the Owner's representative, such pipe work may be arranged in trenches or buried with adequate corrosion protection.

Drains shall be provided at all low points and vents at all high points as per actual layout regardless of whether the same have been shown in the flow diagrams or not. Pipelines shall be sloped towards the drain points. Drains on all steam lines shall be provided with suitable trap assemblies. Each trap assembly shall be provided with isolating, bypass and telltale valves. Drains shall be provided also at appropriate points to enable online instruments, control valves, etc., to be removed from the line for repairs or replacement. Any additional requirement of drains/vents indicated by the Owner's representative while reviewing Bidder's piping drawings shall be provided by the Bidder without any additional cost.

All equipment/piping drains shall be piped upto the nearest flash boxes/floor drains, as required, by the Bidder. Similarly, all vents shall be piped outside the buildings or flash tanks, as required, by the Bidder.

Overhead piping shall have a minimum vertical clearance of 2.3 meters above walkways and working areas and 8 meters above roadways unless otherwise approved by the Owner/ Owner's Representative.

5.8.6 PIPE HANGERS AND SUPPORTS

Design and Manufacture of Hangers/Supports shall conform to ASME B 31.1, MSS-SP-58, MSS-SP-89.

Design and engineering of hangers and supports for all piping systems supplied by the Bidder is the responsibility of the Bidder. Maximum use of the plant steel/concrete structures shall be made for taking pipe support. All auxiliary structural steel as required for the provision of hangers, supports, restraints, anchors, etc., on Bidder's piping system shall be designed, engineered, and supplied by the Bidder.

The location of the hangers and supports shall be so chosen as to avoid interference with other piping and their supports, cable trays and conduits, ventilation ducts, structural members, equipment, etc. However, the spacing between successive hangers/supports shall not exceed the maximum recommended spans indicated in codes.

Bidder shall provide anchor at all the terminal points (for hot pipes) and the anchor design shall be by Bidder. Load transferred due to Owner piping would be furnished to the successful Bidder for design of anchor.

The safety valves are to be located close to the headers, the headers shall be designed for full reaction force due to safety valve discharge at rated capacity

All hangers and supports shall be erected such that they are vertical when the piping is in cold condition (rated parameters). However, in piping system connected to the rotating equipment nozzles, it may be required to design and erect the hangers/supports in the piping near the equipment nozzle as per the requirements/recommendations, if any, of rotating equipment manufacturer(s).

The Bidder shall furnish detailed arrangement sketches for each support, restraints, anchor, snubber etc. The sketches shall include the key plan identification no., bill of quantities, design load, operating load, spring stiffness, amount of pre-compression, centre line elevation of pipe, spring box position/orientation, etc.

Hangers support tag no. shall be marked on all pipe hangers/supports, restraints and anchor assemblies. The design loads, hot and/or cold loads shall be stamped on respective constant and variable springs.

5.8.7 WELDING & HEAT TREATMENT

All heat treatment, welding, post and pre weld temperatures shall be as per the code ASME B31.1. The weld edge preparation shall be as per ASME B16.25.

5.8.8 INSPECTION AND TESTING

All pipes shall be tested hydrostatically / pneumatically, after erection, at pressures given in the applicable codes. The test pressures shall be maintained until all welded/ flanged joints are inspected for leakage or at least for thirty minutes. Minimum Inspection requirements shall be furnished to the successful Bidder after award of contract, based on which actual Inspection plan shall be furnished by Bidder for approval by Owner/Owner's Engineer.

All temporary piping, fitting, accessories, valves, specialities etc. required for the various erections and commissioning activities such as chemical cleaning, hydraulic test etc shall be in the scope of the Bidder

5.8.9 CLEANING

All hot bent, forged formed, fabricated and straight pipes shall be chemically cleaned, pickled or wire brushed and plunged with air blast or shot/grit blast to remove all sand and scale from the inner surface as applicable.

The following cleaning operations shall be carried out after hydrostatic tests:

- a) All piping will be mass flushed, in addition to the specific cleaning operations as described below, as required

- b) Main steam, HP & LP bypass piping shall be steam blown. Necessary target plates, for steam blowing, shall be provided.
- c) Extraction steam, condensate, boiler feed suction and discharge and heater drain, and vents piping shall be alkaline flushed.
- d) Auxiliary steam piping, steam piping to turbine drives; pressure reducing stations and other users shall be steam blown.
- e) Fuel oil piping shall be mass flushed.
- f) Compressed air piping shall be blown by air at compressor discharge pressure.
- g) Turbine lubricating oil piping shall be pickled and passivated and flushed with DM water
- h) Where control valves, flow nozzles, orifices and other piping appurtenances are to be installed, they shall be installed only after chemical cleaning operation. After the completion of the chemical cleaning the Bidder shall cut spool pieces of required length and install the components

5.8.10 UNDERGROUND PROTECTION

Where pipelines are buried, underground protection shall be provided for the piping system as indicated by any one of the methods given below:

- a) Coal tar primer, coal tar enamel, inner wrap of fiber glass, final outer wrap of enamel impregnated fiber glass. Total thickness of coating shall not be less than 4.0 mm.
- b) With anti-corrosive tape of 4 mm thick conforming to AWWA C 203-93.

Pipe surfaces shall be cleaned by shot or sand blasting before application.

Tests to be carried out after application

- a) Bond/Adhesion test
- b) Holiday test

5.8.11 GENERAL REQUIREMENTS OF VALVES

a) GEAR OPERATOR:

Gear operators shall be provided on the following basis:

Valve Type	ASME Class	Size Requiring Gear Operator
Gate Valve, Globe valve & Diaphragm Valve	150 Class	350 mm and larger
	300 Class	350 mm and larger
	600 Class	300 mm and larger

	900 Class	150 mm and larger
	1500 Class	80 mm and larger
	2500 Class	80 mm and larger
Ball valve/ Plug valve (Other than pressure balance plug valves)	150 Class	150 mm and larger
	300 Class	150 mm and larger
	600 Class	100 mm and larger
	900 Class	80 mm and larger
	1500 Class	80 mm and larger
Butterfly Valve	150 Class	200 mm and larger
	300 Class	150 mm and larger

Gear operators shall be suitable for a differential pressure corresponding to the maximum valve rating at room temperature.

b) INTEGRAL BYPASS

Gate valves shall be provided with integral bypass valve, as per MSS-SP 45, as follows:

Classes 150 and 300	-	350 mm and larger
Class 600 and higher	-	200 mm and larger

Type of bypass valve shall generally be the same as the main valve. Bypass pipe shall be at least schedule 80 and material of construction of bypass valve and pipe shall be compatible with the main valve.

- c) Valve stems shall be of wrought materials and not of castings.
- d) All gate, globe and piston valves shall be provided with back seating arrangement to facilitate replacement of gland packing with the valve in service.
- e) Check valves of sizes 350 mm and larger shall be provided with dashpot arrangement to prevent slamming and hammering.
- f) Hardness of seating surfaces shall be a minimum of 350 BHN and a minimum differential hardness of 50 BHN shall be provided between seats to prevent galling. This is not applicable for stellited seats.
- g) All carbon steel valves of ASME pressure rating upto class 150 and 300 shall have stainless steel trim (13% Cr) unless otherwise specified and ASME pressure rating class 600 and above shall have stellited trim. All alloy steel valves shall have stellited seats.

- h) Bonnet is Pressure sealed for 65NB and above valves, when the Pressure class is 900 class and higher. Bolted Bonnets are used for 65NB and above valves with Pressure class less than or equal to 600 class. The Bonnet is of Integral type when the valve size is 50NB and below.
- i) Valves for oil system (Ball and Plug valves) shall be of fire safe design.
- j) Ball valves shall preferably be of three-piece design. If 3-piece design is not commercially available for a particular size, 2-piece design may be acceptable.

5.8.12 TESTING REQUIREMENTS

Valves shall be hydro tested and pneumatic tested as per the relevant ASME/BS/IS codes. Valves shall be tested for the following.

- a) Body hydro test
- b) Seat and Backseat test
- c) Pneumatic test
- d) Leak test shall be carried out on Check valves at 25% of seat hydro test pressure.
- e) Pop test and Blow down test shall be done for Safety relief valve as per ASME SEC VIII.
- f) Hydro test and Vacuum test are performed for Rubber Expansion (RE) joints.

5.8.13 THERMAL INSULATION

Thermal insulation shall be provided for all hot piping and equipment with fluid temperatures greater than 60°C.

Specific requirements of thermal insulation are detailed out in below. Further, insulation thickness indicated in Table 1 shall be regarded as minimum acceptable thickness. If calcium silicate insulation is adopted, the thickness shall be calculated with maximum thermal conductivity as given in ASTM C533 and temperature shall be over the finish (aluminum cladding). Care should be taken while fixing the insulation mats, no welding shall be permitted on HP/LP cylinder & steam chests for fixing nuts, bolts, lugs, for their mats.

SI No	ITEMs	UNITS	VALUES
a)	Insulation Material		Lightly bonded mineral wool / pre-formed calcium silicate (up to 550°C)
b)	Equipment		All equipment as applicable except steam turbine
c)	Finishing Cement		No
d)	Sheathing Material		Aluminium

	For pipes		i. Insulation outside dia. above 450mm – Sheet thickness – 20 SWG.
			ii. Insulation outside dia. 150 to 450mm – Sheet thickness – 22 SWG.
			iii. Insulation outside dia. below 150mm – Sheet thickness – 24 SWG.
	For Equipment		i. Flues & ducts – Sheet thickness 1.0mm
			ii. SG casing & rear wall enclosure – Sheet thickness 1.6mm.
	Design thickness is / should be based on:		
	i. Station Temperature	°C	30
	ii. Outer surface temperature on surface of sheathing	°C	60
e)	Codes & Standards		ASTM C680 ASTM C533 BS 5970 BS 3958

TABLE-1

Temp (°C)	51–100	101-150	151-200	201-250	251-300	301-350	351-400	401-450	451-500	501-550
Pipe Dia										
15 mm (1/2")	25	25	40	40	50	65	80	90	100	115
20 mm (3/4")	25	25	40	50	50	65	80	90	100	125
25 mm (1")	25	40	40	50	65	80	90	100	115	125
40mm (1-1/2")	25	40	40	50	65	80	90	115	125	140
50mm (2")	25	40	40	50	65	80	100	115	125	150
65mm (2-1/2")	25	40	50	50	80	90	100	125	140	165
80mm (3")	25	40	50	50	80	90	100	125	140	165
100mm (4")	40	50	50	65	80	90	115	125	150	165
150mm (6")	40	50	50	65	80	100	115	140	165	190
200mm (8")	40	50	50	65	80	100	125	140	165	190
250mm (10")	40	50	50	65	90	115	125	150	175	200
300mm (12")	40	50	65	75	90	115	140	150	190	215
350mm (14")	50	65	75	75	90	115	140	165	190	215
400mm (16")	50	65	75	75	90	115	140	165	190	215
450mm (18")	50	65	75	75	90	115	140	165	190	225

500mm (20")	50	65	75	100	115	115	140	165	200	225
550mm (22")	50	65	75	100	115	115	140	175	200	240
600mm (24")	50	65	75	100	115	115	140	175	200	240
625mm (25")	50	65	75	100	115	115	140	175	200	240
650mm (26")	50	65	75	100	115	115	150	175	200	240
700mm (28")	50	65	75	100	115	115	150	175	215	240
800mm (32")	50	65	75	100	115	125	150	175	215	240
900mm (36")	50	65	75	100	115	125	150	175	215	240
950mm (38")	50	65	75	100	115	125	150	175	215	240
1000mm (40") & above flat Surfaces	50	65	75	100	115	140	170	215	250	300

Insulation thicknesses are calculated considering aluminium sheathing for the ambient temperature of 30°C. The above values hold good for mineral wool insulating material having the following densities.

- (a) Temperature up to and including 400°C - 100 Kg/m³
- (b) Temperature > 400°C up to 550°C - 150 Kg/m³

This is the minimum requirement considering ambient temperature 30°C same to be modified (increase) based on site actual ambient temperature.

5.8.14 MATERIAL SELECTION

Piping, valves & specialties, and thermal insulation material selection depends on the service and the design conditions. Material selection for various services in power plant are listed in the following tables.

PIPING & FITTINGS MATERIALS

SL. NO.	SERVICE	SIZE (MM)	PIPES	FITTINGS	FLANGES	GASKETS	LINE JOINT
1	STEAM TEMP. ABOVE 550°C AND UPTO 593°C	NB 65 & ABOVE	ASTM A335 P91	ASTM A234 WP91	ASTM A182 F91	SPIRAL WOUND SS 316	BUTT WELDED
		NB 50 & BELOW	ASTM A335 P91	ASTM A182 F91	ASTM A182 F91	SPIRAL WOUND SS 316	SOCKET WELDED
2	STEAM TEMP. ABOVE 510°C AND UPTO 550°C	NB 65 & ABOVE	ASTM A335 P22	ASTM A234 WP22	ASTM A182 F22 Class 1	SPIRAL WOUND SS 316	BUTT WELDED
		NB 50 & BELOW	ASTM A335 P22	ASTM A182 F22 Class-1	ASTM A182 F22 Class-1	SPIRAL WOUND SS 316	SOCKET WELDED
3	STEAM TEMP. ABOVE 400°C AND UPTO 510°C	NB 65 & ABOVE	ASTM A335 P11	ASTM A234 WP11	ASTM A182 F11	SPIRAL WOUND SS 316	BUTT WELDED
		NB50 & BELOW	ASTM A335 P11	ASTM A182 F11	ASTM A182 F11	SPIRAL WOUND SS 316	SOCKET WELDED
4	STEAM UPTO 400°C	NB 65 & ABOVE	ASTM A106 Gr. B	ASTM A234 WPB	ASTM A105	SPIRAL WOUND SS 316	BUTT WELDED
		NB 50 & BELOW	ASTM A106 Gr. B	ASTM A105	ASTM A105	SPIRAL WOUND SS 316	SOCKET WELDED
5	BOILER FEED SUCTION/ CONDENSATE	NB 65 & ABOVE	ASTM A106 Gr. B	ASTM A234 WPB	ASTM A105	SPIRAL WOUND SS 316	BUTT WELDED
		NB50 & BELOW	ASTM A106 Gr. B	ASTM A105	ASTM A105	SPIRAL WOUND SS 316	SOCKET WELDED
6	BOILER FEED DISCHARGE & RECIRCULATION	NB 65 & ABOVE	ASTM A106 Gr. B (for design pres. upto 150 kg/sq.cm) or ASTM A106 Gr. C (for design Pres. greater than 150kg/sq.cm(g))	ASTM A234 WPB ASTM A234 WPC	ASTM A105	SPIRAL WOUND SS 316	BUTT WELDED
		NB 50 & BELOW	ASTM A106 Gr. B (for design pres.	ASTM A105	ASTM A105	SPIRAL WOUND SS 316	SOCKET WELDED

			Upto 150kg/sq.cm) or ASTM A106 Gr. C (for design pres. greater than 150kg/sq.cm(g))				
7	LUBE OIL & CONTROL / HYDRAULIC OIL (U/S FILTER)	NB 65 & ABOVE	ASTM A106 Gr. B	ASTM A234 WPB	ASTM A105	GRAFOIL	BUTT WELDED
		NB 50 & BELOW	ASTM A106 Gr. B	ASTM A105	ASTM A105	GRAFOIL	SOCKET WELDED
8	LUBE OIL & CONTROL / HYDRAULIC OIL (D/S FILTER)	NB 65 & ABOVE	ASTM A312 TP316 (SEAMLESS)	ASTM A 403 WPS316	ASTM A182 Gr. F316	GRAFOIL	BUTT WELDED
		NB50 & BELOW	ASTM A312 TP316 (SEAMLESS)	ASTM A182 Gr. F316	ASTM A182 Gr. F316	GRAFOIL	SOCKET WELDED
9	DEMIN. WATER/ INSTRUMENT AIR	NB 65 to 150	ASTM A 312 TP304 (SEAMLESS)	ASTM A 403 Gr. WPS304	ASTM A 182 Gr. F304	TEFLON	BUTT WELDED
		200 to 350	API 5L Gr. B, ERW (3mm Rubber lined)	ASTM A234 WPB 3mm Rubber lined	ASTM A 105 3mm Rubber lined	TEFLON	FLANGED
		NB 50 & BELOW	ASTM A312 TP 304(ERW)	ASTM A 182 F304	ASTM A 182 F304	TEFLON	SOCKET WELDED
10	ACID AND ALKALI SYSTEM	NB 65 to 150	ASTM A53 Gr. B(Welded) (5mm thick hard rubber lined-ebonite)	ASTM A234 WPB (5mm thick hard rubber lined-ebonite)	ASTM A 105 (5mm thick hard rubber lined-ebonite)	TEFLON	FLANGED
		NB 200 to 450	API 5L (5mm thick hard rubber lined-ebonite)	ASTM A234 WPB (5mm thick hard rubber lined-ebonite)	ASTM A 105 (5mm thick hard rubber lined-ebonite)	TEFLON	FLANGED
		NB 50 & BELOW	PVC (UV Stabilized)	PVC (UV Stabilized)	PVC (UV Stabilized)	TEFLON	PVC JOINT
11	PASSIVATED DM WATER, SERVICE WATER SYSTEM,	NB 65 & ABOVE	ASTM A53 Gr B (ERW)	ASTM A234 WPB	ASTM A105	TEFLON/ CNAF	BUTT WELDED

	SERVICE AIR SYSTEM						
		NB 50 & BELOW	ASTM A53Gr.B (ERW)	ASTM A105	ASTM A105	TEFLON/ CNAF	SOCKET WELDED
12	COOLING WATER & AUXILIARY COOLING WATER SYSTEM	ALL SIZES	GRP	GRP	GRP	CNAF	BUTT & WRAP
13	POTABLE WATER SYSTEM	NB 65 to 150	ASTM A53 Gr B, GALVANISED	ASTM A234 WPB GALVANISED	ASTM A105 GALVANISED	CNAF	FLANGED
		NB 50 & BELOW	ASTM A53 Gr B, GALVANISED	ASTM A105 GALVANISED	ASTM A105 GALVANISED	CNAF	SCREWED
14	FUEL OIL, FUEL OIL DECANTING HEADER	NB 65 & ABOVE	ASTM A 106 Gr. B	ASTM A 234 WPB	ASTM A105	GRAFOIL/ PTFE	BUTT WELDED
		NB 50 & BELOW	ASTM A 106 Gr. B	ASTM A 105	ASTM A105	GRAFOIL/ PTFE	SOCKET WELDED

Notes:

1. All mandatory tests shall be carried out as per ASME Boiler & Pressure Vessel Code ASME Section-II. Additional tests shall be conducted as indicated below:

For ASTM A 335 P91, P22, P11

- a. S-1 Product Analysis
- b. S-2 Transverse Tension Tests (One End) For 25% Of Pipes
- c. S-3 Flattening Test (One End)

For ASTM A 182 GR. F91, F22, F11

- a. Product Analysis
- b. Heat Identification & Tension Tests
- c. Magnetic Particle Examination

For ASTM A 234 GR. WP 91, WP 22, WP 11

- a. Product Analysis
- b. Tension Test
- c. Magnetic Particle Examination

2. Each length of pipe shall be hydrotested at shop as per the applicable Codes/Standards.
3. All branch connections shall be wrought (seamless) or forged steel based on the size and availability based on ASTM Standards.
4. Wherever applicable the required galvanization shall be as per ASTM A 123
5. Above table is the general guideline for material selection of piping component. However, main steam lines and common steam distribution header upto each turbine inlet including MP PRDS (upto 6m downstream length) shall be given with ASTM A335 P22 material.

VALVES & SPECIALITIES MATERIALS

SI No	SERVICE TEMP.	SIZE (MM)	BODY/ BONNET	DISC	STEM	HAND WHEEL	VALVE ENDS
1	STEAM LINES:						
	>510°C & ≤550°C P91	≥65N B	A217 C12A	A217 C12 A	A182 Gr. F6a	A47 Gr.32510	BW
		≤50N B	A182 Gr. F 91	A182 Gr. F91	A182 Gr. F6a	A47 Gr.32510	SW
	>510°C & ≤550°C P22	≥65N B	A217 WC9	A217 WC9	A182 Gr. F6a	A47 Gr.32510	BW
		≤50N B	A182 Gr. F22	A182 Gr. F6a	A182 Gr. F6a	A47 Gr.32510	SW
	>400°C & ≤510°C P11	≥65N B	A217 WC6 or 9	A217 WC6 or 9	A182 Gr. F6a	A47 Gr.32510	BW
		≤50N B	A182 Gr. F11	A182 Gr. F6a	A182 Gr. F6a	A47 Gr.32510	SW
2	≤400°C (COND. BLOW DOWN, BFP SUCTION)	≥65N B	A216 WCB	A216 WCB	A182 Gr. F6a	A47 Gr.32510	BW
		≤50N B	A105	A182 Gr. F6a	A182 Gr. F6a	A47 Gr.32510	SW
3	BFP DISCHARGE & RECIRCULATION SYSTEM	≥65N B	A216 WCB/ WCC	A216 WCB/ WCC	A182 Gr. F6a	A47 Gr.32510	BW
		≤50N B	A105	A182 Gr. F6a	A182 Gr. F6a	A47 Gr.32510	SW
4	LUBE OIL SLUDGE, OILY WATER DRAINS (UPTO	≥65N B	ASTM A216 Gr WCB	ASTM A216 Gr WCB	ASTM A479 Type 410-2	A47 Gr.32510	BW
		≤50N B	ASTM A105	ASTM A479 Type 410-2	ASTM A479 Type 410-2	A47 Gr.32510	SW

	FILTER)						
5	LUBE OIL, CNTRL OIL/ HYDRAULIC OIL (BEYOND FILTER)	≥65N B	A351 Type CF8M	A351 Type CF8M	A351 Type CF8M	A47 Gr.32510	BW
		≤50N B	A182 F316	A182 F316	A182 F316	A47 Gr.32510	SW
6	WATER SYSTEM (EXCLUDING BUTTERFLY VALVES)						
	POTABLE WATER	≥65N B	A126 CLASS B	A126 CLASS B	ASTM B 124 C 37700	A47 Gr.32510	FLANGED
		≤50N B	ASTM B62	ASTM B62/ ASTM B16	ASTM B 124 C 37700	A47 Gr.32510	SCREWED
7	COND. COOLING WATER, AUX. COOLINGWATER	≤50N B	ASTM B148 C95800	ASTM B148 C95800	DUPLEX SS S32750/ MONEL 400 (NO CASTING)	A47 Gr.32510	FLANGED
8	INSTRUMENT AIR	≥65N B	ASTM A 351 CF8	ASTM A 351 CF8	SS304/ A479 Type 304 - 2	Malleable Iron/A47 Gr.32510	FLANGED
		≤50N B	ASTM A182 F 304	SS 304 (FOR BALL VALVES, BALL SS 304 MIRROR FINISHED)	SS 304 (NO CASTING)	Malleable Iron/A47 Gr.32510	SCREWED
9	PASSIVATED DM WATER, SERVICE WATER, SERVICE AIR SYSTEM	≥65N B	A216 WCB	A216 WCB	A479 Type 410-2	A47 Gr.32510	BW
		≤50N B	A105	A182 Gr. F6a (FOR BALL VALVES, BALL SHALL BE 13% Cr STEEL)	A479 Type 410-2	A47 Gr.32510	SW
10	DM WATER	≥65N B	ASTM A 351 CF8	ASTM A 351 CF8	SS 304/ A479 Type 410	Malleable Iron/A47 Gr.32510	FLANGED
		≤50N B	ASTM A182 F 304	SS 304/ A479 Type 410-2	SS 304/ A479 Type 410-2	Malleable Iron/A47 Gr.32510	SW
11	ACID AND ALKALI SYSTEM	≥65N B	A126 CLASS B with 5mm RUBBER LINED/	A126 CLASS B with 5mm RUBBER	A479 Type 410-2	A47 Gr.32510	FLANGED

			A351 Gr CF8M	LINED/ A479 Type 410-2			
		≤50N B	A182 Gr F316	A479 Type 410-2	A479 Type 410-2	A47 Gr.32510	SW
12	BUTTERFLY VALVE	≥65N B	ASTM A216 Gr. WCB/ A126 CLASS B	ASTM A216 Gr. WCB/ A126 CLASS B	A479 Type 410-2	A47 Gr.32510/ MALLEABLE IRON	FLANGED
13	BUTTERFLY VALVE (SEA WATER)	≥65N B	A126 CLASS B with RUBBER LINED	A126 CLASS B with RUBBER LINED/ DUPLEX SS S32750/ B148 C95800	DUPLEX SS S32750/ MONEL 400 (NO CASTING)	A47 Gr.32510	FLANGED
14	BUTTERFLY VALVE (DM WATER)	≥65N B	A126 CLASS B with 3mm RUBBER LINED	A126 CLASS B with 3mm RUBBER LINED/ A479 Type 410-2	SS 304/ A479 Type 410-2	A47 Gr.32510	FLANGED
14	FUEL OIL, FUEL OIL DECANTING HEADER	≥65N B	A216 WCB	A216 WCB	A479 Type 410-2	A47 Gr.32510	BW
		≤50N B	A105	A182 Gr. F6a (FOR BALL VALVES, BALL SHALL BE 13% Cr STEEL)	A479 Type 410-2	A47 Gr.32510	SW

Notes:

1. O ring material shall be Nitrile rubber/ EPDM of shore-A hardness 75° + 5° for Butterfly valves.
2. Gasket material shall be Spiral wound SS 316 for steam and feed water systems and GRAFOIL for oil systems. TEFLON/ CNAF is used for other systems.
3. For Fuel oil System, valves shall be of Anti-static & fire safe design as per API 607
4. For all butterfly valves the counter flanges along with fasteners and gasket shall be supplied by the butterfly valve vendor.
5. Above table is the general guideline for material selection of valve components. However, all valves located at main steam lines and common steam distribution header upto each turbine inlet including MP PRDS (upto 6m downstream length) shall be given with body/bonet and disc material as A217 WC9.

CHAPTER-6

ELECTRICAL DESIGN REQUIREMENT & EQUIPMENT SPECIFICATION

6.0 ELECTRICAL DESIGN REQUIREMENTS & EQUIPMENT SPECIFICATION

6.1 Generator and associated system

The electric generator including all associated equipment but not limited to excitation system, AVR, synchronizing and control equipment, Protection and Relay panel, Generator Auxiliary Cubical (GAC), neutral grounding devices, etc shall be adequately rated to deliver the steam turbine generated power at its output terminals under all operating conditions. During start-up, the generator shall be isolated by opening the circuit breaker at 33kV GIS. The unit auxiliaries shall be fed from the unit auxiliary transformer which shall be fed from 33kV GIS. The generator shall be brought up to the rated speed, voltage and frequency closely matched to the system parameters, and the generator shall be synchronized at the 33kV GIS, and then it shall be gradually loaded.

6.1.1 Generator

The electric generator for the turbine-generator set shall comply with the International Electrotechnical Commission's code IEC 60034 or ANSI/IEEE C50.13 standards. The rating of the generator shall be selected to match the maximum continuous output of the steam turbine. The bidder shall submit generator capability curves for the generator to demonstrate that the generator shall be capable of providing full electrical output matching to turbine and boiler capacity for complete operating range of power factor, frequency, ambient and voltage variations without undue restrictions.

The quality of the generator and its accessories shall be controlled through a shop quality assurance program in accordance with International Standardization Organization (ISO)-9001, EN 29001 or BS 5750 Part 1 and other equivalent international quality standards.

The generator shall be designed in accordance with IEC Publications 60034-1 through 60034-3 or ANSI Standard C50.13. Testing shall be done in accordance with the IEC 60034 series of Publications or ANSI/IEEE Standard 115.

The cooling system for generator will be CACW (IC9A1W7). The coolers would be adequately sized so that with one cooler section out of operation / under maintenance, the Generator can carry the rated load continuously without exceeding the permissible temperature rise.

The stator and rotor winding insulation shall be non-hygroscopic type and to Class H standards in accordance with IEC 60085. Design of generator shall limit the temperature rises to Class F materials temperature limits. Resistance type temperature detectors shall be provided where the highest temperatures are expected in the winding, core, cooling air inlet and outlet, bearings, etc. Duplex type RTDs shall be provided for each bearing.

Anti-condensation heaters shall be provided for the air circuits, generator windings, excitation system, and control cubicles. Heaters shall be capable of maintaining the air temperature above that of dew point to prevent condensation. These heaters shall automatically switch on when the generator is taken out of service.

The generator shall be factory tested to an overspeed of 20% above rated speed and shall be capable of repeatedly withstanding the overspeed resulting from full load rejection, without undue stresses and with an adequate margin of safety. Shaft vibration probes shall be provided in the generator bearings.

Continuous partial discharge monitoring system shall be provided. The partial discharge shall be winding embedded type and include flux probe as well. All the readings shall be made available to remote control system in real time for trending. Special Tools for assembling and dismantling of the generator coolers, handling, removal and insertion of generator rotor, including jacks, slings, lifting beams, skids, shaft extensions, shall be provided.

An online rotor/shaft grounding voltage monitoring shall be provided.

6.1.2 Generator excitation system

The electric generator set shall be provided with an excitation system of brushless rotating diodes type and it shall include solid-state voltage controls with 2x100% automatic voltage regulator (AVR) and 2x100% manual voltage regulator (MVR). The detail of Auto and Manual Channel configuration are mentioned below,

Channel-1 Auto to Channel-2 Auto

Channel-1 Manual to Channel-2 Manual

Channel-1 Auto to Channel-2 Manual

Channel-1 Manual to Channel-2 Auto

The excitation system shall be one of high initial response type as defined in IEEE Standard 421.1. The continuous current capability of the excitation system at maximum ambient conditions shall be adequate for the operation of the generator at full load, rated power factor and at 105% terminal voltage, with the generator field at maximum temperature.

The excitation system shall be capable of supplying its ceiling voltage and the growing field current associated with the sudden application of ceiling voltage to the generator field for at least 5 seconds. The ceiling current shall be at least 2 times the rated field current. The transient thermal capabilities of the excitation system for periods of more than 5 seconds shall be higher than the

short-time thermal capabilities required in Section 7.1 of IEEE Standard C50.13 for the generator field winding.

The excitation system shall meet the requirements of the interconnection system but in any case the AVR shall be capable of maintaining the steady-state terminal voltage of the generator within $\pm 0.2\%$ of the set point over the entire operating range of the synchronous machine.

The excitation equipment shall operate reliably and shall not impose restrictions on the availability of the generators due to excitation equipment faults or malfunctions according to excitation architecture and relevant redundancy.

If a brushless rotating excitation system is offered, it will basically consist of:

- A three-phase, rotating armature alternator;
- Rotating rectifying diodes and
- Excitation controls.

The excitation system and equipment shall be complete with fast response continuously acting two Automatic Voltage Regulators (AVR), and Two Manual Voltage Regulator (MVR), Power System Stabilizer (PSS) in accordance with the Electrical Grid requirements, limiters and stabilizers, droop compensation and cross circuit compounding, field suppression equipment and all control, monitoring and protection equipment to enable operation from the CCR. The regulations functions shall include, but not be limited to, voltage, field current, reactive and active load droop/compensation, under excitation limiter (UEL) and overexcitation limiter (OEL), maximum stator current (lead/lag), volts-per-Hertz (V/Hz) limiter, power factor/reactive load regulation, and power system stabilizer (PSS). The protection functions shall include, but not be limited to, over current protection, overexcitation protection, V/Hz protection, loss of excitation protection, and generator overvoltage protection.

The excitation system shall be provided with an online field ground detection system that monitors the soundness of the field insulation. The brushless exciter the system shall provide online detection automatically through a set of auxiliary slip rings on the shaft and brushes for momentary contact. A system to detect open circuits and short circuits in the assembly of rotating diodes and fuses shall also be provided. Online automatic monitoring shall be provided for detection of diode failure also.

6.1.3 Synchronizing Equipment

Automatic synchronizing facilities backed up with check synchronizing circuits shall be provided for the generator circuits. Synchronizing equipment shall operate satisfactorily in conjunction with the automatic excitation control and turbine speed governing equipment. Generator Breaker Synchronizing panel will be located in Central Control Room (CCR) of TG Building.

6.1.4 Generator Auxiliary Cubical (GAC)

a. Constructional Features of the Cubicle

Generator Auxiliary cubicle shall be fabricated from 3 mm thick aluminium or 2 mm thick cold rolled sheet steel. The cubicle shall be suitable for floor mounting. Base channels along with anti-vibration pads shall be furnished. The cubicle shall be of dust-tight, vermin and weather proof construction. The cubicle shall preferably be designed without louvres. However, if a ventilated type of construction is essential, the louvers shall be covered by G.I. fine wire meshed screens to prevent entry of insects and rodents.

A separate cubicle shall be provided for each phase. Each cubicle shall be in two sections. The front section shall comprise the voltage transformer compartments, and the rear section shall comprise of busbars, lightning arresters with surge counter and capacitors, as specified.

When fabricated from sheet steel, the surfaces shall be cleaned, phosphated and applied with two coats of ready mixed, stoving type zinc chromate primer. After application of primer, two coats of finishing synthetic enamel paint shall be applied, with each coat followed by stoving.

b. Voltage Transformer Compartments

Each single phase voltage transformer shall be mounted in a horizontal draw out type modular compartment. Additional voltage transformers, if specified, shall be arranged in tier formation compartments. The number of tiers shall be limited to three. When four VTs per phase are specified, the front section of each cubicle shall be divided into two vertical portions, with two tiers each. Segregation shall be maintained between each compartment

Each draw out type voltage transformer compartment shall comprise the following:

- One cast epoxy resin type of voltage transformer tested for partial discharge. The partial discharge at 10 per cent over voltage on the highest system voltage shall not exceed 50 pico coulombs.
- Bolted type HRC fuse of adequate rupturing capacity on the primary side
- HRC fuses or high-speed overcurrent switch with auxiliary contacts of approved type and of suitable rating on the secondary side.
- Primary disconnecting contacts (phase and neutral) which will permit access to primary fuse only after complete opening of the contacts.

- Secondary disconnecting contacts which will open prior to primary disconnecting contacts.
- Earthing device which will ground the primary of the voltage transformer on withdrawal of the carriage. The earthing device shall be of fail-safe mechanism. The draw-out carriage shall be earthed at all times.
- Cylinder type of locks which shall have a common set of keys.
- Glass panel on the front of the compartment to visually check the primary disconnecting contact alignment, while in service.
- Suitable automatic shutters to cover all live parts in the plugged-in and drawn-out positions of the VT
- Voltage Transformers Secondary Wiring Marshalling Box
- The secondary wiring of each voltage transformer, after the secondary disconnecting contacts and HRC fuses / high speed overcurrent switches, shall be brought up to terminal blocks located in a separate marshalling box, which is common for all three phases. This marshalling box shall be provided at the middle tier of the middle single phase cubicles and shall be provided with a hinged lockable door with gaskets. Removable gland plate shall be provided in this box for Purchaser's external cable connections.
- VT secondary terminals which are to be earthed shall be brought to separate terminals in this box and thereafter connected to the common earth bus of the VT & SP cubicles.
- Ferro resonance protection to be consider for voltage transformer.

c. Current Transformers

Current transformers (CTs) mounted inside GAC enclosure shall be bar primary, cast resin, ring type and suitable for ambient temperature of at least 90°C. CTs shall be designed for generator rated voltage insulation level and mounted so as to prevent any corona / partial discharges from the bus bar. All secondary terminals of CTs shall be brought to a common marshalling box at each major location. Test reports for the CTs shall be furnished.

d. Surge Protection Equipment Compartment

This compartment shall house the following with segregation maintained. Access to the equipment shall be through bolted covers

- Lightning arresters with specified rating complete with surge counters.
- Capacitors with specified rating, if required. The capacitors shall be non oil type.
- Support insulators for the bus connections as required.
- Bus bars of adequate rating to withstand normal and short circuit current. Suitable connectors shall be provided at all equipment like lightning arrester, capacitor, support insulator, etc.

Each voltage transformer and surge protection cubicle shall be provided with one seal-off bushing at the entrance of the tap-off bus duct. Bushings shall also be provided for bus conductors between sections / compartments of the cubicle.

A common copper earth bus of adequate size shall be provided at the rear of the VT & SP cubicles. Individual connections from each equipment earth terminal/body earth terminal, etc. shall be terminated on this earth bus. Necessary provision shall be made to facilitate further connection to Purchaser's station earth grid.

e. Neutral Connection and Earthing Equipment Enclosure

A grounding using a dry type grounding transformer with secondary connected grounding resister connected to limit the ground fault current less than 15 Amps or less shall be furnished and connected through star point formed by neutral connections enclosure and isolated-phase bus duct. Grounding resister shall be of stainless grid type with a short time rating of 10 minutes. Maximum temperature of resister shall be limited to 350°C. Terminals for mounting neutral current transformer for 100 % start earth fault protection shall also be brought out.

The enclosure shall be provided with space heaters and a thermostat for maintaining normal operating temperature shall also be provided.

The grounding resister compartment of cubicles shall be suitable for indoor service and provided with an enclosure of at least IP-54 to IEC 60529.

6.1.5 Segregated Phase Bus Ducts (SPBD) and Connections

The main busbar connections between the turbine-generator set and the Generator Auxiliary Cubical (GAC) to the Generator Transformer (GT), shall be by the segregated phase bus duct of self-cooled, continuous enclosure minimum flux type of design.

The installation shall be required to carry the maximum bus duct rated current, continuously under all operating conditions. The equipment shall conform to and tests shall be conducted in accordance with, the latest applicable IEC, ANSI, or IEEE standards. The temperature rise, at rated current, above ambient temperature of air surrounding the bus enclosures and cubicles, shall be in accordance with ANSI C37.23, Table 1. Momentary current values which the buses are mechanically braced to withstand shall be not less than recommended per ANSI C37.23 Section 5.4.3.

The neutral connections shall be designed for full phase to earth voltage.

The segregated phase bus duct shall consist of rigid conductors of electrical grade aluminium, mounted on wet process high strength porcelain insulators. Each phase bus shall be enclosed in a separate weather and dust-tight, pressurized, electrical grade aluminium enclosure separate from the adjacent phases. The installation shall be capable of operating satisfactorily at continuous maximum current when any pressurizing unit is not operating. The SPBD insulator creepage distance shall not be less than 25 mm/kV. Bus duct installation shall be maintained at slight positive air pressure of instrument air quality to keep out external dust and moisture ingress.

All bus duct conductors, enclosures, flexible connectors and hardware connections (including tee's) and supporting insulators shall be designed to withstand and limit heating effects of short circuit currents for three phase to ground, line to line and line to ground currents for 3 seconds as per ANSI standards. All conductors, enclosures and supporting structures, insulators, connections, gaskets shall have sufficient mechanical strength to withstand, without incurring any damage, the mechanical effect of any peak momentary currents resulting from a three-phase to ground, line-to-line or line-to-ground short circuit.

Outdoor sections of bus duct shall be designed to withstand forces for prevailing maximum wind, rain and heating effects of solar radiations.

The bus duct shall be designed, including flanges, to permit removal of transformer and generator bushings with a minimum of bus disassembly. Further, the bus duct shall be routed such that the generator end casings, rotating exciter (if required), and any other auxiliaries can be removed without disassembly of the bus duct.

All apparatus shall be phase isolated throughout apart from connection points to apparatus, where full phase segregation may be provided as required.

Outdoor bus duct support structure and hardware shall be of hot-dipped galvanized steel or equivalent processes. All bus duct supports shall be designed to prevent damage of any portion of the installation due to short circuit forces, wind, rain, or seismic criteria. Sunshade shall be provided to reflect the sun radiation and decrease the temperature of the bus ducts.

Bus insulators shall be placed so as to allow easy removal, cleaning and assembly of insulators from outside without dismantling bus duct. Conductors shall be supported on insulators so as to allow alignment and expansion of conductors due to temperature changes.

Bus duct support structures shall be continuously earthed in an approved manner by earthing conductor to the grounding grid. Bus duct enclosure shall be earthed at one point or multiple points based on bus duct vendor's design and standard practice.

The bidder shall submit type test reports of similar SPBD of the same or higher ratings, otherwise type testing of the SPBDs shall be done. Extrapolated type test reports will not be acceptable to Owner.

a. Flexible Connections, Joints and Disconnecting Links

Flexible connections shall be provided at all terminations and where necessary to accommodate thermal expansion or other differential movement of conductors and enclosures, CT removal and to ensure that no undue force or vibration is transmitted to external equipment and structure of the main buildings.

For all joints approved means like tinning or silver plating shall be provided for mating surfaces to prevent electrolytic corrosion and good electrical contact.

Disconnecting links shall be provided in the tee-off connections to the transformer to allow continued operation of the generator in the event that any transformer is required to be out of service or removed for maintenance. Enclosure end caps shall be provided to close open enclosure ends and retain pressurization when any transformer has been removed. The links shall be arranged so that the main protection can be retained during an outage of the particular transformer.

b. Bus Duct Enclosures

The outer surface of bus duct enclosure shall be painted in light grey (RAL 7032) shade and inside shall be painted in black color. A seal-off bushing shall be provided in each enclosure where bus duct comes out of turbine building to ensure that in the event of any fire out-door smoke or flames do not enter turbine building. Total installation shall be maintained at slightly positive pressure of at least 10-15 mm of water column by using dry instrument air to prevent ingress of any moisture in the enclosures. Air tightness of installation shall be guaranteed by demonstrating maximum instrument air consumption of not exceeding 5% of total enclosure volume per hour.

The bus enclosures shall be fabricated and designed to afford easy access to conductor joints and insulators for assembly, inspection, and maintenance. Removable sections, covers and inspection doors in the enclosures shall be furnished with gaskets. The gasket material shall ensure long life without replacement or adjustment and shall be reusable.

The enclosure at the transformer ends shall allow for any thermal movement of the bus duct and misalignment up to 25 mm in any direction.

The enclosure shall utilize a forced air-cooling system encompassing redundant fans, filters, air dryers, etc. Redundant pressure switches shall be provided to monitor the enclosure pressure and shall activate an alarm at the DCS in the event of low air pressure in the enclosure.

Filter drains shall be provided at terminations and at all low points in the horizontal portions of the bus structure, to ensure the elimination of any condensation that might collect in the enclosures.

The connection between the bus duct enclosures and flanges at the generator auxiliary cubical and transformer tank shall be provided with insulated gaskets.

The connection between the bus duct enclosures and flanges at the generator auxiliary cubical shall ensure continuity of minimum flux type of design. Shorting plates between enclosures shall be provided at all terminating points to ensure continuous type design for entire bus duct installation.

6.2 TRANSFORMERS

6.3.1 Service Transformers

Adequate number of unit service transformers (6.6/0.433kV) shall be provided. Primary and secondary voltage level, number, and placing of transformers shall match normal practices for electrical equipment in the region. BIL rating of transformers shall be selected based on IEC standards as applicable for the project. Service transformers may be designed for indoor application.

Indoor application transformers shall be of dry type cast resin with mechanical protection enclosure rated to IP-41 and temperature rise limited to Class-H.

High-voltage terminal box suitable for bus duct or cable connection shall be provided based on choice for external connections. Transformers directly coupled to switchgear busbars shall have terminal chamber integral to transformer with clamp type connectors. Low-voltage bus connection to switchgear shall be rated for full rating of transformer at lowest voltage as minimum. Temperature monitoring and controls system shall be furnished. OCTC of +/-5% with five steps shall be provided. High temperature alarm shall be provided in the central control DCS.

6.3 CONTROL AND INSTRUMENT TRANSFORMERS

6.4.1 Current Transformers

All current transformers shall comply with the requirements of IEC 60044 relevant parts. The current transformers, unless otherwise approved, shall have one (1) Amp secondary windings rating except for primary rating of 1000 A and above when it shall be rated for 5A. The secondary windings of each set of current transformers shall be earthed at one point only made through a link in an accessible position.

Each current transformer shall be of approved ratio, accuracy class, and output as determined by the bidder to match the rating of the circuit to which it is connected. The secondary windings shall be wired to shorting type terminal blocks and the connections suitably braced to prevent contact with the main circuit. All current transformers shall be provided with rating plates.

Current transformers used for performance tests and revenue metering shall be of accuracy class 0.2.

6.4.2 Voltage Transformers

All voltage transformers shall comply with the requirements of IEC 60044 relevant parts. Primary windings shall be connected to the HV/LV circuit through renewable fuses of approved type, generally to IEC 60282 or IEC 60269, and shall be readily accessible. The primary winding shall be connected to the switchgear through renewable fuses and shall be readily accessible.

Secondary fuses shall be provided on each voltage transformer and secondary windings shall be earthed at one point only through a link in an accessible position. All voltage transformer fuses shall be provided with labels indicating their function and phase color.

Voltage transformers shall be of the air or epoxy resin insulated type and metal cases shall be earthed. Voltage transformers used for performance tests metering shall be of accuracy class 0.2 or better.

6.4 SWITCHGEAR AND MCC

6.4.1 General Requirements

The switchgear shall be designed, manufactured, and tested in accordance with the latest IEC, ANSI, and NEMA standards as applicable. Each MV switchgear, LV switchgear and MCC shall have dual incomers so that failure of one incomer shall not cause of loss power to the connected loads or any reduction of output. The switchgear shall be complete with LOTOTO provision and access control via LAN Network.

The design of the equipment shall be such as to prevent accidental contact with live metal and to avoid the spread of fire or damage from short circuits or other cause. Cubicle type equipment shall include barriers to segregate the equipment for each circuit and main and subsidiary bus bar compartments.

All enclosures containing electrical equipment which can cause rise in temperature shall be provided with thermostatically controlled anti-condensation heaters operating at 240V or less.

All switchgear shall be located indoors in non-hazardous, air conditioned, environment controlled and dry areas and shall be metal clad cubical type incorporating circuit breakers, contactors, and high breaking capacity fuse gear with air insulating bus bars chambers, current transformer chambers, voltage transformers and cable boxes. Outdoor equipment shall be subject to Owner approval and shall be weathertight.

If a switchgear enclosure/panel is contained indoor but without air conditioning for any specific reason, the enclosure/panel rating shall be to IP 54 or better. If for any reason a switchgear needs to be installed outdoor, the enclosure/panel shall be to minimum IP65 weather proof and of stainless steel material.

All switchgears shall be covered by an arc flash study and appropriate labelling should be done for each panel indicating the arc flash level.

The switchgear shall be normally controlled from the DCS and local control, for emergency shutdown and maintenance, shall be provided. The DCS shall have electrical device position indications. Control selector switches to allow the point of control from local, remote or maintenance shall be provided and shall be lockable in any position.

To provide maximum reliability, all load centers are double ended, equipped with two main breakers and one tie breaker. Main and tie breakers are mechanically interlocked for safety.

All incoming circuits shall be equipped with a voltmeter and ammeter. The meters shall have selector switches to allow all phases to be monitored.

The switchgear shall be provided with circuit labels with Danger Sign as per rated voltage on the front and rear of the board and panels. All enclosures and apparatus shall be clearly labeled, on both the front and back, indicating and at a minimum the full equipment identification number for the device being controlled, English description and function. Complete labels in accordance

with NFPA 70 E shall also be installed. The labels shall be corrosion resistant material, fade resistant and securely fastened.

All electrical disconnect devices shall be provided with means to lock them in the open and out position. When locked out all cabinet and enclosure doors shall have the ability to be closed.

The operation of all devices shall be from an ergonomic height.

6.4.2 MV Switchgear

6.6kV Medium voltage (MV) switchgear shall comprise of circuit breakers / fused backed contactors of vacuum type mounted in fully draw out type, indoor, metal clad construction. It shall have service, test and isolated distinct positions for the withdrawable switchgear with cubicle doors closed. All incomers, bus-couplers and feeders shall be circuit breakers and provision to operating from DCS. Racking mechanism shall have interlocks to prevent breaker being left in any intermediate position and visible position indicators from outside shall be provided. Remote/DCS control for both RACK-IN and RACK-OUT operation. Automatic shutters interlocked with breaker movement shall be provided so as to prevent access to cubicle busbars with breaker not in service position or removed from cubicle. Truck type circuit breakers shall be designed to avoid excessive impact loads being imposed on the floor finish in front of the cubical when the trucks are withdrawn. Switchgear shall be dead front type and electric arc safe design.

Circuit breaker operating mechanisms shall be trip free type so designed that in the event of failure to the latch in the closed position or if a trip impulse is given during the closing stroke, it shall not be possible for the circuit breaker to open except with normal speed and travel.

Electrical closing mechanisms shall be motor wound spring or solenoid type. Where stored energy operating mechanisms are employed a lockout device shall be incorporated which shall prevent operation whenever the energy stored is below that required for satisfactory operation.

A mechanical device positively driven in both directions shall be provided on all mechanisms to show whether the circuit breaker is open or closed and shall be operative when the circuit breaker is in service, open, isolated or grounded positions. The device shall be visible when the cubical doors are closed.

A mechanical trip button suitably shrouded and recessed to prevent inadvertent operation and with facilities for padlocking shall be provided on the outer door of all each electrical isolation device.

The switchgear manufacturer shall furnish one set of accessories for test, inspections, maintenance and operation.

Each unit of the switchgear shall be furnished with space heaters to prevent condensation of moisture within the switchgear.

Cable and bus bar earthing facilities shall be provided. The design of any earthing devices shall be such that the device cannot be connected unless the breaker is open and in the isolated position.

Each of the switchgear line-ups shall include at least one (1) complete breaker/contactors feeder equivalent to the highest rating feeder from that board with all accessories, at the time of handover. Switchgear shall be placed so as to allow future expansion on at least one side for each bus section. Each of the switchgear line-ups shall also include 10% spaces for future expansions.

6.4.3 LV Switchgear

LV auxiliary power supply system shall comprise a number of main switchboards which will in turn supply motor control centres and distribution boards associated with the respective station and unit auxiliary loads.

The switchgear shall be of the free-standing cubicle pattern suitable for three phase 3-wire or 4-wire operation, with high resistive, grounding. Single phase-ground fault shall be limited to 5A to allow continuous operation of the switchgear. An alarm shall be generated in CCR DCS for the operator's attention. Alternatively, switchgear shall be designed for a solidly grounded LV system with Type-2 coordination based on IEC 60947.

The construction of the switchgear shall be such that the internal separation by barriers complies with form 3A separation in accordance with the requirements of IEC 61439-1.

The circuit breakers and or MCCB shall be air break, triple pole, horizontally withdrawable with independent manual spring closing and electrical trip release suitable for 220V DC operation.

Each circuit shall be self-contained within its own cubicle with an individual access door. Circuits shall be separated from each other by earthed metal. Cubicle doors shall be provided with lift-off type hinges and shall have facilities for being locked in the closed position. It shall be possible to operate each switch without the need to open the cubicle access door.

Cubicles may be arranged vertically in tiers, the number being limited by ergonomics/access and the need to ensure the circuits are thermally independent.

The switchgear shall be designed so that it is possible to safely work within each cubicle with the equipment withdrawn and the incoming contacts energized.

Cubicles shall be suitable for safely terminating all necessary cabling while adjacent circuits are energized. LV Switchgear shall be fuse less type, suitable rating of MPCB/ MCB to be consider in place of Fuse.

Control will be on the same basis as for the MV switchgear.

6.4.4 Switchgear components

a. *Contactors*

Contactors of the electrically held type shall each be equipped with its own control circuit transformer. The control transformers will be in accordance with this Aggregate Technical Specifications. Latch contactors shall be provided as determined by the duty of the particular circuit.

Contactors shall each have an uninterruptible current rating and a category AC3 breaking current rating, at least 50% in excess of the normal full load current and motor stalled current where applicable and in accordance with relevant standards. Vacuum contactor shall be provided for frequent operation feeders like heater, drain pump etc.

A visual mechanical indications device shall be provided on each contactor. It shall be positively driven in both directions to show whether the contactor is open or closed and shall be operated in both service and isolated positions on draw out equipment.

Each piece of contactor equipment in a switchboard shall be screened from adjacent units and any current carrying parts which may remain alive when access is gained to the contactor and moving parts of the isolating device for maintenance so that it shall not be possible to touch live metal parts without the use of tools.

Contactors for motor control shall be suitable for direct-on-line motor starting and shall be capable of withstanding without damage the motor stalled current until the associated protective device operates.

Contactors shall be arranged as type “2” co-ordination for switchgear and type 1 for MCC and shall conform to IEC 60947-4.

b. *Isolating Devices*

In order that they may be made dead for examination, or other purposes, all circuit breakers and contactors shall be connected to the busbars through isolating devices of approved design.. The

isolating devices shall be arranged for operation while the busbars are alive and while no current is passing.

Isolators shall be capable of carrying the rated load current to the circuit and the short time current specified.

On-load isolators shall be capable of making a current equivalent to the specified prospective fault current as limited by the cut-off characteristics of the largest fuse with which it may be associated.

Means shall be provided to prevent movement of the circuit breaker from the isolated to service position when the shutters are padlocked closed.

Plug connections, including those for auxiliary wiring shall be of the self aligning type.

c. *Bus bars and Connections*

Bus bars and electrical connections between the several pieces of apparatus forming the equipment shall be of electrolytic copper and they shall comply with the relevant standard. Bus bars shall be protected against atmospheric corrosion by means of tinning or heat shrink sleeves.

Cubical type switchgear shall have busbar barriers provided between the units to prevent spreading of ionized gasses in the event of a fault. The arrangement of the barriers and bus bar insulation shall avoid the introduction of small air gaps between the conductor and the insulation.

Torque and tightness parameters and recommended inspection frequencies shall be included in the O&M Manual.

Bus bar placement shall be consistent throughout the Facility so that the line side position in a switchboard in one area of the Facility is the same in all others.

Metal shutters shall be provided to cover each of the 3-phase group stationary isolating contacts. Each set shall be capable of being individually operated and individually locked closed. The shutters shall open automatically by a positive drive initiated by the movement of the circuit breaker, voltage transformer carriage or other equipment as required. The closing shall also be automatic.

The bus bar shutters shall be painted and labeled. Line side shutters shall be clearly be marked “Danger – Live Cables” and painted a different color then the bus bar. The bus bar shutters shall be labeled “Bus bars.”

d. Auxiliary Switches

With each circuit breaker, contactor, isolating device and earthing device there shall be supplied all necessary auxiliary switches and mechanisms for indication, protection, control, interlocking, supervisory and other functions to meet the requirements of this Aggregate Technical Specifications. A breaker position switch shall be furnished with each breaker to bypass all “b” auxiliary contacts in remote interlocking circuits when the breaker is in the test position or in the disconnected position.

All auxiliary switches shall be wired up to a terminal board on the fixed portion of the switchgear whether they are in use or not in the first instance.

All auxiliary switches and mechanisms shall be mounted in approved accessible positions clear of the operating mechanisms and are to be protected in an approved manner.

Composite fuse and switch equipment may comprise either a fuse-switch unit with integral fuses, or switch-fuse units in which the air break switch and the connections from it up to the associated fuse shall be so designed as to minimize the possibility of a fault. The equipment shall comply with the requirements of IEC 60947-3 and ensure that the fuse is isolated when it has to be changed.

Switch-fuse units shall be arranged with the switch on the bus bar side of the fuse.

Power fuses shall be of the high breaking capacity cartridge type complying with the requirements of IEC 60269.

Use of fuses shall be limited to very fast acting applications.

Miniature Circuit Breakers

The DC distribution boards associated with the batteries and LV AC distribution boards shall preferably be equipped with miniature circuit breakers on outgoing circuits. They shall be single, double or triple pole as appropriate to the circuit and shall have sealed operating and overload mechanisms.

Ground Fault Circuit Interrupter (GFI) breakers shall be provided as required by Codes and Standards, local requirements and safety requirements.

e. Circuit Breaker Handling Equipment

Suitable handling equipment shall be provided where necessary for easy handling of circuit breakers.

f. Interlocks

Safety interlocks to ensure correct system operation, to avoid unsafe switching conditions and to ensure safe isolation for maintenance shall be provided by mechanical or electrical means.

Mechanical interlocks shall be of the preventative type and shall be arranged as close as practicable to the point at which manual force is applied to prevent miss-operation. Mechanical interlocks shall be installed on all contactors and breakers to ensure the electrical equipment is tripped and remains tripped while the equipment is being racked. Electrical interlocks shall be function to prevent the closing operation of the switches.

Key interlock devices of the Kirk or Castel type shall be provided to prevent the paralleling of certain supplies. An identification system shall be provided and subject to Owner's approval.

6.4.5 Motor Control Centers

MCC enclosure shall be designed, manufactured, tested as per NEMA 3S. All equipment for panels shall be located at an ergonomic height of an average operator.

6.5 DIESEL GENERATOR SET

6.6.1 BLACK START DIESEL GENERATOR

The diesel engine generator will serve as black start generator when the grid supply is not available for starting up the generating unit.

The black start diesel engine driven generator will be capable of providing power to start up loads of one STG unit. The diesel engine will be standby duty & be of the four-stroke, turbo-charged and intercooled, compression ignition type with direct fuel injection operating at a speed not exceeding 1500 r.p.m. The black start diesel generator shall include pollutant analyser at stack outlet with online monitoring facility. The engine & generator will comprises all accessories as listed below.

- 6600 V, 3 Phase, 50 Hz, AC output generator
- Heavy duty ultra capacitors shall be used instead of Battery.
- Engine battery or compressed air system starting system
- Engine lubricating oil, cooling radiator and exhaust systems

- Engine fuel oil supply system and fuel tank
- All interconnecting pipe work, valves, vents, drains and supports
- Anti-vibration mounts between equipment and the skid or between skid and structural/civil
- foundation. All piping connections to engine subject to movement due to the anti-vibration mounts except the exhaust will be via steel braided flexible hoses.
- Complete control/start/operating system suitable for unattended mode
- Complete system as required for black start purposes.

6.6.2 EMERGENCY DIESEL GENERATOR

Three (3) emergency diesel generator sets (“EDG”) shall be furnished to provide the necessary AC power to safely shut down the Facility upon loss of all AC power. The bidder shall determine emergency diesel generator rating which shall include, but not be limited to, the following essential loads:

- Battery Charger(s), DCS,
- Turbine oil systems. Turning gear, Generator seal oil pump, Lube oil tank vapor extractor
- Air compressor; (as required), Service water pump (as required), Vital AC power system (UPS)
- Fan Auxiliary Oil Pumps (ID, FD, PA, etc. as required)
- Diesel Generator Battery Charger, Diesel Generator Fuel Oil Pump
- Chimney Obstruction Lighting
- Electronic / Control Room Lighting Load (20% of normal), Switchgear Area Lighting Load (20% of normal), UPS Area Lighting Load (20% of normal), Transformer yard area lighting (20% of normal)
- Elevators
- HVAC systems for control room, engineering station room and electronic room in the central control room building

The diesel generator controls shall include provisions to synchronize with the Facility emergency switchgear to enable a live transfer from emergency power to normal power distribution. The diesel generator control system shall also include provisions to start automatically upon detection of loss of normal source of power to the Facility essential power switchboards/ MCCs. Additionally the emergency diesel generator shall have the following capabilities:

- Synchronizing capabilities to emergency switchboard for parallel operation with system
- System should be able to close breaker to a “dead bus”.

The engine shall have a continuous rating at its governed speed of not less than the overload kW rating of the generator. The engine rating shall equal or exceed the generator motor starting capability. The engine shall maintain its speed at the overload rating of the generator. The engine shall be of current design and manufacture and shall conform to the recommendations of the "Standard Practices for Low and Medium Speed Stationary Diesel and Gas Engines" of the Diesel Engine Manufacturers Association insofar as these standards apply.

The diesel generator shall include a double walled Fuel Oil day tank conforming to National Fire Protection Association (NFPA) 30.

The diesel generator and accessories shall conform to NFPA Standards NFPA 30, NFPA 37, and NFPA 110

A fuel system shall include a Fuel Oil strainer, fuel pump and duplex-type pre- and fine- filters, piping, valves, fittings, and controls necessary for operation.

Baseplate/skid mounted diesel generator set of appropriate rated output. Local control panel incorporating all necessary controls and indications for the control of the generating set;

Room or enclosure for DG set including emergency lighting and ventilation.

Dual battery system and charger; each battery capacity shall be sufficient for six consecutive attempted starts; The bidder shall provide integral accessory-storage battery units for starting the engine, complete with battery stand, battery charger, charge control and automatic voltage regulator, ammeter, and thermal cutout in suitable drip proof enclosure with adequate provisions for ventilation.

Heavy duty ultra capacitors shall be used for starting of EDG.

A control panel shall be enclosed-type, NEMA Type 12 or IP-54 designed and constructed to include standard controls and instrumentation;

All necessary piping and inlet and exhaust ductwork, filters and silencers;

Cable connection to and control of the circuit breaker on the bus that the generator output is terminated.

Engine periodic testing and loading facility shall be provided.

Cooling shall be by an engine mounted fan cooled radiator. The cooling system shall be designed for the maximum ambient temperature. All fans, motors, ducting, supports, piping and valves required for this purpose shall be provided. The cooling system shall be thermostatically controlled.

A closed-circuit cooling water pump shall be supplied. It shall be direct driven from the engine but shall be housed separately from the crank case sump and oil tank, thus minimizing the possibility of pollution of the lubricating oil by water from gland leakage or similar causes.

The engine must be capable of an immediate quick start and a thermostatically controlled immersion heater shall be provided to maintain the engine cylinder jacket water at a suitable temperature.

The engine lubrication system shall conform to applicable requirements of NFPA codes 30 and 37. The diesel engine may stand still for a considerable period yet must be immediately available for full load. Any special lubricating arrangements necessary to meet this condition shall be provided. At a minimum the lubricating oil capacity shall be sufficient for 24 hours continuous operation.

The engine shall be equipped with a suitable governing system to provide speed regulation within 5% at any constant load condition from 0% to 100% rated load and capable of the speed (and frequency) requirement specified herein. A mechanical device operating independently of the governing system shall be provided to limit the over speed to a safe value and to cut-off the fuel supply directly.

The generator shall be rated for continuous operation and shall comply with the requirements of the relevant parts of ISO 8528 and IEC 60034 over the specified range of ambient conditions. The generator shall be designed for performance Class G2.

The generator shall be of the salient pole rotating field type with enclosure to IP 41 and air-cooled by means of fans on the rotor shaft. The cooling system shall be filter ventilated (ICOA1 to IEC 60034-6).

The generator and exciter insulation shall be Class H. The temperature rise of the generator and exciter windings shall not exceed the limits for Class F insulation when the machine is delivering its basic continuous rating at the ambient conditions specified.

The EDG shall have full control from DCS (loading, start, stop, synchronization, etc.). The DCS shall incorporate Facility blackout logics for the emergency critical drives such that they start automatically upon EDG power restoration. EDG shall be adequately sized to support simultaneous start of the most critical essential drives without being cascaded.

6.6 ESSENTIAL SERVICES AC AND DC SYSTEMS

6.6.1 Battery Systems

Ungrounded DC system consisting of battery system(s) of appropriate voltage levels per unit shall be provided. The batteries shall be sized to handle the duty cycles determined in the final design. Nickel Cadmium electrolyte Battery shall be sized as per IEEE 1189. Batteries must be able to supply full projected load for no less than 2 hours after loss of charging system.

220V DC system shall have both poles fully insulated and suitable for unearthed operation. Batteries shall be sized to include an aging factor of 25%, a 20% design margin, and temperature correction factor based on expected battery room temperature limits. Batteries shall be selected so that they will not require replacement earlier than 20 years. All momentary loads shall be assumed to be of one-minute duration. DC system sizing calculation and battery selection basis shall be provided for Owner's review. Batteries shall be placed in Air Condition room.

Dual redundant Float Cum Boost Chargers (FCBC), each sized to provide 100 % DC system load for the each generating unit, along with charging load of the battery shall be provided. Power supplies to each charger shall not be from a common bus (subject to a single point of failure). Each charger shall have capacity to fully charge a battery in 8 hours maximum. Chargers shall maintain the voltage of DC system within permissible limits while float or boost charging.

Each battery charger shall be provided with local alarms and instrumentation and provision for remote indication of common alarm with fault indication to DCS. Each battery charger shall be equipped with AC input and DC output circuit breakers. Means to deduct earth fault in DC system shall be provided.

Charger DC output breakers thermal overloads shall be disabled, and only short circuit protection shall be incorporated.

Protective devices in DC distribution panels shall be equipped with double pole circuit breakers for each incoming, interconnecting and outgoing circuit. Breakers and switches shall have an interrupting capacity greater than the maximum available short circuit current and the bidder shall verify that the interrupting devices are DC rated for the maximum available fault current. All cables and the DC distribution system shall be designed to withstand the maximum available short circuit current. In addition, battery main leads and main distribution panel buses shall be rated so that the temperature rise due to the battery one-minute design current does not exceed the emergency overload temperature.

A full set of battery test accessories shall be provided, mounted in a box.

6.6.2 Uninterruptible Power Supply (UPS) System

All AC equipment, instrumentation, communication, and protection systems which cannot tolerate a disconnection of power supply and is required to operate continuously such as a

distributed control system (DCS) and other local control systems shall be powered with supplies from an uninterruptible power supply system (UPS) system.

The UPS equipment shall be single phase having rectifier, static switch, powered from station battery system, a manual bypass switch, a Constant Voltage and Constant Frequency (CVCF) for bypass mode. All equipment shall be cubicle mounted and complete with local alarms and instrumentation as well as provision for remote indication of common alarm with fault indication to DCS.

All uninterruptible loads shall be supplied at the same nominal voltage which shall be 230V. The equipment shall be designed to supply switch mode type loads with in-rush values being 200% of the equipment rating.

The UPS equipment shall be provided with isolation facilities to permit full replacement without disrupting any part of the systems to which it is normally connected.

The UPS equipment shall be powered from batteries of the DC system, which is sized to provide for a standby period of 2 hours when supplying 125% of the maximum continuous load of its associated distribution board without the need for enhanced ventilation.

The static switch shall be capable of carrying the continuous, short time (overload) and short circuit specified for the UPS system and shall be used for automatic transfer between the synchronized static inverter and the alternate ac supply. When the normal power supply is lost, the static switch shall transfer to the alternate supply within 0.25 cycles.

The equipment shall be capable for operation with and input voltage variation of $\pm 10\%$ and frequency variation of $\pm 5\%$ and shall comply with the following:

Sl. No.	Parameter	Requirement
i.	Output Voltage Static tolerance Dynamic Tolerance	As required by Facility installation +1% +4% for 100% load change
ii.	Output regulation	Output voltage Regulation $\pm 1\%$ Output frequency regulation $\pm 0.2\%$
iii.	Harmonic distortion	3% maximum
iv.	Overload capacity	150% for 1 minute 125% for 10 minutes
v.	Short circuit current	2 x rated current for 10 seconds
vi.	Ambient temp range	0 to 40°C
vii.	Cooling	Natural
viii.	Noise level	60 dB(A) max

For maintenance purposes a manual by-pass switch shall be provided to allow the DCS to be powered from an alternate source. This shall consist of a second AC supply which will allow maintenance procedures to be carried out safely and without interruption to system operation.

6.7 PROTECTIVE EQUIPMENT

6.7.1 General

Protective gear shall be provided to disconnect faulty circuits with speed and certainty and without interference with healthy circuits. They shall also be such as to prevent incorrect operation of circuit breakers or contactors as a result of transient phenomena not arising from a faulty condition of the section of line or plant associated with each set of relays, but which may occur during fault periods due to disturbances on the system.

Permanent facilities shall be provided for the convenient testing of protective equipment in place without the need to remove wires.

At a minimum digital protection equipment shall be provided for the following equipment:

- a) Generators;
- b) Auxiliary Transformers;
- c) Medium Voltage (MV) Switchgear;
- d) Low Voltage (LV) Switchgear; and
- e) MV Motors.
- f) LV Motors

The protection relays for the generator shall be mounted in relay protection cabinets to be located in the TG Building Control room. The protection relays for the MV switchgear, LV switchgear and MV motors shall be located on the respective switchgear.

The bidder shall prepare relay coordination calculations to ensure that a short circuit or an earth fault shall be cleared without cascading to upstream circuit breakers.

The protection relays shall be microprocessor based multi-function type of latest, proven technology available and shall be provided with multiple functions that can be selectively used or disabled.

6.7.2 Relays

All relays and protection shall comply with the requirements of the appropriate parts of the IEC 60255.

Electronic, solid-state protection relays, preferably of the programmable microprocessor type incorporating fault and transient measurement memories, matrices for programming tripping sequences and auxiliary relays shall be provided.

All relay cases shall prevent the ingress of dust and shall meet the requirement of IEC 60529, classification IP 54.

All protection relays, including those for motor circuits, shall be of the hand reset type, or alternatively operate through a hand reset tripping relay. The action of resetting shall not cause the associated equipment to start automatically.

Each protection relay or protection system shall be provided with an adequate number of output contacts of suitable rating to carry out the tripping functions, alarm indication, indication and remote monitoring as required. All protection relays shall be provided with soft link to DCS through IEC 61850 communication protocol of all measured electrical parameters without limitation on configured span and measured value.

Wherever possible the design of the relay schemes shall be on the “fail-safe” principle. Care shall be taken to ensure that loss of DC supply or an open circuit does not cause incorrect opening or closing of a circuit breaker. Circuit breaker or isolator repeat relays should be of the latching type and a discrepancy alarm shall be provided to check correct operation of the relays following circuit breaker or isolator operation.

6.7.3 Protection Systems

The type of protection schemes required shall include but not be limited to the following sections. Protective relays and systems shall be provided to detect and discriminate all credible faults on each item of the Facility and equipment and their power supply source. In the event of unacceptable electrical system disturbances occurring, the protection shall operate, positively and consistently, maintaining adequate discrimination, to minimize damage to the Facility and equipment and disturbance to the system as a whole. It shall be designed to preclude, all possibilities of inadvertent operation. All relays to TIME SYNC through common GPS and critical events to be captured through DR(disturbance recorder).

a. *Generator Protection Systems*

The generator protection system shall be provided with state of art digital multifunctional relay of proven make and model for the application. Selected relay shall have extensive self-monitoring capabilities and communication facility through serial links with operator terminals (PCs) and control systems. All Micro-processor based multifunction digital relays shall be provided with on-line self-diagnostic alarm capability. Generator protection circuit shall be totally redundant with auto synchronizing facility. Two multi-functional programmable digital relays shall be provided for

each generator protection. Each fed from a separate set of current transformers to provide redundant protection from sensing devices to tripping mechanism. The multi-function relays shall include, as a minimum, the following protective functions:

- Generator Differential;(87G)
- Stator Earth Fault;(64G, 59N, 100% stator)
- Negative Sequence;(46)
- Loss of Excitation;(40)
- Reverse Power; Inadvertent Generator Energizing (32R)
- Under current or Low forward power (37)
- System Distance Backup;(21)
- Inverse Time Phase Overcurrent; (51)
- Over excitation; (24)
- Stator overload (49)
- Undervoltage; (27)
- Generator over voltage (59)
- Over/Under Frequency; (81)
- PT fuse failure alarm
- Generator rotor Earth fault alarm and protection ; (64R)
- Generator Synchronism Check; (25)
- Lockout Relays (to trip the switchyard circuit breakers and mechanical equipment (such as turbine inlet valves); (86G)
- Exciter Field Earth. (64F)
- Pole slipping. 78/21G
- Overexcitation relay. 59/81(v/Hz)
- Dead machine relay. (27/50G)
- Stator phase and ground instantaneous and time over-current (50P, 50G, 51P, and 51G)
- Neutral over-voltage (59N)
- Inadvertent energization

Generator protection shall consider the following:

- Differential protection shall not operate for magnetizing in-rush currents or for through flows to external faults with worst-case symmetrical current conditions.
- Separate lockout relays shall be used for primary, back-up and breaker failure relay systems.

- Interlocks associated with generator circuit breaker failure scheme shall be used as applicable.
- The various tripping methods, such as “simultaneous trip,” “sequential trip,” etc., shall be given proper considerations and will be appropriately applied.
- The generator and its prime mover shall be protected from over- and under-frequency operation in accordance with ANSI C37.106.
- Digital, multifunction type indicating meters shall be provided.

b. *Transformer Protection Systems*

Service Transformer Numerical Protection Relay to be provided at 6.6kV MV Switchboard.

c. *Switchgear and Motor Protection Systems*

The microprocessor based multi-function relays shall include, as a minimum, the following protective functions. The relays shall be mounted on the related compartments of the respective switchgear.

a) *Medium-Voltage Switchgear*

- Bus Undervoltage / Over voltage;
- Bus Fault Comparison;
- Incoming Feeders Phase instantaneous Overcurrent
- Phase time over current
- Earth Fault
- Outgoing Feeders Phase instantaneous Overcurrent and Earth Fault.

b) *Low-Voltage Switchgear*

- Bus Undervoltage; and
- Incoming Feeders Phase Overcurrent and Earth Fault.

d. *Medium-Voltage Motors*

The microprocessor based multi-function relays shall include, as a minimum, the following protective functions. The relays shall be mounted on the related motor feeder compartments of the respective switchgear.

- Short circuit (50)
- Ground Fault Protection (50G)
- Stator RTD (49)
- Bearing RTD (38)
- Unbalance phase loading (46)
- Phase reversal (47)

- Phase current unbalance;(51)
- High-impedance differential protection; (87M) for ≥ 600 kW
- High-impedance differential protection; (87M) for ≥ 2000 kW
- Speed switch and locked rotor (Coal mills) (14+51R)
- High vibration. (Alarm)
- High Vibration trip (> 180 kW motors).

e. Digital Fault-Monitoring and Disturbance Recorder

A digital fault-monitoring and disturbance recorder system (FMS) shall be provided, which shall cover the entire power station electrical system items, including the following:

- Incomers and couplers of all MV, LV and Generator switchgears.
- All medium-voltage switchgear feeders and MV, LV motor feeders.
- All LV & MV feeders shall have digital energy meter with EMS system (Energy management system)

6.8 MOTORS

6.8.1 General Requirements

Motors shall comply with the requirements of IEC 60034 or NEMA-MG-1 (For NEMA rated motors). All motors shall be IE3 Energy Efficient and construction.

All AC motors shall be designed for continuous operation. DC motors shall be designed for continuous operation at any voltage between $\pm 10\%$ of nominal voltage without exceeding permitted temperatures and without injurious sparking at the commutator.

The medium voltage (MV) motors shall include those motors rated above 160 kW. The low voltage (LV) motors shall include those rated 160 kW and less. Motors up to 0.2 kW may be of single-phase type. However, all motorized actuators for valves shall be of three phase type.

All medium voltage motors shall have space heaters. The space heaters shall be rated for 230 volts. They shall be located and insulated so they do not damage motor components or finish. They shall be sized as required to maintain the motor internal temperature above the dew point when the motor is idle. All outdoor-mounted low voltage motors shall be provided with space heaters. A separate space heater terminal box and isolating facilities shall be provided for each motor.

Motors shall be provided with suitable terminal boxes and terminal bushings which may be oversized to accommodate cable sizes calculated per Site ambient conditions. Terminal boxes shall be designed so as not to direct any explosive gases towards the person standing near the motor in case of fault.

Degree of protection provided by the enclosure shall be IP-54 per IEC 60529 (NEMA 3S for NEMA rated motors) for indoor motors and IPW-55 for motors located outdoors. (NEMA 55 for NEMA rated motors).

Motor windings shall be insulated with materials having at least thermal classification H. The temperature rises shall not exceed the permissible limits for Class F materials.

An earthing terminal of appropriate design and adequate current carrying capacity shall be provided adjacent to the motor box.

6.8.2 Medium Voltage Motors

All motors above 160kW will be motors of Medium Voltage 6.6kV with Class H insulation with temperature rise limited to Class F. All motors will be of IP-55 with industrial enclosure. All motors shall be of TEFC / TETV type preferably. The motor Terminal box shall be PSTB type.

Medium voltage motors shall conform to IEC 60034 or NEMA MG-1 based on the Country's requirements. Motor shall be sized such that they have at least 5% margin over design duty point at service factor 1.0 (Continuous duty). Nameplate horsepower/KW multiplied by the 1.15 motor nameplate service factor shall be at least 20% greater than the driven equipment operating range maximum brake horsepower. The motors shall be designed for DOL full voltage starting. Motors shall be suitable for 2 consecutive hot starts and 3 equally spaced starts in one hour at specified ambient.

Motor shall be suitable to start and accelerate with driven equipment connected at any voltage from 90% rated voltage to 110% rated voltage. Motors shall not stall when voltage momentarily dips to 70% of rated level. During supply changeovers motors running at full speed initially shall be able to re-accelerate when voltage is restored after changeover. Such motors may be subjected to phase voltage which is out of phase to internal induced voltage phasor when voltage is applied in such conditions.

All medium voltage motor shall be furnished with bearing and winding temperature 3 wire RTDs wired to the DCS/ Motor protection relay for monitoring, protection and alarm functions. Two out of three in case of winding and two out of two in case of bearing, voting schemes shall be implemented. Each bearing shall have two temperature detectors set for alarm and trip levels. Each winding shall have three temperature detectors. A separate RTD terminal box shall be provided on the motor.

Motors shall be designed for full voltage starting and frequent starting and shall be suitable for continuous duty in the specified ambient. Intermittent duty motors are not permitted. Motors that will be fed from an inverter shall meet the inverter duty motor requirements of NEMA.

The 6.6kV motors shall have mica tape turn and mica tape ground wall insulation and corona (partial discharge) tapes (grading tapes) shall extend a minimum of 4 inches into the end turn area from the stator core. Paint shall not be used for grading.

All medium voltage motors shall have surge withstand capability in accordance with NEMA C50.41, Section 18.3. Surge capacitors shall be considered for long length motors as per standard.

The solid shaft shall be fabricated of a corrosion-resistant material or furnished with corrosion-resistant treatment.

Rotor Temperatures: Maximum temperatures after second consecutive start shall not exceed 300°C rise (adiabatic).

The motors shall be designed so their copper or copper alloy rotor bars and end rings shall not exceed a total temperature (adiabatic) of 300°C maximum after two starts.

The motors shall be provided with mountings for vibration sensing equipment in the horizontal and vertical directions at each bearing to facilitate mounting of vibration sensors. Location of flat areas to facilitate mounting of vibration sensors for pumps shall be in accordance with ANSI/HI.

Bearing housing vibration velocity shall not exceed the unfiltered values per ISO 10816 when measured in three mutually perpendicular directions on the bearing housing, and on the motor shaft extension in the vertical and horizontal direction.

All MV motors shall be provided with shaft and bearing housing vibration monitoring system with links to DCS for real time recording and tripping. Redundant probes shall be provided for each bearing housing and the shaft.

Space heaters rated at 800 watts or less shall be wired for operation on 230 volts, single phase. Space heater leads shall be stranded copper cable with 600-volt insulation and shall include terminal connectors. Space heaters shall be sized as required to maintain the motor internal temperature above the dew point when the motor is idle. The internal temperature shall not cause winding temperatures to exceed rated limiting values nor cause thermal protective device "over temperature" indication when the motor is not energized.

Motors and any other electrical components located outdoor shall be provided IP 65 class or better weather protection. The electrical equipment which is located indoor such as switchgear, electrical and control panels shall be provided IP 41 class or better weather protection.

6.8.3 LV Motors

All motors rated below 160kW will be Low Voltage motors of 415V with Class F insulation with temperature rise limited to Class B.

LV motors shall conform to IEC 60034 standards or NEMA MG-1. LV motors shall be TEFC, air-cooled type. Degree of protection provided by the enclosure shall be IP-54 per IEC 60529 (NEMA 3S for NEMA rated motors) for indoor motors and IPW-55 for motors located outdoors. (NEMA 55 for NEMA rated motors).

All motors shall be able to start and accelerate with minimum voltage at motor terminals of 80% of rated voltage. Motors shall be rated for continuous duty and sized to provide at least 10 % margin over driven equipment design duty point. Insulation shall be class-F limited to class B temperature rise. Motors rated 30 kW and above shall be preferably premium efficiency motors.

Motors rated above 18kW shall be provided with space heaters and rated above 30kW shall be protected with Electronic Over Current Relay (EOCR).

6.8.4 Motor Operated Valves and Damper Actuators

A safety factor of 300% shall be used for sizing of operators for valves and dampers and all drive system components. Operators shall be capable of transmitting design torque (including safety factor) within the torque range specified by the actuator manufacturer. The strength of the operator mounting, based on the required operator torque, shall not exceed 30% of the yield strength in any mode of stress.

Motor operated actuators shall be complete in all respects including the motor and the necessary controls for automatically stopping the motor when the valve gate has reached the 'full open' or 'full shut' position. A clutch mechanism shall be included to prevent damage in the event of jamming. The motor and control gear shall be placed in such a position relative to the valve that there is no possibility of leakage of steam or water from the valve joints or glands blowing on to the motor or control equipment. All valve actuators shall be provided with hand operation facility shall be provided and be so arranged that the hand operated mechanism which shall automatically disengaged during motor operation and vice versa. Motor operated valves shall be provided with hand wheels having plain polished rims. Valves actuators shall be provided with at least one adjustable torque switch and drum type 4 sets each of NO and NC adjustable contacts of limit switches. Motor actuators shall be provided with a resistance type potentiometer for position indication and anti-condensation space heater. All internal wiring shall be brought out to a single terminal strip. All motor operated valve actuators shall be rated for 3 phase AC supply. Motors actuators shall be rated for short time duty of S2-15 minutes and provided with degree of protection of IP-65 or better based on IEC standards of equivalent. Valves and actuators shall be suitable rated to ambient, process and hazard conditions apart from above basic specifications.

All operators shall be of Limitorque or AUMA or ROTOK make and preferably with integral motor starters. Valves and actuator series shall be selected based on criteria of proven applications. All

MOV actuators shall be of intelligent type with programmable limit/torque settings. All MOVs shall be of same make to minimize spare inventory.

6.9 VARIABLE FREQUENCY DRIVES

6.9.1 Design Criteria

- a. The inverter units shall be microprocessor based and shall be suitable for the site ambient conditions. Necessary de-rating factors shall be considered for temperature correction.
- b. The converter section shall consist of 18-pulse rectification configuration scheme with required line current harmonic filter.
- c. Harmonic filter shall either be active or passive and designed to limit the harmonics generated by the equipment shall be well within the limit so that the system harmonic levels shall meet the requirements specified in IEEE 519. Bidder to note that equipment harmonic levels shall be much less than the THD levels indicated in IEEE.
- d. The inverter section shall be IGBT based type with suitable designed for feeding continuous full load, over load and starting of motor conditions. The inverter shall be provided with current limiting circuitry which will limit the output current to a value which will not damage the inverter or blow its fuses and sufficient capability to prevent damage to itself until short circuit conditions on the output are cleared.
- e. The inverter shall be designed to withstand momentary dips of about 30% in supply voltage for 3 cycles without damage to semi-conductor components or blowing of fuses. Power loss ride through feature for 2 Secs shall be provided.
- f. Motor and VFD shall withstand the voltage and torque stresses developed due to the vector difference between the motor residual voltage and the incoming supply voltage equal to 150% of the rated voltage during fast changeover of buses. The VFD shall have auto-speed search (fly catcher) for starting into rotating load. The VFD must be able to catch the motor spinning and bring to the desired operating speed in the proper direction without stopping the motor or tripping the drive.
- g. The VFD shall be able to deliver motor Class II duty overload as per IEC 60146 -1 standard i.e. 150% of motor rated current for 60 secs, at 50 deg. C temperature. If the motor load exceeds the limit, the drive shall automatically reduce the frequency and voltage to the motor to guard against overload. Necessary de-rating, if required, to be taken into accounts to meet overload requirements. Necessary calculations to arrive at the current rating of the VFD shall be furnished.

- h. VFD shall be provided with automatic sequence control which include start-up of cooling system, interlock checking, automatic start and run-up of drive, planned / emergency shutdown etc.
- i. Input Power Factor (not only the fundamental Power factor) shall be greater than 0.93 at 100% load and rated speed and overall efficiency of the system shall be greater than 95%.
- j. The VFDs shall be provided with Metal Oxide Varistors (MOVs) if required for transient voltage suppression on all three phases of the incoming power line. The VFD shall protect itself from damage due to any grounding or shorting of its output power circuit.
- k. VFD shall be designed considering the location of the motor and its cable surge impedance to take care of the impact of the reflected voltage on the motor end. If required suitable line reactors or reflected wave limiters shall be provided at the motor terminal.
- l. VFD shall be provided with suitable breaker and DOL starter to bypass the VFD in case of VDF failure / mal-operation. Necessary motor protection relay with suitable interlock arrangement with the VFD circuit shall be considered. Bypass shall be made such that, VFD can be taken out for maintenance without disturbing the bypass mode.
- m. Fault diagnostic feature shall be built into the system to supervise the operation and failure of the VFD system and with the necessary storage of events.
- n. VFD controller shall have facility to receive external trip and close signal and also provided with programmable auxiliary contacts for the remote operation and control.
- o. The interface of VFD shall be considered as required for data communication with PLC/DCS system for online/ real time monitoring. Required hardware such as cables, converters shall be provided to meets the communication requirement.

6.10 CABLING SYSTEM

6.10.1 MV Power Cables

6.6kV system cables shall be 6.6 kV (UE) grade suitable for use in medium resistance earthed system, stranded & compacted copper conductor, extruded semi conducting screen over conductor, XLPE insulated, semi-conducting followed by copper tape screened, extruded black PVC Type ST – 2 inner sheathed, aluminium/GS wire armoured, overall FRLS extruded black PVC outer sheathed, conforming to IEC for constructional details and tests.

6.10.2 LV Power Cables

LV Power Cables shall be 1100 V grade, single / multi core, stranded copper conductor, XLPE insulated, with PVC inner sheath, armoured and outer sheath made of FRLS PVC compound, generally conforming to IEC. The cables used for DC system shall be of single core type.

6.10.3 Control Cables

Control cables shall be annealed high conductivity 1100 V grade, multi core, minimum 1.5 sq. mm cross section, stranded copper conductor having minimum 7 strands, PVC insulated, black PVC inner sheathed / galvanised steel wire armoured, overall black FRLS PVC outer sheathed generally conforming to IEC. In situations where accuracy of measurement or voltage drop in control circuit warrants, 2.5sqmm and 4 sq.mm. cables required shall be used.

6.10.4 Instrumentation Cables

Instrumentation cables shall be 1100 Voltage grade, 0.5 sq. mm, stranded high conductivity annealed, tinned copper, twisted pair (with min. 12 twists for meter) extruded XLPE insulated with overall and / or individual screening, extruded PVC inner sheathed, galvanized steel wire armoured, extruded outer sheathed with FRLS PVC compound. Instrumentation cables carrying digital signals shall have overall screening along with drain wire and analogue signal carrying cables shall have each pair screening and overall screening along with each pair drain wire and overall drain wire. Cores to be identified by colour and numbering on primary insulation.

6.10.5 Fire Survival Cables

Power and control, single/multi core, stranded copper conductor fire survival cables complying with IEC-60331 shall be provided for areas as per power plant standards.

6.10.6 Cable Properties

- a. The sheath shall be resistant to water, UV radiation, fungus, termite, and rodent attack.
- b. The outer sheath of FRLS PVC compound shall meet the following performance requirements:
 - The critical oxygen index value shall be minimum 29 when tested at 27+ 20C as per ASTM-D-2863 and the temperature index shall be minimum 2500C at oxygen index value of 21 when tested as per ASTM-D-2863.
 - The maximum acid gas generation as determined by titration method shall be less than 20% by weight when tested as per IEC-60754-1. Halogen acid content in outer sheath in FS cables shall not be more than 2%.
 - Fire survival shall pass flammability tests as per IEC-331.
 - The smoke generation under fire shall have maximum smoke density rating of 60% when tested as per ASTM-D-2843. Smoke density in FS cables shall not exceed 20%.
 - The cable outer sheath shall pass the ultraviolet tests as per DIN 53387.

- The cables shall pass the tests for Water absorption tests as per IEC.
- c. The finished cable shall pass the flammability test as per IEC 332-1 and IEEE-383. In addition, it shall also pass flammability test as per Class F3 of Swedish Standard SS-424-1475.
- d. In addition, cables for devices mounted on or near hot surfaces of Steam Generators, Main steam etc shall have heat resistance type outer sheath.
- e. All HV, MV & LV cable shall have embossing at uniform interval for size, core, and type.

6.10.7 Cable Terminations

- a. Cables shall be laid in overhead only and underground cable trench/ pit shall be avoided as far as possible. Also, joint markers shall be provided at each joint.
- b. All 1100V termination for XLPE/PVC power cables and control cables shall be by Double compression weather proof type cable glands. Heavy duty, tinned, long barrel copper lugs shall be used for termination.
- c. Cable terminations and cable joints for use on electrical system operating at voltages 6.6kV or higher in indoor and outdoor application shall be of heat shrinkable and Pre-Moulded “PUSH ON” type system.

6.10.8 Cable Carrier System

- a. The cable carrier system shall be designed considering the following :
 - Facility for easy laying of cables.
 - Access to maintenance.
 - Neat and aesthetic appearance.
 - Safety of equipment & personnel.
 - Ground water seepage.
 - Drainage system for oil and water.
- b. Cables shall be laid in galvanized / steel prefabricated ladder (for power and control) / perforated (instrumentation) type trays and in conduits. Also joint markers shall be provided at each joint. The cable trays shall be laid vertical in boiler and Material Handling area.
- c. Cable trays and supporting structures in chemically corrosive area like battery room shall be avoided to the extent possible. But if the same has to be envisaged, the support structures shall be of mild steel painted trays finished with chlorinated rubber based paint/epoxy paint.
- d. Following methods of cable laying shall be followed in the power plant.
 - a) Outdoor Areas

- Transformer yard ---- Overhead Cable gallery
- Boiler area ---- Main routes: Overhead cable racks with trays in vertical formation and with conduits to branch off connections. Cable routes from TG to Boiler platforms shall be in overhead cable trays at suitable elevations.
- Boiler Platforms --- Cable trays mounted in vertical formation.
- Outlying areas/ Road crossing --- Overhead racks. To the extent possible pipe racks shall be used for supporting the cable trays.

b) Indoor Areas

- TG Building --- Cable trays, conduits/floor chases for branch-off connections.
- Battery Rooms --- Cable Trays
- Utilities & offsite buildings --- Overhead trays for Switchgear/MCC

- e. Cable trenches shall be avoided where possibility of oil and water collection exists.
- f. No direct underground burial cables shall be laid except lighting tower, street lighting. For some exceptional case like isolated individual equipment it shall be allowed after approval by the owner.

6.10.9 Cable Trays, Covers and Installation

- a. All outdoor cable trays are to be provided with covers. All vertical cable tray race ways are to be provided with covers. Cable trays shall be of ladder / perforated type complete with all necessary coupler plates, elbows, tees, bends, reducers, earthing and other accessories. Cable trays of ladder and perforated types and the associated accessories such as coupler plates, tees, elbows, etc., shall be fabricated from 14 gauge (2mm thick) mild steel sheets. Cable tray covers shall be provided for all. The cable tray accessories like trays, elbows, bends, etc., shall be fabricated and galvanized before bringing to site. Cable tray covers shall be fabricated from 16 gauge (1.7 mm thick) MS sheets. All the sheet steel shall be hot dip galvanized.
- b. Inside widths of trays shall The cable trays shall be supplied in standard lengths of 2500 mm and clear be as follows:
- Perforated type trays: 150, 300, 450 and 600 mm.
 - Ladder type trays: 300, 450 and 600 mm.
- c. 1100 V rated cables of sizes 120 sq.mm and above shall be laid in single layer. Single core cables used for 3-phase AC power circuits shall be laid in Trefoil form with suitable PVC aluminium clamps to hold the cables.
- d. Slotted angles shall not be used for cabling. In all locations smaller size cable trays of 50 mm / 100 mm wide shall be used for one or two cables.

- e. Plate inserts for cable tray mounting structure shall be embedded during civil construction in floor slabs at 1000 mm spacing. Wherever embedded plates or steel structural beams/members are not available for welding the cable tray mounting structure, the M.S. plate shall be provided and is to be fixed to floor slab by four anchor fasteners of minimum 16 mm dia. with holding power of at least 5000 kg.
- f. Spacing between cable tray mounting structures shall be 1000 mm for horizontal straight run of cable trays unless otherwise noted.
- g. Loading on a horizontal support arm shall not exceed 120kg / metre run of cable/ tray (for say maximum width of tray 600W).
- h. Width of the horizontal arms of the mounting structures shall be same as the tray widths required in the cable layout drawings plus length required for welding to the vertical supports (maximum tray width will be 750 mm) except where shown otherwise in the layout drawings.
- i. The length of the vertical supporting members for horizontal cable tray runs shall be to suit the number of cable tray tiers indicated in the cable tray layout drawings.
- j. Spacing between horizontal support arms of vertical cable tray runs shall be 600 mm unless otherwise noted.
- k. Cable trays shall be welded to tray mounting supports.
- l. Minimum clearance between top most tray tier and structural member/ceiling shall be 300 mm.
- m. Minimum vertical clearance below the bottom of the lowest cable tray tier and any structural member shall be 200 mm and 300 mm in case of steam or process pipe lines.
- n. The vertical clearance between two cable tray tiers shall be as per IEEE-384.
- o. However, considering a flange height of 100mm and max. OD of cable (laid in trefoil formation), 275mm is opted in project when density of cable trays is high otherwise standard clearance adopted is 300mm.
- p. A clear walk space of minimum 800 mm x 950 mm to be provided for cable trays in cable/pipe racks.

6.10.10 Conduits & Pipes

- a. Steel conduits shall be used for sizes upto 63.5mm. The conduits shall be manufactured by electric resistance welding process and shall be hot dip galvanised.
- b. Galvanised steel pipes shall be used for sizes from 80mm onwards. The pipes shall be manufactured by electric resistance welding and hot dip galvanised.

- c. Flexible steel conduits shall be manufactured with electro galvanising process.
- d. Conduits shall be seamed by welding and shall be hot dip galvanised both inside and outside. Conduits and fittings shall be as per relevant standards.
- e. Pipes shall be of heavy duty type as per relevant standards and shall be hot dip galvanised both inside and outside.
- f. Flexible conduits shall be made with bright, cold rolled, annealed and galvanised mild steel strips. Flexible conduits and adaptors shall be as per relevant standards.
- g. Suitable pipe sleeves, adequate in nos. And of adequate size shall be provided in building walls/slabs for passage of cables into a building from cable trays/racks/cable trenches located outside the building. Detail of sleeves and exact locations of such entry points shall be available on relevant project drawings.

6.10.11 Fire-Proof Sealing Of Cable Penetration

Cables / cable tray openings in walls and floors or through pipe sleeves from one area to another or one elevation to another, between the units and within the same unit, shall be sealed by a fire-proof sealing system. The fireproof sealing system (FPSS) shall effectively prevent the spread of fire from the flaming to the non-flaming side, in the event of a fire. The FPSS shall conform to the following requirements:

- FPSS shall have a fire rating of two hours. 100% fire coating shall be coating at ZONE-0 & ZONE-1 area.
- The FPSS shall be subjected to fire endurance test, hose stream test, temperature measurement of non-flaming side as per ASTM-E119. 'Standard method of fire tests of building construction and materials'.
- The FPSS shall also conform to the in-combustibility test carried out in accordance with relevant standard.
- Under fire condition, the FPSS material shall not emit excessive smoke or any corrosive or toxic fumes.
- FPSS shall have minimum life of 25 years.

6.10.12 Fire Break

- a. Fire break shall be provided by applying a suitable fire-resistant coating on cables for the required length to meet the fire rating of 30 minutes.
- b. Fire breaks shall undergo the following tests as per ANSI-IEEE-383
 - Ampacity test

- Flame test
- c. Fire break shall be provided at an interval of 30 metres in the straight portion of each of the cable tray above ground, at intervals of 30 metres in cable trenches and at 5M for all vertical trays. All cable inter section and tee offs shall be provided with firebreaks.
- d. When pipe sleeves are provided for cables from outdoor areas to indoor areas, the pipe opening at the outdoor side shall be sealed by fire proof sealing material, which is also continuously waterproof. The indoor side of the pipe opening shall also be sealed by continuous fire proof sealing materials. The duct banks in outdoor areas also need to be sealed by water proof seals. It is necessary to explore possibility of applying waterproof coating on fireproof sealing.

6.11 LIGHTING SYSTEM

6.11.1 Description

The illumination of various indoor and outdoor areas in the main plant and offsite areas shall be provided as described here. Lighting system shall be designed as per IEC 60598 & the applicable standards. All Lights shall be of LED type only. The lighting system of various areas shall comprise of one or more of the following systems:

- Normal 230V AC Lighting System
- Normal-cum-Emergency 230V AC Lighting System
- Emergency 220V DC Lighting System

6.11.2 Normal 230V AC Lighting System

The lighting circuits in the normal 230V AC lighting system shall be fed through 415V, 3 phase, 4 wire lighting transformers connected to the 415V distribution system. Lighting transformers in each area in the power station shall be fed from a convenient 415V Switchgear/MCC located nearby. All the lighting fixtures connected to this system shall be available as long as supply is available from normal source.

6.11.3 Normal-cum-Emergency 230V AC Lighting System

Certain lighting fixtures considered as "essential" shall be connected to a 415V AC source designated as the 415V Normal / Emergency Bus. The lighting fixtures connected to this system shall be available whenever normal supply is available in the plant and are also backed by Emergency Diesel Generator power supply in the event of failure of normal supply. This supply shall be made available for TG building, switchgear rooms, battery rooms, control room. Aviation warning lighting for Boiler and chimney shall also be fed through this system.

6.11.4 Emergency 220V DC Lighting System

To enable safe movement of operating personnel and access to important control points during a station emergency involving total AC supply failure, DC lighting fixtures will be provided. LED type DC lighting is envisaged at strategic locations in TG building, switchgear rooms, control room, Boiler landings, DG room, near entrances, staircase landings, etc. These fixtures shall be connected to lighting panels fed from 220V plant DC system. These lighting fixtures will normally be 'OFF' and shall be automatically switched 'ON' when normal AC power supply fails. On restoration of normal AC supply, the supply to DC fixtures will be Automatically cut-off.

6.11.5 Illumination Levels

Suitable illumination shall be provided to facilitate normal operation and maintenance activities and also to ensure safety of working personnel will be provided. Following average illumination level shall be considered at working level in different areas:

Area	Average illumination level (lux)
Control room, desks & vertical panels	500
Offices, laboratories & first aid rooms	500
Workshop	500
Rest room	300
Computer & Electronic equipment room	300
Switchgear & relay room	300
Engine – Generator rooms	100
Toilet, Building corridors & stairways	100
All indoor areas not specifically listed	200
Transformer yard	150
Battery room	200
Gas receiving area	100
Fuel storage area	50
Outdoor plant area not specifically listed	20
Roadways & car parks	20
Gates (where vehicle documents checked)	100
Site perimeter fence	20

The average illumination mention in above table shall be as per IS standard and best industrial practice

6.12 EARTHING AND LIGHTNING PROTECTION

6.12.1 General Requirement for Earthing

- Earthing system will be according to IS 3043 and local rules & Regulations.
- Protective earthing and service earthing will be connected together to create common earthing system with common earthing electrode.
- Earthing rods & conductors will be designed based on soil resistivity and maximum ground fault current. The earth conductor will be adequately sized to withstand the maximum fault current for 1 sec without any deformation and with tolerable temperature rise.
- Steel reinforcing bars of concrete structure of the building (Columns, beams, foundation, and footing) will be connected all together by welding to achieve electrical continuity. If steel reinforcing bars do not have enough size for maximum ground fault current they will be augmented by additional earth conductor.
- Separate earthing electrode will be considered for steel reinforcing bars of concrete foundation and footing that is in direct contact with the earth. If earthing resistance is too high such earthing electrode will be augmented by additional electrodes.
- Earthing resistance of common earthing system will be less than 1 (one) Ohm.
- G.I. strip will be installed in concrete of grade slab to connect all columns to create one common earthing electrode. Reinforcement bars of each column will be connected to the grid of G.I. strip by welding

6.12.2 Protective and Service Earthing

- For equipment earthing G.I strip will be installed as main earthing bus bar. Size of G.I strip for main earthing bus bar will be adequately sized.
- Connections between the main earthing bus bar and various equipment will be carried out by PVC insulated copper or aluminum conductor or G.I strip.
- The following will be earthed by connection to the main earthing bus bar: -
 - System neutral. (Neutral point of the distribution transformers).
 - Potential transformer secondary.
 - Metallic non-current carrying parts of all electrical apparatus, such as lightning arrestors, transformers, switchgears, motors, lighting fixtures, power panels, cable trays, terminal boxes, etc.
 - Steel structures
 - Storage tanks
 - Cable shields and cable armour.

- To provide electrostatic protection of pneumatic transfer pipelines their flanges will be bonded and they will be earthed at every 25 meters.
- All electrical equipment will have two separate and distinct connections to the earth.
- Earthing bus bar for other free-standing panel will be connected to the main earthing bus bar with two separate and distinctive connections.
- Each motor frame will be connected to the main earthing bus bar. Protective conductor of the motor power supply cable will be connected to the earth point inside motor terminal box and to the MCC earth bus bar.
- Additional core will be considered for local control station earthing. It will be connected to the earth post of each local control station and to the MCC earth bus bar.
- Cable armour will be earthed on both side of the cable, but cable shield will be earthed only on one side (panel side – source side) of the cable.

6.12.3 Earthing Electrode Type:

Transformer & Generator Neutral Earthing	Copper plate type
Body Earthing	GI pipe electrode
DCS Earthing	Copper rod / As per DCS vendor's recommendation
Main earth loop material	GI strip
Substation earth loop	GI / copper

6.12.4 Lightning Protection System

- Lightning protection system for BTG package buildings at plant will be provided depending upon the lightning flash density, area of exposure / collection etc.
- Lightning protection system consists of suitable sized horizontal conductors that are laid over the rooftop of every building and are connected to individual lightning protection earth pits through a test link. All the lightning protection earth pits are interconnected by a suitable sized flat and finally the system is connected to the Plants Main Earthing system at minimum of two places.
- Lightning conductor will be GI strip.
- Lightning Protection system to be consider for chimney structure.

6.9.2 Tests

All Routine tests for all the major electrical equipment of the BTG package shall be carried out as per relevant standards. Type test certificates for similar equipment supplied by the Bidder shall

be submitted. In case Type test certificate for similar equipment is not available, the same shall be conducted in presence of Owner.

CHAPTER-7

C&I DESIGN REQUIREMENT & EQUIPMENT SPECIFICATION

7.0 C&I DESIGN REQUIREMENTS & EQUIPMENT SPECIFICATION

7.1 SYSTEM DESCRIPTION

The instrumentation and control (I&C) system called for in the specification shall be a comprehensive system integrating the functions of plant monitoring, control and protection of the total power plant, to facilitate the task of integration, co-ordination and autonomous operation of the plant sub systems/equipment namely Steam Generators (SG), Steam Turbine Generator (STG) & their associated auxiliaries, BOP system, material handling and complete plant electrical systems. The specification & details indicated are not exhaustive and Bidder to consider the required Instrumentation & Control system for the complete Power Plant Systems.

The overall I & C system design shall ensure the following:

- a) Maximize safety for the plant personnel and equipment.
- b) Safe, reliable, efficient and easy operation of the plant under all operating conditions.
- c) Maximize availability and efficiency of the plant through system redundancy.
- d) Consistent control & instrumentation philosophy – usage of standard functional modular hardware and software design
- e) Ability to operate under all specified conditions (start-up, normal operation, disturbances and shut down) automatically and/or by remote manual control from relevant control room.
- f) Malfunction of any component or loss of supply leading to fail-safe condition
- g) Provide accurate and reliable information to the plant operators and management
- h) Provide the operators the following facilities:
 - i) Complete information for plant equipment status / abnormal and critical conditions.
 - ii) Alarm notification.
 - iii) Logging of equipment/component failure duration and data availability for failure analysis
 - iv) Historical data storage and retrieval facility for long term monitoring of plant equipment performance

7.2 SCOPE OF SUPPLY

7.2.1 Unless otherwise specified, all the requirements/quantities specified are on per unit basis.

- a. Distributed Control System (DCS) of uniform hardware complete with data highways, operator stations with LED screens & LVS, engineering workstations, historical storage

unit, all other peripherals, interfacing with other plant control systems cabling etc. for operation / monitoring and control of main power plant .

- b. In case of UPS/DCS failure, hardware tripping of ID VFD and PA fan 6.6 KV breaker and must be implemented for all critical equipment.
- c. Boiler Protection System /Burner Management System i.e protection & interlocks shall be TMR system or SIL 3 certified System. The SIL 3 certified safety system shall be of the same family as of DCS and shall reside on the plant data highway along with the DCS controllers. The same shall be implemented in independent controllers and shall be as per NFPA 85.
- d. Turbine integral control system shall be provided in hot redundant configuration and shall comprise of Electrohydraulic Turbine Governing system (EHTC), Turbine Supervisory Instrumentation (TSI), and Automatic Turbine Run-up system (ATRS). Turbine Protection System i.e protection & interlocks shall be TMR system or SIL 3 certified System.
- e. Vibration Analysis System for Steam Turbine.
- f. Coal , Limestone and Ash Handling system shall be monitored and controlled through PLC based control system with soft link and critical signals hardwired with DCS.
- g. Other systems like the Compressed air system, Emergency DG set, Fire protection system, Fire detection & alarm system, etc. that are implemented in MPCS/PLC shall be interfaced with the Plant DCS through soft link and critical signals shall be hardwired.
- h. Smart soot blower control (if required) shall be PLC based intelligent control system.
- i. Dedicated microprocessor / PLC based system for the ESPs as described under the Electrical section of the specification. Hardwired signals and redundant OPC links to the DCS for monitoring of this system shall be provided.
- j. Details of control systems and hardware envisaged for the total power plant with interfacing requirements with plant DCS are detailed in subsequent, Annexure-1 (Operation and Control Concept and Interface and Hardware requirement).
- k. Sequence of Events Recording system integral to the DCS and safety system with 1 ms resolution or better shall be provided
- l. Wherever the same process parameter is used for both the safety system and the DCS, the corresponding field sensors shall be connected to the safety system and the input signal to the DCS shall come as hardwired outputs from the safety system to the DCS.
- m. The DCS and safety systems shall be provided unit-wise and independent set of controllers of these systems shall be provided for equipment / systems common to both units .

- n. The DCS based control system shall be interfaced to the GIS and AIS SCADA system. (refer electrical section for details) through redundant OPC links and hardwired signal exchange.
- o. Historical data storage and retrieval system with redundant historians implemented with RAID-1 configuration.
- p. DCS shall also implement the basic requirements of plant performance monitoring (Plant heat rate, SG efficiency, Auxiliary power consumption etc.) as per relevant ASME standard
- q. DCS shall be provided with HART /Foundation field bus compatible I/O cards. . For minimum requirements of Foundation Fieldbus system refer Annexure-II.
- r. 1 no. of 70" LCD TV screen / unit interfaced to one of the OS of the DCS.
- s. Master Clock System (100% redundant) with associated time synchronisation equipment, cabling, slave clocks, etc. shall be provided. For details refer Table 1. Additionally, Time sync to be consider for all protection relays, CILMS including GIS
- t. 2 x 100% UPS supply (220V) for plant I&C loads (control systems including HMI, master clock system, VMS, CEMS, SWAS, field instrumentation etc) complete with its distribution .UPS and UPS power distribution to all I&C loads in Bidder's scope is included in the Bidder's scope. DC power requirement shall be derived by the Bidder from the UPS using appropriate redundant power supplies and diode ORing units. All distribution boards shall be provided with adequate (minimum 20% after commissioning) wired spare breakers. I&C equipment such as control systems including HMI, master clock system, VMS, CEMS, SWAS (except chillers), field instrumentation (incl. flame scanners, drum level indicators, etc.) CCTV system, etc. shall be powered by the UPS.
- u. Control Desks and cabinets including Control room and equipment room panels, consoles, panels, cabinets, racks, chairs etc
- v. All field Instruments and sensors including pipe mounted items, flow elements (FE) and accessories., final control elements like control valves, de-superheaters, control dampers and actuators etc
- w. Foundation fieldbus-based transmitters with associated spur and field barriers, flow elements (FE) and accessories; final control elements like control valves, control dampers and actuators etc
- x. Latest version of DD files shall be provided by Instrument vendor.
- y. Foundation field bus field manager (with software).

- z. All HT drives shall be provided with bearing temperature & vibration monitoring for each bearing of drive motor & driven equipment and motor winding temperature monitoring. Vibration sensors shall be provided on X & Y directions on DE & NDE of drive & motor. Vibration sensors with transmitters shall be provided with 4-20mA output from field hardwired to DCS.
- aa. Steam And Water Analysis System (SWAS) complete with sampling system and analysers & instruments.
- bb. Continuous Emission Monitoring System (CEMS)
- cc. All junction boxes (Signal and power), transmitter racks (as applicable), cubicles, enclosures, local panels, marshalling panels, pneumatic and process hook up hardware and other erection materials and accessories including Earthing system (separate electronic and frame earth).
- dd. Canopy shall be provided for field instruments and all the Junction boxes (PJB, CJB and FF JB.)
- ee. Supply, laying & termination of all Instrumentation cables, Control cables, Compensating cables, Special cables, Pre-fabricated cable, Redundant Data Highways, foundation fieldbus cables etc., including the field cables for all types of applications, Control and power cable megger (before laying) etc.
- ff. Redundant communication with the refinery DCS (other's supply) shall be considered. The mode of communication shall be shared during detail engineering. Bidder shall consider two number (2) Ethernet communication modules (in the technical scope) and approx. 2 kms fibre optic cables along with cable trays for the same.
- gg. Two set of **FO** cables from BTG Control Room to CCR aprox 1 KM distance bet two control Room by bidder.
- hh. Supply & installation of branch cable trays for connecting upto main/sub-main cable trays (branch cable tray within the battery limit) starting from field sensors/devices in Bidder's scope.
- ii. Maintenance and erection tools and tackles
- jj. Essential spares
- kk. Inspection and testing for I&C system equipment
- ll. CONSUMABLES: All consumables required for Operation and Maintenance of the plant.
- mm. Erection, Field Testing And Commissioning: The Bidder's scope includes Erection, pre-commissioning checks, testing, calibration and commissioning of all Instrumentation

and Control system equipment for the complete power plant supplied under this contract to the complete satisfaction of the Owner. The scope includes provision of all necessary erection materials, consumables, tools and tackles, provision of calibration/testing equipment required for erection/testing/commissioning and handing over the same to Owner after completion of erection/testing/commissioning. Contractor's scope of work will also include any additional instruments supplied by other contractors/Owner which is required for proper & satisfactory performance of the power plant (subject to mutual agreement with Owner regarding cost implication.

nn. Engineering Documentation.

oo. O & M manuals

pp. Training Of Purchaser's Personnel

7.3 UNITS OF MEASUREMENT

All instruments shall be calibrated, and their scales shall be graduated on the basis of the following units:

- a kg / cm² (g) for process pressure
- b mm WC / mmHg for vacuum (absolute)
- c mm WC, kg / cm² (g) for differential pressure
- d kg / cm² (g) for pneumatic supply and signal line pressure
- e °C for temperature
- f 0-100% for position and level metering
- g m³/h, l/h for flow of liquids
- h t/h, kg/h for steam flow
- i Nm³/h, N l/h for gas (1.013 bar/273.15 K)
- j µm (micrometre) for eccentricity and vibration
- k RPM for speed of rotary machines
- l mm for differential and absolute expansion
- m Hz for frequency
- n A, kA, mA for current
- o V, kV, mV for voltage
- p W, kW, MW for power
- q Wh, kWh for active energy
- r t, kg for weight
- s mS/cm, S /cm for conductivity
- t kg/dm³, kg/m³ for density
- u cP for viscosity
- v h-s for time

7.4 DESIGN REQUIREMENTS

7.4.1 FIELD INSTRUMENTS

- 7.4.1.1. The design and installation of instruments shall be generally in accordance with ISA/API recommended practices and other applicable standards like BIS, IBR etc. Material specifications and practices shall, in general, conform to appropriate ASTM or equivalent standards. All standards and code of practices referred to herein shall be of the latest edition prior to the date of purchaser's enquiry.
- 7.4.1.2. Discrete instruments (like speed, pressure, temperature and flow switches etc.) should not be used if they have interlocks for equipment or process safety. Instead of switches, continuous measuring instruments with trip amplifiers for interlocking purpose shall be used for continuous indication of that parameter in PLC/DCS.

7.4.2 SIGNAL TRANSMISSION

- a The standard signals for transmitting measuring and control signals (all analog signals) shall be Foundation Fieldbus.
- b Digital signals may be Foundation Fieldbus or conventional depending on the type of device being controlled and the number of signals involved as per table 1 for details.
- c In case Foundation Fieldbus option is not available for a particular type of instrument 4~20mA Smart HART type instrument can be used with prior approval from Customer/Consultant.
- d Transmitters shall be of the two-wire type with auxiliary power supply via the signal line. Wherever 2 wire transmitters are not available (e.g., magnetic flowmeter), 4 wire transmitters shall be used with isolated output.
- e All temperature measurements shall be with temperature transmitters.
- f Binary signals - Proximity switches as per NAMUR design or potential free contacts with 24V DC interrogating voltage.
- g The standard range for pneumatic control equipment shall be 0.2 - 1.0 Kg/cm²g. Every package vendor using HART instruments should also supply the latest HART communicator.

Table 1

S No.	INSTRUMENT TYPE	CONNECTED VIA			REMARKS
		FF	HARDWIRED	ETHERNET	
1	Switches all type		HARDWIRED		

2	Status signals from MCC/Switchgear (running/trip indications)		HARDWIRED		
3	Start/Stop commands from PB near drives		HARDWIRED		
4	Start/Stop commands from DCS.Process trips initiated through DCS		HARDWIRED		
5	On/off valve having SOV and limit switches	FF (Communication to DCS via topworks positioner)	HARDWIRED (for Trip & Protection System)		
6	Output from DCS		HARDWIRED		
7	MOV-On/Off type	FF	HARDWIRED (for Trip & Protection System)		
8	Intelligent Relay System (MCC)			(HOLD)	IMCC relay shall be considered in each feeder (in MCC) for monitoring of data like current, voltage etc Bidder to consider the cables and connectors for the same along with required cards at DCS end.

9	VFD		HARDWIRED (for Trip & Protection System)	HOLD	VFD controls (DI/DO) shall be hardwired. Speed reference, speed (RPM) feedback, current signal will also be in hardwired. However soft communication shall be there for parameter like current, RPM and Voltage monitoring.

- 7.4.2.1. All belt conveyors shall be supplied with required quantities belt sway, pull cord, zero speed switches. Belt scale with required no. of load cells shall be provided for the conveyors as required. Minimum 4 nos. of load cells to be used for belt weighers. All the Belt conveyors switch (e.g. Pull cord & belt sway switches) shall be hooked-up with the Belt watch panel for monitoring the activated/operated switch number. All the pull cord switches & belt sway switches shall be with auto detectable termination modules, suitable for communication with Belt watch system. Belt tear Switch shall be used as applicable.
- 7.4.2.2. Chute jam switch shall be provided as required. Magnetic separator and metal detector for conveyors as required.
- 7.4.2.3. All silos shall be fitted with 3D radar type level transmitter for solid level measurement and signaling.
- 7.4.2.4. All sumps tanks shall be fitted with ultrasonic type level transmitter.
- 7.4.2.5. Supply of any additional instruments (if required) is to be in the scope of respective vendor to carry out performance guarantee tests.

- 7.4.2.6. Final control elements (control valves, etc.) shall generally be pneumatically operated. Hydraulic & Electric actuator shall be provided for higher torque requirement.
- 7.4.2.7. The design of electronic instruments shall be in compliance with the electromagnetic compatibility requirements as per IEC 801 'Electromagnetic compatibility for Industrial Process measurement and Control equipment'.
- 7.4.2.8. The material components which come into contact with the fluids to be measured shall be resistant to corrosion caused by said fluids. It shall also be compatible with the piping material when being clamped, welded or connected by other methods.
- 7.4.2.9. All field instruments shall be damp-proof and dust-proof, minimum protection class as per IEC 529 shall be as follows:
- Electronic transmitters: IP-65
Local indicators: IP-65
Pneumatic instruments: IP-55
All instruments/devices shall be immune to interference due to normal walkie-talkies with output of 1W at UHF.
- 7.4.2.10. All instruments and equipment's shall be suitable for use in a hot, humid, dusty and highly caustic atmosphere in which caustic gases, dust and/or chemicals may be present. As a minimum, all instruments and enclosures in field shall be dust proof and weatherproof to IP-65 as per IEC-529/IS-2147 and secure against the ingress of dust, fumes, dampness, insects and vermin. All external surfaces shall be suitably treated to provide protection against corrosive plant atmosphere. Canopies (removable type) shall be considered for field instruments and junction boxes.
- 7.4.2.11. Instrument cases for all field instruments (like PG, TG etc.), shall be of SS. All instrument tubing shall also be of SS316.
- 7.4.2.12. No RTD and T/C cards shall be considered. Cards for only 2 wire and 4 wire instruments (4 to 20 mA signals only). For RTD and T/C, transmitters shall be considered.
- 7.4.2.13. All Transmitters, Valve TOP unit, Positioner can be Die cast Aluminium with suitable paint.
- 7.4.2.14. Preferred materials of construction for parts exposed to the atmosphere are polyester or epoxy, fiberglass, plastic, stainless steel.
- 7.4.2.15. Instrument Field Junction Boxes, Local Panel & Power Distribution boards shall be fabricated from SS.
- 7.4.2.16. The use of zinc & zinc alloy, Low copper & copper alloy and aluminium & aluminium alloy is permitted only when coated with suitable and approved paint or coating, as the atmosphere is highly caustic.

7.4.2.17. For temperatures within the range 0 to 400°C RTD sensors should be used.

7.4.2.18. All field switches, RTD and thermocouple heads in hazardous areas shall generally be of explosion proof construction for reason of economy.

7.4.2.19. Certification and approval for intrinsic safe/explosion proof equipment shall be by any one of the following agencies:

- a. Physikalisch-technische Bundesanstalt (PTB-Germany)
- b. ATEX OR any other authority licensed in the European Community.
- c. Central Mining Research Station (CMRI).
- d. Factory Mutual (FM)/ Underwriter's Laboratories (UL)

7.4.2.20. Sensor Redundancy – For the entire plant - Main plant & all utilities

- a. All sensors for the following causes of trips shall be triple.
 - i) unit trips
 - ii) boiler trips
 - iii) turbine trips
- b. All sensors for the following causes of trips shall be dual
 - i) All HT equipment trips.
 - ii) All LT equipment trips.
- c. All sensors used for closed loop control shall be redundant.
- d. Single sensors shall be provided for the following
 - i) Alarm,
 - ii) Measurement /indication.

All three trips related signals shall have different cable tray, route, JB, marshalling cabinet and different I/O module.

7.4.2.21. The Foundation fieldbus transmitter shall have following features as Minimum: -

- a. FF devices shall have a physical means such as a switch / jumper or password security to prevent the transmitter configuration from being altered.
- b. Shall have a Characterizer Block for strapping tables.
- c. Shall have an Integrator Block for totalisation.

- d. Shall have an Arithmetic Block for functions such as level or density calculations.
- e. Shall have an Input Selector Block for voting or averaging applications.
- f. Shall have software download capability for upgrades or product enhancements via field bus segment with the segment in operation.
- g. Shall have guided routines (methods) for calibration and restoration of sensor defaults.
- h. Shall have the capability to display data from other devices on the LCD meter
- i. Shall have block execution times less than 45ms.
- j. All transmitter shall have following block as minimum: Resource Block, Transducer Block, LCD Block, Analog Input (2 Nos), PID Control Block (optional).

Note: Some Foundation Fieldbus input devices can have up to eight inputs per device which can lead to excessive macro cycle times (> 1 sec) for the segment. Where such devices are used for control / tripping purposes, the segment allocation must be adjusted to ensure that the macro cycle requirements of the H1 card are achieved, i.e, the number of devices on the segment is limited to only one.

The manufacturer shall demonstrate macro cycle times in the event of any anomaly with input devices to confirm acceptability.

7.4.3 CONTROL SYSTEM

7.4.3.1 FOUNDATION FIELDBUS (FF) PHILOSOPHY

The following points will be followed as a minimum for designing the FF technique:

- a Macro cycle time should be 1 second.
- b Minimum unscheduled communication time on each segment should be 400milliseconds.
- c Voltage level at the instrument end should be 10.5 V DC.
- d As far as possible, all instruments should be polarity insensitive and with FF check mark on the name plate.
- e Device coupler should have the following features:
 - Short circuit protection
 - Inbuilt terminator
 - Spur fault indication
- f Star Connection to be followed at Junction box side. Daisy chain, point to point connection will not be followed.

- g Maximum 3 junction boxes can be used in a segment.
- h In general, 8 instruments can be connected in a segment however unscheduled communication time of 400 milliseconds will govern the number of instruments in a segment. Further, in a segment not more than 2 close loops should be assigned. If Loop requires faster response time than no of monitoring loop/closed loop shall be reduced on segment. For process critical loop only one closed loop & remaining monitoring devices (Max 6 Nos of device per segment) shall be assigned.
 - Type A : Critical : One control loop & remaining monitoring loop (Max 6 Nos of device per segment)
 - Type B: Non critical: Two control loops & remaining monitoring loop (Max 8 Nos of device per segment)
 - Type C: Monitoring loop: Max 8 Analog Input per segment
- i Normal segmentation and partitioning rules should be applied, for example, redundant equipment shall be located on separate I/O modules
- j Any device that connects onto a Foundation Fieldbus segment must be certified for use by the 'Fieldbus Foundation'.
- k Device Turn-on Time: Performance within specifications in less than 20 seconds after power is applied, when damping value is set to 0 seconds.
- l Diagnostics: Basic status information such as sensor status and loop diagnostics shall be available in all FF devices. If self-diagnostics detect a sensor burnout or a transmitter failure, the status of the measurement needs to be updated accordingly.
- m All positioner shall have in built PID block & LAS capability.
- n Surge protection device shall be provided in Trunk out from Power Conditioner & incoming of JB. Surge protection shall be provided in critical field devices.

7.4.3.2 ALARM PHILOSOPHY

- Adequate alarms should be provided to give audible and visual warning of any process and machine malfunction in the plant.
- All trips shall have a pre-trip warning alarm in addition to an alarm at the trip condition.
- All package alarms including pre-trip warning alarms and trip alarms (shutdown alarms) shall be annunciate on the local panel.
- All rotating equipment's shall have status indication provided on the local panel/ DCS.
- Fail-safe' type with normally closed alarm contacts shall be used.

7.4.3.3 All MCC DI & DO shall be isolated using inteposing relays.

7.4.3.4 Field DI shall be isolated with current limiting circuit to guard against short circuit / accidental grounding of field wires

7.4.3.5 All field DO s shall be provided with interposing relay

7.4.3.6 The number of inputs / outputs per module shall be restricted to the following maximum:

- a Analog inputs : 08
- b Analog outputs : 08
- c Digital inputs : 32
- d Digital outputs : 32
- e Pulse inputs : 16
- f A / D conversion shall have a resolution of 16 bits minimum. D / A conversion shall have a resolution of 12 bits minimum.

7.4.4 CONTROL SYSTEM PHILOSOPHY

- a. Functionally distributed and geographically Distributed Control System (DCS) is envisaged for the complete plant.
- b. The boiler protection system and the Turbine protection system shall be implemented in triple modular redundant (TMR) /SIL 3 control system.
- c. The Boiler protection system, TG protection system and the main plant DCS shall be of same make with all control and HMI hardware residing on the same data highway.
- d. For the purpose of functional distribution, main plant DCS shall have independent set of controllers for SG auxiliaries, TG Auxiliaries, BOP systems and electrical systems. Grouping of controllers shall be based on criticality and availability requirements. Bidder shall quote the number of controllers considered in the offer.
- e. The grouping of control loops in controllers shall be done based on the following criteria:
 - i) input / output (I/O) handling capacity of the individual controllers such that the system availability in the event of loss of one controller is not less than 50% (i.e. Whenever there is more than one similar equipment ex.: Feed water pump, necessarily each of such equipment shall be implemented in different controllers).
 - ii) I/O channel & module requirements considering redundancy and spare channel requirement.
 - iii) Controller loading under all operating conditions (worst loading conditions) shall be maximum 50%.

- f. Worst Loading Conditions for DCS system: For DCS system the worst loading condition shall include the following tasks:
- i) All process inputs scanning, and processing is in progress and all the data is transmitted over the main data bus every one second.
 - ii) All closed loop controls in operation
 - iii) All open loop controls in operation
 - iv) All output devices are in operation with rated performance/speed.
 - v) Control/information request is initiated on control monitor.
- g. No two critical Open loop or closed loop controls shall be implemented in same controller. Balance loops shall be grouped suitably without compromising availability, specified spare I/O capacity and spare processing and data bus capacity. Bidder shall submit the controller grouping based on the above guidelines along with the bid and the same shall be a proven design in a similar capacity of the plant.
- h. Main plant DCS shall also implement the basic requirements of plant performance monitoring (Plant heat rate, ST heat rate and efficiency, SG efficiency, Auxiliary power consumption) of the respective unit.
- i. The Human Machine Interface (HMI) comprising operator and engineering stations, large video screens, printers, etc. for two (2) units will be located in the CCR.
- j. Minimum number of HMIs to be provided in the CCR shall be as follows:

Operator Console	DCS System	No. of Operator Workstation (OWS)	No. of Engineering Workstation (EWS)	LVS Display Unit [70" size]
Unit-1 (Main plant DCS Unit#1 network)	OWS	3		
	Historian Console	2	-	
	OPC server	2	-	
Similarly for Unit#2,	LVS	-	-	1
	PRM station for FF Instruments:	1		

- k. PRINTERS – All are network printers & freely assignable (except for dot matrix printers).
Shift in-charge console - 1 No common for both Units

- l. Management information system 1 No common for either Units with a provision of 3 or 4 licences.
- m. 1 No. Plant Performance PC common for both units.
- n. Generator synchronisation will be achieved through auto synchroniser with action initiated from DCS. Manual synchroniser for each unit is provided as part of generator control panel.
- o. Software/license for Report Package to be considered.
- p. Large Video Screen (LVS) display (70" size) shall be provided for each unit. Provision to display CCTV shall also be provided.
- q. Hard wired back up console is not envisaged. However, emergency Push Buttons for SG & TG trip (two button trip) shall be provided on the unit auxiliary console. The hard-wired signal is routed through the DCS, however without passing through controllers and directly tripping the equipment's.
- r. Emergency local stop push button operation shall be provided for all HT drives except for motorised valves and solenoid valves.
- s. For motorized valves open/close functions shall be available in the integral starter of the actuators
- t. The DCS and other control systems shall be time synchronized with the signals from the Master clock system.
- u. Sequence of Event Recording (SOE) shall be Integral to DCS with 1 msec. resolution and time stamping at input card level.
- v. Annunciation functions shall be Integral to the DCS with programmable priority levels with audio-visual output
- w. Redundancy Requirements in DCS shall be as given below :
- x. Redundancy Requirements -Redundancy requirements at various levels are as follows:
 - i Analog inputs / output modules for closed control loops : 1:1
 - ii I/O communication modules with CPU : 1:1
 - iii I/O power supply modules : 1:1
 - iv CPU for control, I/O communication, network communication : 1:1
 - v Power supply for all CPUs : 1:1

- vi I/O bus between CPU and I/O with all necessary hardware : 1:1
- vii Media and modules for network communication : 1:1
- viii Foundation Fieldbus H1 interface module : 1:1
- ix Foundation Fieldbus segment power conditioner : 1:1
- x Historian. : 1:1
- xi Redundancy of any servers (if applicable) .
- xii Redundant sensors shall be wired to different I/O modules in different racks/rows.
- xiii For all critical signals for which redundant sensors are not possible, shall be wired to redundant Input cards.
- xiv Triple redundant modular configuration shall be provided for Boiler & Turbine protection. The automation level outstations shall be able to continue to operate safely in the event of a total communication failure and/or failure of the supervisory level.
- xv Grouping of systems / equipment in the controllers of the main plant DCS shall be based on criticality and availability requirements. Bidder shall indicate the no. of controllers considered in the offer.

7.5 DISTRIBUTED CONTROL SYSTEM (DCS)

- 7.5.1 The DCS shall integrate the functions of monitoring, control and protection of the plant / systems included in the DCS as per the scope of this enquiry. It shall facilitate the safe, reliable, easy and efficient operation of the plant and shall ensure high plant availability.
- 7.5.2 The system shall be engineered such that any malfunction / component failure leads to minimal disruption to normal plant operation and to ensure fail-safe condition.
- 7.5.3 The DCS shall be complete with all hardware, software, system cabinets, I/O cabinets, interfaces & accessories that are required to make the system complete - whether specifically mentioned in this specification or not. The DCS shall be of modular, secure and deterministic architecture. It shall be expandable in future by adding controllers, I/O modules, HMI and servers.
- 7.5.4 The system shall be provided with dual redundancy for the processors, power supplies, power supply modules, I/O interface modules, modbus modules, plant data bus (Controller and HMI

level), I/O bus and remote I/O bus. In case of client-server type of architecture, the servers shall be redundant.

- 7.5.5 The availability of the system shall be 99.9% or better. Supporting calculations and analysis for the availability shall be submitted during detailed engineering. The system shall be capable of integrating with systems supplied by others using industry standard protocols such as Modbus, OPC, IEC 60870, IEC 61850, etc
- 7.5.6 All cards of the system shall be replaceable under Power On Condition (hot swappable). The system shall support extensive hardware self-diagnostics up to the card level. The scope includes all required software licenses to comply with the functionality and requirements specified herein. The software licenses shall be provided for the project (e.g. organization or site license) and shall not be hardware/machine-specific. The licences shall be permanent and valid for the service life of the plant.
- 7.5.7 Processor requirements:
The processor shall be microprocessor based with minimum 32 bit and capable of running multiple loops of different scan times with assigned priority. The processors shall be hot redundant and change over in case of failure of the main processor shall be bumpless. It shall have adequate capacity of volatile memory to store dynamic plant data. Also, it shall have adequate capacity of non-volatile or battery-backed memory to store programmes and standard software to perform control, data acquisition and diagnostic functions. Battery back-up shall be for duration not less than 100 hours. The processor shall be capable of implementing complex and advanced control strategies using exhaustive algorithms and tools including mathematical functions, logic (Boolean) functions and various control techniques (multivariable, feed forward, feedback, cascade, auto tracking, ratio and bias, dynamic dead band, proportional, integral, derivative and their combinations, auto inching, auto limits, blocks, run-ups, run downs, over rides, analogue hold and any other techniques as may be necessary). Programming shall be supported through function block diagram, sequential flow sheet, ladder diagram and structured text.
- 7.5.8 Input / Output (I/O) modules:
Galvanic / optical isolation shall be built in for all I/O modules. With all standard features For output modules, it shall be possible to configure the failsafe position that each channel is to attain in case of failure of controllers or communication between controller and I/O modules.

- 7.5.9 All types of cards shall operate on 24V DC power. The power supply for the system and for the field interrogation / device powering shall be segregated. Digital outputs shall be provided with interposing relays (IPRs) to interface to the load / MCC / switchgear / signal exchange to third party systems. The IPRs shall be changeover contacts rated as per the load, freewheeling diode across relay coil (copper), Inputs and outputs not be combined in a single module.
- 7.5.10 Sequence of Events (SOE) recording system shall be provided integral to the DCS to record selected events related to unit or major equipment trip at 1 milli second resolution. Time stamping shall be done at the card level.
- 7.5.11 The communication protocol of the plant data highway shall be IEEE 802.3/802.4. It shall be proven for robust, industrial use and shall operate at 100 Mbps or higher bandwidth. The ethernet switches shall be fault tolerant and redundant. On-line addition or removal of devices on the network shall be supported. Layer 2 switches to be used for DCS internal devices and Layer 3 switches for connectivity to 3rd party network.
- 7.5.12 Where remote I/O locations are specified as per the scope of supply, redundant fibre optic I/O bus for interfacing remote I/O modules to the DCS controller in the plant central control room (CCR) – including corresponding media converters shall be provided.
- 7.5.13 DCS system performance under worst load conditions shall be as tabulated below. Worst loading refers to the condition where all process inputs are being scanned, data is being continuously transferred on the system bus, all open and closed loops are in operation, all output devices are in normal operation, operator has requested for graphic page / information on the OWS and there is burst of 100 alarms per second for a period of 10 seconds.
- | | | | |
|----|--|---|---|
| a) | Scanning rate of analog signals | : | Maximum 250 ms |
| b) | Scanning rate of digital signals | : | Maximum. 100 ms |
| c) | Scanning rate of pulse signals | : | Max. 100 ms |
| d) | Loop execution time for CLCS | : | Maximum 250 ms (for all Loops) |
| e) | Loop execution time for OLCS | : | Maximum 100 ms (for all Loops) |
| f) | Loop execution time for protection and governing Controls of steam turbine | : | Maximum 20 ms (if OEM requires faster execution, OEM requirement shall apply) |
| g) | Updating rate of Analog display | : | Maximum 1 second |
| h) | Updating rate of Digital value display | : | Maximum 1 second |
| i) | Updating rate of pulse signal | : | Maximum 1 second |

- j) Time for display on screen : Maximum 1 to 2 seconds on demand
- k) Keyboard command execution time : Maximum 1 second

7.5.14 System loading and spare capacity in the system at the time of handing over to the project Owner shall be as below. These shall be after counting for the specified spare channels, modules and after incorporating final logic programming.

- a) Processor loading: 50%, Memory loading: 50%, Data highway loading: 50% & License for tag nos. shall be provided such that 60% spare tags shall be available after commissioning of the system.

7.5.15 Spare capacity in the DCS shall be provided as tabulated below. The system shall be so engineered that additional controllers, power supplies, racks or drivers are not required to utilize these spare capacities and the system loading requirements specified above shall be complied. The specified spares shall be evenly distributed across the system (processors, racks and cabinets).

7.5.16 Spare I/O channels for each type of module used. Spare I/O slots with wiring up to the terminal blocks and Spare space in the cabinet for mounting I/O racks and terminal blocks in future The spare channels shall be wired to the terminal blocks. For digital outputs, interposing relays shall be included:20%

7.5.17 Gateways for communication links shall be suitable for redundant and bi-directional communication. The gateways shall be so configured as to have minimum two (2) nos. spare communication ports.

7.5.18 Recommendations from original equipment Manufacturer considering manufacturer standard and proven design of the system will be considered for package systems. They shall meet Design & functional requirements.

7.5.19 Local displays for the Local Control Systems shall be provided. Also, a Engineering Station (PC Based) shall be provided as programming and diagnostic stations complete with licensed software for site modification.

7.5.20 Human Machine Interface (HMI)

The Engineering cum Historian workstation shall be with minimum server grade configuration based on Intel – Xeon quad core processor or better. The operator work stations (OWS) shall be with minimum Intel Core i7 processor. All servers and workstations shall be with internal

speaker and LED TFT anti-glare monitor; latest version of Windows certified by DCS supplier for their HMI software; anti-virus software; Adobe Acrobat read/write software. MS office software/license shall be provided for Engineering station.

- 7.5.21 RAID-5 configuration to be provided for Engineering cum Historian stations. This shall be considered for server in case of client-server configuration of DCS.
- 7.5.22 The DCS HMI software for the operator workstations shall provide an intuitive interface to the operators for plant control and monitoring. These shall include:
- a) Control functions comprising Plant, Area, Group, loop, individual IO wise graphic (mimic) pages with displays and functions for performing control functions (permissive criteria, issuing commands, adjustment of set point, bias, loop tuning parameters, etc.), auto / manual mode selection, sequence control, criteria bypass, etc. A display page shall have maximum 6 loops. ISA standard graphic symbols library for generating mimics shall be provided.
 - b) Alarm notifications to alert operator to equipment malfunctions, process abnormalities, control deviations and control system faults. System shall support minimum three (3) levels of priorities. System shall automatically exclude 'out of service' or 'bad' points. It shall be possible to have a permanent alarm window on the screen with the three most recent alarms. It shall be possible to distinguish conditions that are still in alarm state and acknowledged by operator, still in alarm and unacknowledged by operator and reverted to normal condition prior to operator acknowledgement.
 - c) Trend plots - Real time and historical trending with up to 8 configurable pens per trend group shall be provided. X-Y plots –Logs / reports for reporting select parameters that are sampled at configurable intervals (10 seconds to 1 hour) shall be supported. The system shall facilitate generating and configuring custom reports by plant O&M personnel.
 - d) Performance calculations – using sampled process data, the system shall be capable of performing calculations such as plant heat rate, turbine heat rate and efficiency, boiler efficiency, heat exchanger performance, efficiency of major drives and auxiliary power consumption. The performance calculation package shall be based on standards like ASME and BS.
 - e) Equipment Operating History – This facility shall be provided to accumulate the running hours, number of starts and stops and cumulative run time from previous overhaul for various drives and equipment.
 - f) The system shall include a hierarchical password protected system access that allows functions available to a user to be defined as per the hierarchy.

- g) All operator actions such as changing set points, acknowledging alarms, start / stop commands, etc. shall be logged in the system.
- h) The operator workstations shall be freely assignable and interchangeable.

7.5.23 The system shall include a global distributed real-time data-base available to all devices on the network.

7.5.24 The shift-in-charge station functions shall include all functions as the operator station except that operation functionality shall be disabled.

7.5.25 Engineering cum historian workstation (EWS) shall have all features as the OWS and the functionality to perform engineering functions of the control system as outlined below: It shall be possible to view and analyse system diagnostics from the EWS.

7.5.26 The EWS shall also be used for historian purposes. Selected analog & digital data points and control software derived / calculated points from the DCS including those acquired through communication links shall be archived in the historian. The system shall have the facility to backup older data onto DVDs and restore the same for historical data analysis.

7.5.27 Printers shall be provided for hard copies of reports, graphics, logics and loops in the system. All printers shall be connected through a print server. Print server shall be connected to DCS network in a redundant fashion. It shall be possible to print from any OWS or EWS at any of the printers.

7.5.28 Control desk and Operator chairs

Ergonomic control desks with robust and aesthetic construction shall be provided to mount the various workstations and printers. Each desk shall have multiple outlet power sockets with fuse protection. Each workstation desk shall include an enclosure with ventilation fan to install the workstation. Internal wiring to be performed at manufacturer's works.

The desks shall be fabricated from CRCA sheet of minimum 2 mm thickness and provided with anti-vibration pads. Finish and colour shall be the same as specified for DCS cabinets. Ergonomic, swivelling type chairs with height adjustment, armrests, lumbar support and wheels shall be provided.

7.5.29 BOILER PROTECTION SYSTEM

- a) Boiler protection system shall be independent for each boiler.

- b) System shall be triple Modular Redundant (TMR) or SIL 3 certified (from and authorized agency) redundant system .
- c) The system shall be of same family of hardware and software as of DCS system and shall directly sit on the plant data bus.
- d) System shall be fail-safe type with minimum Safety-Integrity Level 3 as defined in IEC 61508.
- e) System shall be preferably certified for SIL 3 level with applicable Class by an authorised agency.
- f) System shall have an integrated sequence of event recording and alarming facility with a resolution of 1 mili-second for all input signals
- g) The system shall be able to provide fault diagnostics covering up to 99% on all the possible internal failure of hardware.
- h) System shall be able to carry on-line modification of application programme. Necessary tools for engineering modification shall be provided.
- i) Triple redundant sensors shall be provided for each field input condition for BOILER protection where ever feasible and practicable.
- j) Protection system output shall be directly hardwired to field control elements.
- k) Where the same field sensor signal is used for both Boiler protection and plant DCS, field sensor shall be directly connected to the protection system and the input signal to plant DCS shall come as an output from protection system.
- l) Other requirements detailed for DCS system in this specification will also be applicable.

7.5.30 TURBINE PROTECTION SYSTEM

- a) Turbine protection system shall be independent for each Turbine.
- b) System shall be triple Modular Redundant (TMR) or SIL 3 certified (from and authorized agency) redundant system.
- c) The system shall be of same family of hardware and software as of DCS system and shall directly sit on the plant data bus.
- d) System shall be fail-safe type with minimum Safety-Integrity Level 3 as defined in IEC 61508.
- e) System shall be preferably certified for SIL 3 level with applicable Class by an authorised agency.

- f) System shall have an integrated sequence of event recording and alarming facility with a resolution of 1 mili-second for all input signals.
- g) The system shall be able to provide fault diagnostics covering up to 99% on all the possible internal failure of hardware.
- h) System shall be able to carry on-line modification of application programme. Necessary tools for engineering modification shall be provided.
- i) Triple redundant sensors shall be provided for each field input condition for Turbine protection where ever feasible and practicable.
- j) Protection system output shall be directly hardwired to field control elements.
- k) Where the same field sensor signal is used for both Turbine protection and plant DCS, field sensor shall be directly connected to the protection system and the input signal to plant DCS shall come as an output from protection system.
- l) Other requirements detailed for DCS system in this specification will also be applicable.

7.6 PROGRAMMABLE LOGIC CONTROLLER (PLC)

- 7.8.1 The microprocessor based Hot-redundant PLC system shall perform protection logic, interlock and sequential control functions such as binary logic operation, set/reset operation, timers, counters, logic blocks, math functions, Boolean functions & timer functions. PLC shall complete with processor, I/O cards, memory modules, racks, mounting accessories. The scan time for digital inputs shall not be more than 60msec and execution 120msec. The system shall be loaded to maximum 60% under worst loading conditions. The system shall be redundant in processor, power supply and communication interfaces. The system shall have self-diagnosis features. The operation, monitoring and programming shall be performed from the HMI station. The system shall have facility for connecting to DCS using hot redundant bi-directional OPC communication link.
- 7.8.2 PLC shall be microprocessor-based system, modular in construction and expandable in future by adding additional modules. The system shall be designed to be fault tolerant through design and by the use of redundant hardware.
- 7.8.3 On-line replacement of any module shall be possible in a way that removal and addition of any module shall be possible without de-energizing the system. Further there shall not be any interruption in the system while replacing a faulty module except for the inputs/outputs which are being handled by the module.

- 7.8.4 Operation of PLC shall be completely unaffected by a momentary power loss of the order of 20 milli seconds.
- 7.8.5 All the controllers/cards located in field or located in rooms having air conditioner without chemical filter shall confirm to conformal coating (preferably G3) on controller, I/O cards.
- 7.8.6 System hardware & marshalling cabinets shall have cooling fans, lighting facility and two no's (min.) of utility sockets inside it.
- 7.8.7 Licensed programming software along with all required hardware accessories, etc. shall be provided for future updation.
- 7.8.8 The PLC system shall be capable of withstanding noise errors due to electromagnetic interference (EMI) or radio frequency interference (RFI) including nearby radio stations, handheld 2-way walkie-talkie sets, mobile phones, electrical storms, solenoids, relays or contractors carrying heavy currents. RFI/EMI noise immunity shall be as per SAMA standard PMC 33.1. The surge withstands capability for input/output modules shall be as per IEEE 472.
- 7.8.9 PLC shall communicate with DCS on Redundant Modbus Serial link.
- 7.8.10 The processor shall have capability to implement all the control functions required to execute the logic schemes. The size of the memory shall be sufficient for the storage of the programmed instructions required by the logic schemes with 40 % extra space for future expansion. Memory shall be non-volatile. In case volatile memory is provided, battery backup shall be provided for a minimum of three months to keep the storage intact. A battery drain indication shall be provided at least one week before the battery gets drained.
- 7.8.11 Each I/O shall be galvanically isolated from external control circuit by suitable means. Each I/O shall be protected against the reversal of polarity of the power supply voltage to I/O. Each module shall have a LED for each I/O per channel to indicate the status of each Input/Output. Each output shall be short circuit proof and protected by using fuse. Visual indication of fuse blown must be provided for each output. 20 % spare I/O shall be provided as a contractual spare.

ANALOG: -

Max. No. of I/P per Module: - 8

Max. No. of O/P per Module: - 8

DIGITAL: -

Max no. of I/P per Module: - 32

Max no. of OI/P per Module: - 32

System shall have RS232/RS485, USB each two ports for communication interface.

- 7.8.12 1:1 redundancy shall be provided for CPU, memory modules, I/O cards for all control loops, power supply, Bulk Power supply communication card and communication bus and operator station
- 7.8.13 PLC Console (Operator Interface)-Industrial grade, reputed make, Coloured, Operator Interface shall be used for View, Control and programming. Vendor shall recommend the number of operator interfaces based on his package system. The monitor size shall be 32" minimum. Keyboard shall be provided with lock and key to prevent any unintentional programs modification. A printer (LaserJet) shall be provided along with the system.
- 7.8.14 PLC cabinet can have front & Back door arrangement based on layout. Wiring at sided of cabinet is not allowed. Each cabinet shall have cooling arrangement. Current & Voltage indication shall be provided for power cabinet.

7.7 BASIS AND TECHNICAL SPECIFICATION FOR INSTRUMENTS

- 7.6.1 Bidder shall consider transmitters in place switch.
- 7.6.2 Each sensor/ transmitter shall be furnished with a SS316 nameplate, permanently fastened to the sensor body with SS316 wire.
- 7.6.3 The below list is indicative but not exhaustive and bidder shall consider the type of instruments as applicable covered under this specification.
 - a) Pressure Indicators/DP indicators- Direct reading, pipe mounted Pressure gauges of die-cast aluminum body and SS316 for outdoor Coastal environment, with 6 inch (150mm) phenolic dial (white dial with black numerals), SS316 Bourdon tube for high pressure applications and SS316 diaphragm/bellow for low pressure applications. For Seawater applications, SS316L/Hastelly/Monel shall be used for the wetted parts. AISI 304 movements and micrometer type adjustable aluminium pointer, accuracy of ± 1.0 % of span, repeatability of 0.25%, provision of blow out disc, chemical diaphragm for corrosive and oil services, 3 way needle valve for all gauges, Self cleaning type Pulsation dampener (snubber) for pump and compressor discharge lines, Accuracy for draft pressure gauges shall be 1.6% or 2% of span. Syphon for all steam lines, chemical diaphragm for oil, slurry and corrosive services, etc. SS316 nameplate, permanently fastened to the sensor body with SS316 wire shall be provided. Material of accessories shall be SS. IP65 or equivalent degree of protection for enclosure. Overrange protection shall be 50% above maximum pressure. SS Armoured

capillary of 10 M shall be provided as required. Process connection shall be ½"NPT (M) & 2" flanged for diaphragm seal, bottom mounting type for installation on pipe and back mounting type for installation in panels. Zero stopper, Glycerine filled gauges for installation in vibration prone areas eg. BFP area. Zero & span adjustment facility required.

- b) Pressure Switches/DP Switches-Non indicating type, field mounted Pressure Switches with casing of aluminium (epoxy coated) and SS316 for outdoor Coastal environment,, SS316 element and repeatability of $\pm 1\%$ of span, siphon, snubber and pulsation dampners as required by process with 3 valve manifold, chemical diaphragm for corrosive, slurry and oil services & mounting brackets. For Seawater applications, SS316L/Hastelloy/Monel shall be used for the wetted parts. SS316 nameplate, permanently fastened to the sensor body with SS316 wire shall be provided. Material of accessories shall be SS. Auto reset micro switch with internal adjustment for set values with 2 SPDT contacts rated for 240V AC, 5A or 220V DC, 0.25A. Alarm and shutdown switch settings shall not be adjustable from outside housing. IP 67 or equivalent degree of protection for enclosure. Overrange protection 50% above maximum pressure. Scale for setting shall be provided. Piston actuated for high pressure applications and diaphragm/bellows for low pressure/vacuum shall be provided. Process connection shall be ½" NPT (M) and 2" flanged for diaphragm seal.
- c) Pressure Transmitters/DP Transmitters/Flow transmitters (DP type/Level transmitters/DP type) (SMART) -Micro-processor based 2 wire indicating type (LCD display), rack mounted with accuracy of $\pm 0.075\%$ of span, external zero and span adjustment, self diagnostics. Power supply 24 V DC; output signal of 4–20 mA DC. IP 65 or equivalent degree of protection. SS316 sensing element shall be provided. For Seawater applications, SS316L/Hastelloy/Monel shall be used for the wetted parts. Housing of transmitters shall be of SS316 .Accessories like snubbers for pump discharge applications and chemical diaphragm for oil, slurry and corrosive application. 10 m PVC covered SS armoured capillary for corrosive, slurry and oil services, etc. SS316 nameplate, permanently fastened to the sensor body with SS316 wire shall be provided. Material of accessories shall be SS. Turn down ratio 100:1. Process connection–1/2"NPT (F) and 3" flanged for diaphragm seal. 2 valve manifold for absolute pressure, 3 valve manifold for gauge/vacuum and 5 valve manifold for DP/level/flow measurements. For Fuel oil applications, SS capillary with ANSI RF flanged ends shall be provided.
- d) Thermometers-Thermometers shall be Industrial type, Bi-metallic for low temperature applications (< 800 C), inert gas actuated vapour pressure type for above 800 C of SS bulb

and capillary. Housing shall be SS316. Dial size–150 mm with white dial and black numerals and process connection–1/2”NPT (M). Accuracy–+/- 1% of span. IP 65 protection class. Accessories include nameplate, mounting brackets and SS Thermo well. SS316 nameplate, permanently fastened to the sensor body with SS316 wire shall be provided. Material of accessories shall be SS316. Thermowell process connection– 1” SW/M33X2/Flanged for Seawater applications and 1/2”NPT (F) on thermowell for thermometer.

- e) Thermowells-Pipe/equipment mounted temperature test wells of minimum SS316/same as pipe material and for Seawater application it shall be Hastelloy/Monel with a process connection of 1” SW/M33x2 thread/Flanged for Seawater/Corrosive applications and instrument connection of ½” NPT (F) in general or 150 RF flanged. Accessories like name plate, plug with chain, etc. shall be provided. Material of accessories shall be SS316. SS316 nameplate; permanently fastened to the sensor body with SS316 wire shall be provided. Thermowell shall be hex head of barstock assembly. Thermowell shall be straight rounded for duct services. In case flanged wells are required for any specific application, the same shall be supplied as required. The thermowell construction shall meet the ANSI 19.3 (latest) requirements. Thermowell shall be designed such that the resonant frequency is above the exciting frequencies generated by vortex shedding in the process fluid. All Test thermowell shall have the plug of minimum SS316/same as pipe material and for Seawater application it shall be Hastelloy/Monel. IBR certification as applicable shall be provided.
- f) Thermocouple Assembly-Duplex, K– Type, 18 AWG, 24 AWG with accuracy as per Class–1 as per IEC 60584–2/ANSI–C–96.1, ungrounded type depending on operating temperature range. Spring loaded mineral insulated thermocouple assembly thermowell details as indicated above and instrument connection of ½” NPT (F) in general or 150 RF flanged. Material of accessories (name plate, etc.) shall be SS-316. SS316 nameplate, permanently fastened to the sensor body with SS316 wire shall be provided. IP 65 or equivalent degree of protection for enclosure. Thermowell with hex head (with screwed cover & SS chain) bar stock assembly with ungrounded junction. For metal temperature measurement, thermocouple pads weldable to M.S pipes shall be provided with 15 m thermocouple extension wires. Element size shall be 18 AWG. Insulation resistance at 540 Deg C shall not be less than 5 M ohms. Temperature devices provided with thermo wells shall be calibrated with the associated thermowell as an assembly. The thermowell construction shall meet the ANSI 19.3 (latest) requirements. All pent house thermocouples shall be supplied with 15mts flexible extension length. Thermowell material for abrasive process application like coal–air mixture, flue gas etc. shall have tungsten carbide coating. For high temperature flue gas

applications such as platen super-heater and de-super heater inlet/outlet etc. T/C shall be provided with ceramic assembly. For high temperature flue gas applications R or S type T/C shall be provided.

- g) Resistance Temperature Detectors (RTD)-Duplex type, PT- 100, with accuracy Class-A/+/- 0.5% of span as per IEC-60751,, response time 15 seconds; Spring loaded mineral insulated three (3) wire RTD assembly with Thermowell details as indicated above and instrument connection of ½" NPT (F) in general or 150 RF flanged. IP 65 or equivalent degree of protection for enclosure. Material of accessories (name plate, etc.) shall be SS316. SS316 nameplate, permanently fastened to the sensor body with SS316 wire shall be provided. Thermowell with hex head with screwed cover & SS chain, barstock assembly. Element lead size shall be 18 AWG. The insulation resistance at 540 Deg C shall not be less than 5M ohms. Repeatability over full range shall be better than 0.02%. RTD shall be supplied as an assembly complete with thermo wells meeting ANSI 19.3 (latest) requirements.
- h) Level Gauges-Tubular type level gauges for low pressure upto 7 kg/sq.cm & reflex type for high pressure water & steam services & vacuum services with automatic ball check valves, illuminator (240 AC), pyrex/tempered toughened borosilicate glass, mica shield, brass guard rods & brass holders. Body material: Forged carbon steel/304SS/suitable for the medium. Accuracy- +/- 2% with vertical scale. Material of accessories (name plate, etc.) shall be SS. SS316 nameplate, permanently fastened to the sensor body with SS316 wire shall be provided. Tubular glass OD shall be 15 mm or manufacturer's standard. Vent & drain valves shall be provided. Connection shall be screwed or flanged (ANSI class 150 RF).
- i) Level Switches-External cage magnetic float operated or displacer type level switches for tanks and vessels and top mounted level switches for sumps and underground tanks, Capacitance/Conductivity/Ultrasonic type for acidic and alkali application. The top mounted level switches shall be supplied with still pipes to suit the requirement. Microswitch with 2 SPDT contacts rated for 240V AC, 5A or 220V DC, 0.25A. Material of float & float chord shall be SS316 & cage material shall be fabricated steel and the material of accessories shall be SS. IP 65 or equivalent degree of protection for enclosure. For Seawater applications, SS316L shall be used for the wetted parts.
Accessories like name plate, drain valve for external case type level switches, mating flange, gaskets (asbestos), fasteners, bolts & nuts, etc. shall be supplied. SS316 nameplate, permanently fastened to the sensor body with SS316 wire shall be provided. Material of accessories (name plate, etc.) shall be SS316.

- j) Flow Glasses-Online flow glasses for pipe size up to 6" with a rotary wheel (not a flapper type) suitable for installation on vertical or horizontal pipelines, material being glass. Body material shall be same as pipe material, rotor & wetted parts shall be bronze.. IP 65 or equivalent degree of protection for enclosure. Upto 50 Nb size, connection shall be screwed & above 50 mm Nb size it shall be flanged– ANSI, 150 RF. Accessories like name plate, mating flanges with gaskets (neoprene), bolts & nuts, etc. shall be supplied. SS316 nameplate, permanently fastened to the sensor body with SS316 wire shall be provided.
- k) Flow Switches-Indicating, Differential pressure, flapper type on line flow switches for line sizes up to 80 mm with an accuracy of $\pm 0.5\%$ of span and dial size of min. 50 mm having SS316 flapper/SS 316 bellows Housing MoC shall be Low Cu Aluminium. Micro switch with adjustable range with 2 SPDT contacts rated for 240V AC, 5A or 220V DC, 0.25A. IP 65 or equivalent degree of protection for enclosure. The material of accessories shall be SS316. Repeatability shall be $\pm 0.5\%$ of span. Overrange protection shall be 50% above maximum flow. Setting shall be tamper proof external adjustment & scale shall be provided for setting. Range spring & orifice plate shall be SS 316 for DP type. For Seawater applications, SS316L shall be used for the wetted parts. NPT for sizes below 2" & for sizes above 2" ANSI 150 RF shall be provided. Accessories like nameplate, mating flanges with gaskets, bolts & nuts, pipe assembly with orifice plate, etc. SS316 nameplate, permanently fastened to the sensor body with SS316 wire shall be provided. 5 way manifold, pipe, fittings (DP type), etc. shall be supplied. All flow switches shall be provided with local flow indication.
- l) Flow Elements-SS316 long radius, welded type flow nozzles as per ASME PTC 19.5 or BS-1042 for all steam and feed water services with D and D/2 pressure tapplings (3 sets); 316SS concentric orifice plate assembly as per ASME PTC 19.5 or BS-1042 for all water services with flange tap connections. For Seawater applications, SS316L shall be used for the wetted parts. Beta ratio of 0.4 to 0.7. The material of accessories shall be SS. SS316 nameplate, permanently fastened to the sensor body with SS316 wire shall be provided. All the flow elements shall have 3 pairs of differential pressure tapplings complete with root valves and 2 pairs of pressure tapplings for line size below 2". The thickness of the flow nozzle shall be as per the application. The flow elements shall be supplied as assemblies with High/low pressure tapplings, root valves as required. Performance Guarantee flow elements shall be provided separately. Butt welded edges shall be prepared as per ANSI 16.25 & flanged connections shall be as per ANSI 16.5 standards. Orifice assembly complete with nipples & valves to be supplied by Bidder shall be one meter long with ANSI class 150 RF SS flanges at

the ends including gaskets, bolts & nuts. Isolating valves shall have SW end connection. Accessories like nameplate, gaskets, bolts & nuts, reservoirs (condensing chambers), 6 nos. shut off valves per assembly, nipple, welding adapters, etc. shall supplied. Bidder shall submit assembly drawing and flow vs DP curve for each flow element.

- m) Magnetic Flowmeter-Inline indicating type with top mounted transmitter & flanged connection. Accuracy: 0.5% of flowrate or volume flow. Repeatability 0.1% of flowrate/volume flow. Housing MoC shall be SS-316 or Low Cu Aluminium (after approval from Owner/Owners representative). Transmitter shall be smart with LCD display and superimposed HART on 4–20mA DC output. Data storage shall be in EEPROM. Shall have diagnostic capabilities. Touch control facility on the indicator for checking the rate/volume and diagnostic messages. Material: Case–AL. alloy with corrosion resistant flow tube and extension pipe– Stainless steel (SS 304) and Lining–fluoro carbon. Material of Accessories shall be SS316. The flowrate shall be available in DCS and flow integration shall be implemented in DCS to indicate volume/mass flow.
- n) Level Transmitter (Ultrasonic Type)-Ultrasonic type level transmitters top mounted with integral local LCD indicator, IP–65 protection, housed in die cast aluminium with epoxy coating or SS316 for outdoor Coastal environment.; 2 wire type transmitter with 4–20mA output with HART protocol; Accuracy $\pm 0.25\%$; Resolution 1mm; Repeatability $\pm 0.1\%$; Linearity $\pm 1\%$; Response time 150ms; Beam angle $< 12^\circ$; Auto false echo–suppression; Accessories like integral cable between sensor and transmitter unit with connectors on both sides, gasket and cable gland,, name plate & metal tag; the material of accessories shall be SS. SS316 nameplate, permanently fastened to the sensor body with SS316 wire shall be provided.
- o) Silo level Transmitter / Indicator-Radar type level transmitters top mounted with LCD indicator shall be provided. IP-65 protection; +24 V DC supply; 4-20mA output with HART protocol; Accuracy $\pm 1\%$; Resolution 0.04"; Repeatability $\pm 0.04\%$; Linearity $\pm 0.01\%$; Beam angle $< 20^\circ$; Accessories like integral cable between sensor and transmitter unit with connectors on both side, gasket and cable gland, digital panel meter, name plate & metal tag; the material of accessories will be SS.
Switch – 2 nos. of SPDT contacts (1 NO and 1 NC) rated for 0.2 A, 220 V DC. All Accessories Like Name Plate (Ss), gasket, flange, cable etc to be provided.

- p) Junction Boxes (JB)- Junction boxes and cable glands shall be suitable for area classification . JB's shall be of SS316. Explosion proof junction box can be Die cast Aluminium with Anti-corrosive paint. Any other material other than SS-316 after prior approval from owner/owner's representative only. Wall/column mounted junction boxes having required number of terminals with 20% spare terminals and cable entry only at the bottom and sealed with fireproof compound; Cage clamp terminal type; IP 65 or equivalent degree of protection for enclosure. Separate terminal blocks shall be used for analog and digital signal and also for signals with different voltages. Removable gland plate shall be supplied. JB shall have single lockable door with gasket, able to open side ways, with common keys. Painting inside shall be glossy white & outside– RAL 7035. Shield bus for screw connection shall be provided. Terminal size shall be suitable for 0.5sq.mm to 2.5sq.mm wire. Terminal blocks shall be vertical. JB shall have provision to add 20% additional terminals. Accessories like metal tag (SS), clamps, fixtures, bolts (SS), nuts (SS), gaskets (neoprene/EPDM), lock & key, fireproof compound for sealing, etc. shall be supplied. The grouping of instruments in JB's is subject to Owner/Project Manager's approval. The doors shall not have screwed type of locking, but turnable hinge based. The JB's are subject to approval prior to manufacturing. All JB's shall be provided with individual canopies to avoid ingress of water. Double compression SS 316 glands with PVC hood shall be used. All the TB's used shall be polyamide to withstand corrosion and the metallic portion shall be coated against rust/corrosion. In general, all cable entries shall be at the bottom.

Signal grouping of Junction Boxes will be as followed:

- Foundation Fieldbus signals
- 4~20 mA signals (exceptional cases)
- Digital input signals.
- Intrinsically safe signals should be in separate junction box.
- 24 V DC power for solenoid valves.
- Any special signals like vibration etc.
- In case PLC is used then DCS and PLC signals should not be combined. Even for PLC
- signals, the grouping of signals to be followed as followed in DCS.

Also for 4-wire instruments, separate Junction Box for Power shall be considered with multicore cable running from PDB cabinet to Power JB & from JB single core connected to each 4-wire instrument with Fuse protection arrangements.

q) **Nameplates**

Nameplates for measurement elements and transmitters shall have the following minimum

requirements:

- Manufactured from stainless steel
 - Must clearly identify the following minimum information.
 - Must utilize lettering and characters that are no less than 3 millimetres in height.
 - Must be attached to all elements and transmitters
 - Should be mechanically affixed to the device. If it is not practical to mechanically affix the
 - nameplate, then the nameplate must be attached using a stainless-steel wire.
 - a. Manufacturer's name, model and serial number
 - b. Any electrical rating and volt / ampere requirement
 - c. Body pressure rating and material
 - d. Specified instrument tag number
 - e. Specified calibrated range
 - f. Hazardous Area Classification / Approval (if required)
- r) Interposing Relays (IPR)-Electromagnetic type IPRs with plug-in type connections, suitable for channel/rail mounting in cabinets; coil rating 24V DC; 2 set of silver plated changeover contacts rated for 0.2A, 220 V DC. Freewheeling diode across relay coil (copper) and self reset type status indicator flag (electronic) shall be provided. All relays shall be mounted in IPR cabinet & relay base (silver plated) internally wired to the external cabling termination block in IPR cabinet. Wiring connection shall be cage-clamp type & termination shall be suitable for 0.5sq.mm to 2.5sq.mm size wiring. Facility to simulate relay operation manually shall be provided. Relays of different contact interrogation voltages shall be separated by a barrier in IPR cabinet. Accessories like name plate (SS) with tag & service inscription, relay base mounting rail/channel, nuts & bolts, etc. shall be supplied. In each cabinet, a DC Voltmeter shall be provided to check the Field Interrogation voltage.
- s) UPS/POWER SUPPLY Distribution Board-The function of the UPS distribution is sub distribution of UPS power supply from UPS to all the utilities viz., system cabinets, HMI and peripherals. Redundant feeders shall be provided for each utility. The cabinets shall be free standing vertical cabinets, designed for indoor location. Material of construction shall be 2 mm thick CRCA. Fluorescent lighting and space heater shall be provided for each cabinet. Isolating switches and HRC cartridge fuses shall be provided for individual feeder isolation. Ammeter and voltmeter shall be provided for incoming feeders to the distribution boards.

Each terminal shall have LED indication with fuses to indicate and isolate earth faults. With SFU, number of feeder and ratings of feeders will be finalised during detail engineering stage. UPS supply will directly come to PDB (power distribution board) cabinet and from the PDB, it will be further distributed to other cabinets and consoles. Even for PJB and other systems, power main source will be from PDB cabinet only.

- t) 24V DC Distribution Board-The function of the 24V DC distribution board is sub distribution of 24V DC power derived from UPS to all the utilities viz., DCS cabinets, other cabinets and all other 24V DC requirements. Redundant feeders shall be provided for each utility through diode auctioneering using diodes of high peak inverse voltage. The cabinets shall be free standing, vertical cabinets designed for indoor location. Material of construction shall be 2 mm thick CRCA. Fluorescent lighting, fire detector and space heater shall be provided for each cabinet. Isolating switches and HRC cartridges fuses shall be provided for individual feeder isolation. Ammeter and voltmeter shall be provided for the incoming feeders to the distribution boards. Features for any other type of Distribution board to be supplied by Bidder shall be subject to Owner/Project Manager's approval. Each terminal shall have LED indication with fuses to indicate and isolate earth faults.

Dedicated PDB panels shall be considered at DCS side for further distributions.

- u) Cabinets, enclosures and panels-System cabinets, I/O cabinets, power distribution boards, local control panels, etc. shall be vertical free-standing type fabricated from CRCA sheet steel of minimum 2 mm thickness. They shall be provided with anti-vibration pads (15 mm thickness), internal illumination lamps operated by door switches, louvers, ventilation fans with filters, thermostat-controlled space heaters, utility power sockets, drawing pocket, lifting eye bolts, safety and signal earth bus, SS name and tag plates, removable front and rear doors and door locks. Cable entry from shall be from the bottom.

All DCS / PLC cabinets shall be mounted in air-conditioned rooms. Ingress protection for indoor mounting shall be IP-42. Local panels mounted outdoor shall be IP-65 and provided with canopy.

Two coats of rust resistant primer and two coats of final painting shall be done to give a durable matte finish. System cabinets shall house the racks, signal-conditioning modules, I/O cards, processor cards and associated power supply units. Field cables may be terminated in distinct marshalling cabinets or at the rear of the system / I/O cabinet with I/O modules mounted at the front. Pre-fabricated cables shall be provided from marshalling / terminal blocks to the I/O racks.

Network cabinet with glass door shall be provided to mount the various Ethernet switches and GPS receiver, signal processor and power supply.

The terminal blocks shall be rail mounted, spring loaded cage clamp type with fuse protection and LED indication. 600V AC grade, 0.5 mm² to 1.5 mm² sized terminals for signal wires and 1000V AC grade, 1.5 to 2.5 for control wires. The terminal blocks shall be grouped based on the type of signals and voltage levels. Interposing relays of different contact interrogation voltages shall be separated by a barrier.

- v) Control Desk-Indoor located, unit control desk suitable for top mounting of HMIs shall be provided. The panel shall be constructed with 2 mm thickness sheet steel, IP42 degree of protection, 2 mm thick of cold rolled steel & doors, fluorescent lighting, blower, louvers with brass mesh (space heater with thermostatic control). The desk shall have lockable enclosures for mounting the CPUs of the HMI and for storing O&M documentation etc. These shall be provided below the desk level.

w) EARTHING SYSTEM

All equipment containing an electrical signal or power supply shall be earthed for personnel safety reasons and for minimizing electrical interference. This includes enclosures, panels, cable armour, cable glands, cable duct/tray, conduit, etc. Design of the earthing system shall avoid the creation of earth loops caused by duplication of earthing paths. Particular attention shall be paid to the isolation of cabinet earth bars within cabinets and their final earthing to a point of zero potential.

Cable screens shall be electrically continuous throughout the cable run and shall be earthed at one point only. This point is the earth bar in the cabinet in which the cable is connected. Signal Earth{Field instrumentation (Circuit ground, shields, drain wires etc.), LCP , Junction Boxes} shall be connected to dedicated earth pit.

All panels shall be equipped with an earth bus securely fixed along the inside base of the panels. Provision shall be made for future extension of the earth bus, if need arises. Panel Earth for Panels,racks, consoles,shelters etc. shall be connected to Plant Electrical Earth pit . Control system console/ panel earthing shall be as per DCS vendor recommendation.

- x) Control Valves-Multistage, anti-cavitations, Balanced, modulating, globe type, cage guided, single ported, diaphragm type of actuator with hand wheel, SMART Pneumatic positioner, air filter regulator, air lock device, solenoid valve as applicable, limit switches and position transmitters completely tubed with junction box. Pneumatic positioner shall be suitable for accepting 4–20mA DC signal. Pneumatic (SS316) tubing complete with accessories, fittings. If any upgradation of the offered system is envisaged before completion of the job to meet the

specified requirements, the same shall be incorporated in the system, with the approval of the Owner without any additional cost. SMART Positioner shall be provided with input/output/bypass gauges. Local position indicator & Non-contact type position transmitter with 2 wire, 4–20mA DC output. All limit switches/position transmitters, E/P converter signals etc., shall be wired out to external block of actuator and respective junction boxes. Either extended type bonnet or cooling fin type bonnet shall be provided for service above 200 Degree C and for other service the bonnet type shall be standard.

The end connections shall be socket welded for sizes below 50 NB and butt welded for sizes 50 NB and above. Flanged connection shall be provided for DM water services, with suitable rubber lined interfaces.

Generally stem and guide material (trim) shall be SS 316 stellited, and plug and seat material shall be 17–4 PH SS, except for specific applications like DM water, HP bypass services. Control valve body material and actuator type shall subject to Owner's approval. The trims supplied shall be suitable for quick changing. Actuator housing shall be of pressed steel construction.

Trim shall be designed such that trim exit velocity shall be limited to avoid cavitation. All control valves shall have a leakage class of V.

The action of valves on failure of operating media shall be determined by the process requirements with regard to safe operation and emergency shutdown requirements

Control valve sizing shall be accompanied with data sheets. Following sizing calculation details shall be furnished for each Control valves:

Valve CV calculation & Characteristic curve

Noise (both hydro static and hydrodynamic) calculation

Actuator sizing calculation

Actuator linkage mechanism for each control valve shall be subject to Owner's approval

- y) Pneumatic block valves-Balanced, on off, plug type, single ported, gate valve. Body material shall be ASTM A 216 GR WCB with end connection socket welded for sizes 50 NB and below & butt welded for sizes above 50 NB and flow direction shall be horizontal. Leakage class shall be class V.

Bonnet: Std. type of material ASTM A 216 GR WCB & packing material GRAFOIL.

Trim: Cage guided, metal seated with flow characteristic of quick opening with stem, plug, seat and guide material of SS 316.

Actuator: Diaphragm (Nitrile) type with hand wheel & travel indicator and adjustable stop. It shall be sized for shut off differential pressure.

Accessories like air filter regulator, solenoid valve, limit switch with IP65 enclosure, etc. shall be supplied. Actuators & accessories requiring tubing shall be mounted and tubed.

- z) Control Damper Drives-Pneumatic actuator type, located in flue gas/air area with damper shaft bearings mounted externally. Bearings are grease lubricated. Blades (SS) shall be linked together. Accessories like position transmitters (2 wire) with 4–20mA DC output, Local Position indicator, position locks, limit/torque switches, etc. shall be supplied, after integrating, calibrating & testing at works. Smart Positioners with all required accessories, required for the positioning of control damper drives shall be provided. Spare cams for accommodating any change in characteristic to achieve better process control during commissioning shall be supplied as required. All the field mounted Damper accessories (position indicator, limit switches etc.,) shall comply to IP 65. Actuator linkage mechanism for each control valve shall be subject to Owner's approval.

- aa) SMART Positioners of Control Valves/Dampers.-Positioner shall be microprocessor based with digital communication by means of HART protocol. Positioner has to be 2–wire, 4–20 mA loop powered by the control system and capable of split ranging operation.

The SMART positioner shall be suitable for both single acting and double acting actuators. The SMART positioner shall be fully modular in construction with Encapsulated printed wiring board and pressure gauges inside the positioner cover to protect from transit/site damage.

SMART positioner shall be a Double stage positioner. The first stage of the positioner shall be typically a flapper–nozzle that serves as a high–gain pre–amplifier. This sensitivity shall be maintained over a wide range of dynamic conditions. Second stage shall be a power amplifier that provides power to drive the actuator. Preferably this shall be a pneumatic relay. Spool Driven type SMART positioners are not preferred due to Higher Dead Band and Poor responsiveness. The SMART positioner shall have pressure sensors to measure the pneumatic outputs to the actuator

The control algorithm for the positioner shall use feedback signal from the motion of the pneumatic relay beam instead of pressure feedback to minimize pneumatic related effects and for stable and smooth response of the control valve. The SMART positioner shall have user adjustable tuning sets to identify the optimum tuning for the total valve assembly. SMART Positioner with HART Communication facility shall communicate all the valve diagnostics to DCS. The electrical housing shall be designed to meet IP65.

- bb) Air Filter Regulator (AFR)-Constant bleed type AFR with an accuracy of $\pm 0.1\%$, inlet pressure range of 5–8 kg/sq.cm and suitable spring ranges (AFR) for use with positioners in control valves, control damper, E/P converters and shut off valves, transmitter purging lines etc; AFR body MOC shall be SS-316. Filtering particles above five microns having sintered bronze filter element. Material of accessories shall be SS. Built in blow down valve shall be provided. AFR shall have automatic drain feature. All accessories shall be supplied. Degree of protection shall be IP65.
- cc) Position Transmitters-24VDC operated Non-contact LVDT type with 4–20 mA DC 2 wire system with an accuracy of $\pm 1\%$; range adjustment and zero adjustment to be provided, also capacitive probe type, digital inductance type is also acceptable; IP65 degree of protection for casing. The output shall be linear. All accessories shall be SS.
- dd) Solenoid Valves-Direct operated solenoid valves, pilot operated for higher sizes, body material of bronze, plunger material of SS316 rated for continuous duty. IP 65 class for enclosure. Insulation class of 'H' for the solenoid. Body ratings shall suit the pressure and temperature conditions.
- ee) All HT drives shall be provided with vibration monitoring. Vibration sensors shall be provided on x & y directions on DE & NDE of drive & motor. Bearings of high speed machines (≥ 1500 rpm) will be provided with accelerometer type sensors and those of low speed machines (< 1500 rpm), velocity sensors will be provided. Vibration pickup shall have sensitivity of minimum 25.4 mv/mm/ second & IP 65 as degree of protection. Vibration sensors with transmitters shall be provided with 4-20mA output from field hardwired to DCS.
- ff) CONDUCTIVITY MEASUREMENT- $\pm 1\%$ FSD, auto temperature compensation, auto calibration, zero check and integral indicator having gate valve insertion type (withdrawable) cell for hotwell conductivity measurements and flow line (screwed) type cell for other services. Housing for cell and analyser shall be weather and waterproof. Output shall be isolated 4-20 mA DC linear signal. Dual channel analyser with independent output signal for each channel of measurement can be used (if required). IP 65 enclosure.
- gg) pH Measurement-Solid state/microprocessor-based system with system accuracy of 0.02 pH, 2-wire type, auto temperature compensation, auto zero check, manual zero and span calibration, integral indicator, isopotential adjustment having flow type cells. Housing for electrode and analyser shall be IP65. Output shall be isolated 4-20 mA DC linear signal.

Accessories shall include preamplifier, screened junction box for electrode. Dual channel analyser with independent output signal for each channel of measurement can be used (if required).

- hh) Silica Analyser -Continuous colorimetric with an accuracy of +/-5%, response time better than 10 min for 90% change including sample switching, six number of sample streams with sample shut-off solenoid valve having features like auto zero & span calibration, ambient temperature compensation and integral indicator. Self-diagnostic features shall include alarm for no reagent, calibration fault and silica concentration low/high. Analyser housing shall be weather and waterproof. Output shall be isolated 4-20 mA DC linear signal. Housing enclosure shall be IP-65.
- ii) Pull cord, belt sway and zero speed switches-A canopy made of 5mm M.S. plate shall be provided over the lever of each pull cord switch and for each belt sway switch so that spilled over coal lumps do not trip the belt by actuating the lever. Enclosure shall be provided for pull cord and belt sway switches. The degree of protection for all protection switches shall be IP-65. All switches shall have 2 NO & 2 NC potential free contacts. The switches shall be addressable type.
- jj) Pull-Cord Switches-Pull Cord (manually reset type) emergency stop switches shall be located along both the sides of entire length of all conveyors. The spacing shall be at an interval of not exceeding 30 meters. Adequate length of PVC coated wire rope and all accessories shall be furnished. From either end of conveyor pull cord switches should not be more than 15m. Also a local trip indication (Cluster of LEDs) shall be provided with each pull cord switch. Pull cord switch shall have C.I. body with additional enclosure to prevent ingress of dust.
- kk) Belt-Sway Switches-Belt Sway limit switches (auto reset type) shall be furnished in pairs at periodic intervals of minimum 30m to limit belt sway to permissible extent. For any conveyor, however, minimum two pairs of switches shall be provided. These switches shall be placed not more than 15 m from either end of conveyor. Belt sway switch shall have C.I. body with additional enclosure to prevent ingress of dust.
- II) Non-Contact Type Zero Speed Switches -Each conveyor shall be provided with a zero speed switch (auto reset type) at the tail end for sequential operation of the system. In case of belt speed falling below the tolerable limit, the same switch shall stop the conveyor. The speed

setting should be adjustable. Necessary provision to be kept in control circuit to by-pass the switch during starting.

7.6.4 Cables-

7.7.4.1 Class A type Foundation Fieldbus cables are to be used. The major parameters of the Class A type cable are:

- Wire Size : 0.8 mm² (18 AWG) spur cable & 1.3mm² (16AWG) Trunk cable
- ii. Attenuation: 3 dB/Km at 39 Khz
- Max, Capacitance: 150 pF/m
- Characteristic Impedance: 100 ohms +- 20% at 31.25 JHZ
- Individual and overall Shield: 90 % coverage

7.7.4.2 For 4-20 mA current signal, 1-5 V DC voltage signals, RTD signals and 24 V DC interrogation alarm and interlock signals etc., twisted screened single or double pair/triad cables of 1 mm² (multi strand) shall be used from sensor to junction box. Multi pair cables with individual & overall screen shall be considered from control room up to junction boxes. Required parameters for intrinsic safe signal handling shall be considered, wherever applicable, according to Indian Standards or British Standards.

7.7.4.3 For thermocouple signals, thermocouple extension wire shall be used. Wire size AWG 16 gauge shall be used for extension wire. Colour coding and EMF error limitations of extension wires shall be generally as per ISA recommendations. For solenoid valves and relay based safety interlock system 2.5 sq.mm. bare copper conductor control cables as per Indian Standards shall be used. If requested by manufacturers, special control cables shall be used (for instance, radioactive level transmitters).

7.7.4.4 The following cables in general shall be used for Instrumentation as applicable:

a Signal & Control cables

- Single pair
- 2 pair
- 6 pair
- 8 pair
- 12 pair ,24 pair
- 1 triad, 2 triad, 6 triad, 8 triad, 12 triad
- T/C extension cable, 1 pair
- 1 Core,2 Core, 3 Core
- 8 Core
- 14 Core
- 24 Core

- b Power cable
 - 3 Core
- c Foundation Fieldbus cable:
 - Single pair cable.
 - 4 pair cable

7.7.4.5 Cross section area for core cable (e.g. 2.5mm²) is minimum requirement. Vendor shall verify size requirement with voltage drop & minimum voltage requirement at device.

7.7.4.6 All cable shall be flame retardant, oil & sunlight resistant. Considering mechanical protection armouring shall be considered for above cables.

7.7.4.7 FO cable shall be single mode, unitube construction, armoured with 6/12 cores of fiber

7.7.4.8 Pair cables with individual screen shall be used for DI signals and core cables shall be used for DO signals.

Foundation Field Bus Cable Colour code:-

TYPE	COLOUR CODE
Foundation Field Bus Cable	Positive: Orange Negative: Blue

7.7.4.9 Fiber Optic cables: For Fiber optic Cable minimum 20% spare core or two no. whichever is maximum shall be provided.

Mono mode type fiber optic cable shall have following parameters:

- Wavelength band optimized: 850nm / 1300nm / 1550nm
- Mode field diameter: 9-10µm + 10% of nominal value
- Cladding diameter: 125µm + 2.4%
- Core diameter: 9 µm
- Non-concentricity core/cladding: not more than 2m < 1 µm at 1550nm
- Non-circularity of cladding: not more than 3m < 2.5 µm
- Cut-off wavelength: 1200nm, 1250-1320nm, 1525-1580nm,
- Attenuation: less than 0.3-0.4 dB/km at 1300nm, 0-60 degC less than 0.15- 0.25 dB/km at 1550nm, 0-60 degC

- Armour – Required

7.6.5 FERRULING

The ferrules used should be PVC, white coloured, tubular, machine printed of appropriate sizes.

7.6.6 CABLE TRAYS

- 7.7.6.1 Instrument cabling shall be in general overhead.
- 7.7.6.2 Mainly stainless GI trays should be used in plant. Wherever there is possibility of huge spillage of caustic, MS painted cable tray shall be used.
- 7.7.6.3 Pre-fabricated cable trays shall be hot dip galvanized. The fasteners shall be electroplated. Cutting of trays at site shall be minimized. As far as possible pre-fabricated bends shall be used.
- 7.7.6.4 Ladder trays shall be made from angles and flats.
- 7.7.6.5 The width of the cable trays shall in general be 150mm, 300 mm, 600 mm and 750 mm.
- 7.7.6.6 Perforated G.I. trays shall be used from junction boxes to individual instruments. They shall be hot dip galvanized, made of at least 2.5 mm thick sheet. In general, the desired sizes are:
- 50 mm W x 20 mm H
 - 75 mm W x 20 mm H
 - 100 mm W x 20 mm H
 - 150 mm W x 25 mm H
- (Length of each tray section shall be minimum 2.5 meters.)
- 7.7.6.7 Minimum 20% spare space shall be left in each tray for future use.
- 7.7.6.8 As far as possible separate trays shall be provided for Field Bus cables on piperack. However if required for optimization Branch trays within unit may have field bus cables combined with instrument cables provided distance criteria is satisfied.
- 7.7.6.9 Two (Main and redundant) separate route shall be provided for PLC/DCS Data Highway communication cable to ensure one mishap will not disrupt DCS communication . These cables can run in communication trays (telephone). However if communication tray is not available, than cable can be laid in Fieldbus/Fire & Gas cable tray provided distance criteria is met (As per site condition, it shall be planned accordingly).

- 7.7.6.10 Low Voltage Electrical & Low Voltage instrumentation cable trays are segregated as Low Voltage Electrical trays shall also contain VFD cables, from which more segregation is required for instrumentation (4~20mA) & Fieldbus cables.
- 7.7.6.11 For runs at right angles and inside plant section (where cable density is less), 300 mm is permissible.
- 7.7.6.12 Intrinsic safe cables and non-intrinsic safe cables shall be segregated. 230 V, 50 Hz power cables for instruments shall preferably run in separate tray. If running in same tray, minimum 150 mm space shall be left between signal cables and these power cables.
- 7.6.7 System Cabinets- These cabinets shall house signal-conditioning cards, input/output cards, processor cards and associated power supply units. Indoor located, free standing vertical type system cabinets with IP-42 enclosure and with 2 mm thick sheet metal of cold rolled steel; double doors with neoprene gaskets; fluorescent lighting, anti vibration pads of 15 mm thick; blower & louvers in each cabinet; Exhaust Fans with louvers & filters provided on upper side to remove hot air, fire proof compound (50 mm thickness) for sealing cable entry (bottom); Space heaters with thermostat, The racks in system cabinets shall have provision along with plug in sockets/back plane to accommodate the spare slots/modules as specified elsewhere. The colour of the cabinets shall be indicated at detailed engineering stage. Doors shall have concealed type of hinges and swing of 100o on the side to help the operator. Power supply distribution shall be provided. Painting shall be oven baked '2 primer coats and 2 final coats* epoxy / powder coating, with matt finish. Cable entry shall be from bottom through removable split gland plates. Sufficient space shall be left near the cable entry area for proper glanding of field cable. All wires shall be routed through covered PVC ducts. PVC ducts shall be sized liberally to ensure that future wiring can be easily accommodated without the duct overflow. Separate ducts shall be used for intrinsically safe 'IS* and non-intrinsically safe 'NIS* circuits. Whereas standard duct colour is grey, colour of IS ducts shall be blue. All components shall be provided on front and rear surfaces of the mounting plate. No component shall be mounted on the sides/doors/gland plates or in the bolting space provided between the adjacent cabinets. DCS component mounted shall be at distance of min.300mm from bottom. Looping of wires for distribution of power is not acceptable. Every cabinet shall have a monitoring unit which shall monitor stop / stalled or open circuit condition of ventilation fans as well as cabinet temperature. Red LEDs shall indicate individual fan failure. An LED digital display shall indicate the cabinet temperature. A common potential free contact output shall be available for annunciating any of the fan faults and high cabinet temperature, on OS. These alarms shall be taken in series with indication on DCS graphic
- 7.6.8 **UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEM**

220V, 2x100% rated hot redundant UPS system operating in synchronised mode and with static bypass to regulated supply shall be provided for complete plant for feeding the loads requiring UPS supply such as Turbine and Boiler field instruments, DCS and other control systems. The DC back-up duration is considered as 60 minutes. UPS shall be with super-maintenance bypass facility. The system will comprise of 2x100% rated hot redundant UPS system (two sets of converters, inverters & 2 X 100 % battery banks) operating in synchronized mode and with static bypass to regulated supply and AC Distribution Board. The system will have a selector switch. In the 'Normal' position of the selector switch, the UPS loads shall be supplied by two UPS, sharing 50% load each, with output of both UPS being automatically synchronized with each other. If one UPS fails, the healthy UPS will supply the full 100% load by the operation of the static switch. In the event of failure of both the UPS, the load shall be fed by the standby regulated supply through static switches. When any one of the UPS is under maintenance, the selector switch shall be suitably changed such that the healthy UPS supplies 100% load. When only one UPS is feeding the load, the output shall be synchronized with the frequency of the standby source.

The UPS system and associated ACDB (two incomer one bus coupler) shall be located in the Central Control Building for respective Switchgear Buildings for locations based on the requirement.

7.6.9 **TIME SYNCHRONISATION EQUIPMENT**

Time synchronisation equipment shall be complete with all hardware and software to receive the synchronizing signals from remote satellite and provide outputs to synchronize the plant wide all programmable control systems to ensure a common time reference

The system shall be designed in a 100% redundant configuration and will include two master clock systems

The master Clock shall be configured as Real Time Clock with display of time in 24 hrs format and date and shall drive slave clocks located in different plant control buildings.

The offered master clock system shall be a fully wired panel consisting of the following minimum items:

- a GPS Antenna
- b GPS Receiver
- c Signal Processing Unit
- d Local and Remote display units (slave clocks) – 3 nos. (at least)
- e Power supply
- f All required cables, mounting accessories, cabinet for the processing electronics, etc

The fully wired panel shall accommodate signal receiver, signal processing unit, power supply unit. Technical features of the master clock system shall be as follows:

a	GPS Antenna Type	: Helical
b	Signal Receiver	: Microprocessor based
c	Tracking method	: Code / Carrier tracking
d	Output data format	: NEMA 0183
e	Communication speed	: > 9600 BPS
f	Output rate	: every second
g	Signal Processing Unit	: Microprocessor based Digital type
h	Reference	: OCXO with stability of 1 PPM.
i	Time Accuracy	: 1 1 msec or better.

Time synchronizing signals shall be able to communicate through multiple protocols like IRIG-B, NTP.

All the Slave clocks shall derive impulse from the Master clock. Each Slave clock shall be connected to Master Clock by 2 pair copper wire with annealed, tinned, stranded Copper conductor, PVC insulated, PVC sheathed, GI round wire armoured, overall FRLS PVC sheathed. It shall be ensured that loss of any slave display unit does not affect the display of any other slave unit. Slave clocks shall be weatherproof construction suitable for indoor or outdoor use.

Slave Clocks shall be digital type with updates at every second. The display shall be of six digits for hours, minutes and seconds. Display element shall be red LED and the digit size shall be 100 mm minimum for a viewing distance of 20 metre. Anti glare glass cover shall be provided. Slave clocks in control rooms shall be wall/panel mounting decorative type.

7.6.10 **HART MANAGEMENT SYSTEM (HMS)**

A dedicated standalone PC based HART Management system (HMS) shall be provided for centralized configuration, maintenance, diagnostic and record keeping of all electronic smart transmitters and smart valve positioners. HMS shall be complete with its server & user PC, and shall be Integral with DCS.

7.6.11 **SPARES**

Bidder to consider below spares as minimum while submitting the recommended spare list on unit price basis

- a. For all field Instruments, a min of one (1) or 10% of the quantity of each type or range - whichever is higher is to be provided for each unit.
- b. This includes all equipment mounted instruments, pipe line mounted instruments, transmitters, temperature elements, RTD, thermocouple, Air filter regulator, I/P convertors, position transmitters etc
- c. For JB, transmitter rack - a min of one (1) or 10% of the quantity of each type or range- whichever is higher shall be provided
- d. For control / pneumatic valves, a min of one (1) or 10% of the quantity of each type or range of packing and gaskets, actuator diaphragm, pilot relay and O-rings- whichever is higher shall be provided
- e. For solenoid valves, a min of one (1) or 10% of the quantity of each type or range of coil (each rating and insulation), gaskets and O-rings- whichever is higher shall be provided.
- f. Spares as required for 3-year operations of the following systems shall be supplied for FE, Microprocessor based control systems, Local panels, GPS, video wall etc

7.6.12 The specification & details indicated are not exhaustive and Bidder shall consider the required Instrumentation & Control system for the complete plant. Technical features of all field instruments & control systems are subjected to Purchaser's approval before procurement.

7.8 STEAM & WATER ANALYSIS SYSTEM (SWAS)

- 7.8.1. Following analytical instruments complete with their sampling system shall be provided for continuous monitoring of quality of process fluids:

Sl. no.	Sample	Unit-wise or plant common	pH	Specific Conductivity	Cation Conductivity	Silica	Dissolved Oxygen	Sodium
a.	Make Up Water at Deaerator Inlet	Unit	X	X		X		X
b.	CEP discharge	Unit			X	X		
c.	Feedwater at economiser inlet	Unit	X	X	X		X	
d.	Saturated steam	Unit	X	X				

e.	Main steam	Unit			X	X		X
f.	Blow down drain	Unit	X	X	X			X
g.	Closed cooling water	Common	X	X				
h.	Condensate return (If any)	Unit	X		X		X	X

Note: The above samples and parameters are the minimum requirement. Any other samples and parameters as required based on detailed engineering and boiler manufacturer's recommendations shall also be provided

- 7.8.2. Steam and Water Analysis System shall be furnished for continuous monitoring and control of water and steam purity in the plant cycle and at other important points as specified in this specification. The output of the system shall be connected to the DCS
- 7.8.3. The sampling system shall obtain samples from steam and water system, which shall be adequately conditioned and fed to analysers for continuous analysis and provide parallel facility for grab sampling.
- 7.8.4. The analyser outputs shall be used for providing Continuous monitoring of various parameters using indicator with isolated analog output of 4-20mA, DC for each monitoring parameter in plant monitoring system
- 7.8.5. The offered system shall be complete with sample conditioning devices and monitoring instruments (for temperature, pressure, flow & sample) and analysers as well as all required accessories to provide a complete and integrated sampling and analysis system as per the intent and requirements of this specification.
- 7.8.6. The system shall be complete with all sample tubing from primary root valves on process fluid lines/equipment to bulk head of SWAS panel. The necessary cooling water & electrical supply up to the SWAS package shall be provided
- 7.8.7. All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian/ International standards (IS/ASTM/ASME and/or IEEE).
- 7.8.8. Sample Conditioning System

Sample conditioning system design shall meet with the requirements as specified in ASME PTC 19.11-1997. It shall receive and condition all samples as required by the respective analyzers connected to the sample streams. This will include conditioning components as specified herein and shall cover the following:

GENERAL

- i. Sample filtering
- ii. Sample cooling (using as many primary and secondary coolers as required to reduce the temperature to 25°C; chilled water system to be provided for secondary coolers). Only cooler with DM water as coolant shall be used.
- iii. Temperature control with Thermal Shut-Off Valve
- iv. Pressure reduction and control as required. The pressure-reducing device in combination with back pressure regulator should be capable of regulating the pressure/ flow, irrespective of the upstream fluctuations, even at low flow or low-pressure conditions.
- v. Flow rate control with the help of glass tube purge rotameter with a built-in regulating valve
- vi. Two identical 100% capacity chiller units, 100% capacity chilled water pumps, 100% capacity chilled water circulation pumps and storage tank with automatic make up for the secondary cooling.
- vii. Other treatment as required by individual analysers or specified herein

7.8.9. The sample conditioning system shall provide samples at the temperature pressure and flow as required by the analyzer within tolerance of $\pm 1^{\circ}\text{C}$, at a pressure of about 2 kg/cm² and at flow rates as required by individual analysers/streams. Vendor to clearly specify the maximum sample temperature that can be handled by each analyser offered.

7.8.10. Sample line to analyzer elements shall incorporate an anti-siphon design to prevent possibility of running dry because of a broken or plugged sample line

7.8.11. Steam and Water Analysis System (SWAS) Panels

- a. The SWAS panels shall have two sections namely sample conditioning section and analyser section. The first section shall be the wet section of SWAS panels. The second section shall be the dry section housing the analytical transmitters, signal conditioning devices and other requisite accessories and multi-stream analysers like silica, sodium, etc. All monitoring instruments and controls for sampling system shall be located on the front & shall be grouped accordingly to function in a logical and orderly fashion. There shall be a general progression of flow from top to - bottom and left-to-right to minimize sample line length, purge times and material exposed to sample.
- b. Similarly, the conditioning components for each stream shall be grouped together wherever possible.

- c. Indicating instruments such as pressure, temperature and flow shall be arranged above the grab sample valve. Sufficient clearance shall be maintained between instrument banks of adjacent sample points so that there is no confusion in reading these instruments
- d. Constructional Features: The SWAS panel (wet panel) shall be of open frame freestanding type construction. Analyser Panel (Dry Panel) shall be of enclosed type construction and mounted in air-conditioned section of the SWAS room. The sheet steel used in both these panels shall be 2 mm thick
- e. Piping, Tubing And Accessories
 - i All internal piping, tubing and system components required for making the system complete shall be shop installed and tested prior to shipment to project site
 - ii All the fittings on sample lines in the sample conditioning system should be double ferrule compression type. The physical arrangement of the tubing and wiring shall, in all cases, be so as to permit easy access for maintenance of all items of equipment
- f. The sample condition system internal tubing so arranged with isolation valve that for maintenance of any of the instrument / analyzer shall not affect sample of other analyzer.

7.9 CONTINUOUS EMISSION MONITORING SYSTEM (CEMS)

- 7.9.1 The analyzer system shall include extractive analyzers, sample probes, sample conditioning, heated sample lines where required, calibration gas bottles for zero and span, calibration accessories, and mounting hardware for installation, hardware & software etc., Bidder to ensure completeness and operability of the system.
- 7.9.2 The system shall be capable for remote calibration facility from Pollution control Board servers.
- 7.9.3 Only those systems which have been field-proven, engineered, programmed, and fully integrated shall be used. These systems shall be capable of performing the required functions and shall be complete in all respects. The system shall be capable of providing on line reliability which meets or exceeds all Codes and Standards that apply. The Facility uninterruptible power supply (UPS) may be used to provide necessary power to achieve the required reliability factor
- 7.9.4 At a minimum continuous monitoring of below parameters shall be provided:
 - a) NOX
 - b) SOX
 - c) PM
 - d) CO
 - e) CO2

- f) O₂
 - g) Mercury Analyser
 - h) Gas flow rate etc.
- 7.9.5 Each point source monitor shall consist of a sample probe, sample conditioning, sample line, and analyzers with individual 4-20 mA outputs for each measurement. Each analyzer shall be specific for the measured gas without interferences by background or trace gas of other components. Measurands & Measurement methods shall fully comply with local regulations and other applicable codes and standards.
- 7.9.6 Sample conditioning shall be furnished to provide a clean dry sample for analysis with the extractive analyzers. Only suitable alloys or Teflon components shall contact wet, dirty sample gas. A moisture sensor downstream of the drier shall shutoff the sample system to protect the analyzers in the event of a moisture break through. Multi-stream switching shall be provided to switch up to multiple streams through the sample system. Streams that are not sampled shall flow continuously through a bypass to reduce transport lag time when selected. Probes and sample line not being sampled shall be back flushed periodically with high-pressure air
- 7.9.7 System shall have the capability for online automatic cleaning (using compressed air or otherwise) of the sample extraction system and opacity monitoring system without dismantling of any of the components
- 7.9.8 A means for calibrating all analyzer cells shall be provided by periodically introducing zero and span gas or gas cells, manually and automatically. All necessary connections, regulators, gauges, solenoid valves, and gas bottles shall be furnished, as required. Calibration cycle time shall be set over fixed internals and sequenced by the controller
- 7.9.9 The CEMS control and monitoring system shall be furnished with redundant data links for interface between DCS and CEMS data acquisition system of Customer.
- 7.9.10 Analyzer room shall house the analyzers, sample conditioning systems, etc. Air-conditioning shall be provided to maintain interior environment at conditions required for the housed equipment constraints. The equipment shall be mounted on a rack, completely piped and wired with all field sample tubing and electrical wiring connections terminating at bulkhead tubing fittings and electrical junction boxes.
- 7.9.11 A rack for supporting span, zero and calibrating gas cylinders shall be furnished, located outside the Analyzer room. Each cylinder shall be provided with a pressure regulator and pressure gauges.
- 7.9.12 The rack shall provide storage space for clear separation and identification of in use, empty and full gas cylinders.

7.9.13 NO_x-Monitor-

- i) Method: non-dispersive infrared absorption or chemiluminescent; microprocessor based
- ii) Accuracy: $\pm 2\%$ of reading.
- iii) Linearity: less than $\pm 1\%$ of span or 1 ppm, whichever is greater.
- iv) Repeatability: less than $\pm 1\%$ of span or ± 1 ppm, whichever is greater.
- v) Span drift: less than $\pm 2\%$ of full scale of range used or ± 1 ppm, whichever is greater, per week;
- vi) Zero drift: less than $\pm 1\%$ of span or ± 1 ppm, whichever is greater, per week
- vii) Response time: < 3 s from entry of the sample into the analyser to attaining 90 % of the final reading.
- viii) Signal output: 4 - 20 mA
- ix) Status signal outputs shall be provided and linked to the DCS.
- x) Ambient op. conditions: 5 - 60 °C

Features like auto and manual calibration, self-diagnostics, etc. shall be provided. All accessories and erection hardware shall be provided.

7.9.14 SO₂-Monitor

- i) Method: non-dispersive infrared absorption or Pulsed UV fluorescent microprocessor based
- ii) Accuracy: $\pm 2\%$ of reading.
- iii) Linearity: less than $\pm 1\%$ of span or 1 ppm, whichever is greater.
- iv) Repeatability: less than $\pm 1\%$ of span or ± 1 ppm, whichever is greater.
- v) Span drift: less than $\pm 2\%$ of full scale of range used or ± 1 ppm, whichever is greater, per week;
- vi) Zero drift: less than $\pm 1\%$ of span or ± 1 ppm, whichever is greater, per week.
- vii) Response time: < 3 s from entry of the sample into the analyser to attaining 90 % of the final reading
- viii) Signal output: 4 - 20 mA;

- ix) Status signal outputs shall be provided and linked to the DCS.
- x) Ambient operation conditions: 5 - 60 °C

Features like auto and manual calibration, self-diagnostics etc shall be provided. All accessories and erection hardware shall be provided

7.9.15 O2 Monitor

- i) Method: Continuous Paramagnetic Oxygen Analyser ; microprocessor based
- ii) Linearity: less than $\pm 1\%$ of span or 1 ppm, whichever is greater.
- iii) Repeatability: less than $\pm 1\%$ of span or ± 1 ppm, whichever is greater.
- iv) Drift: less than $\pm 2\%$ of full scale of range used or ± 1 ppm, whichever is greater, per month;
- v) Response time: < 5 s from entry of the sample into the analyser to attaining 90 % of the final reading
- vi) Filter: 5 micron (ceramic filter).
- vii) Signal output: 4 - 20 mA;
- viii) Status signal outputs;
- ix) Ambient operation conditions: 5 - 60 °C

7.9.16 CO and CO2 Monitors

- i) Method: Non-dispersive infrared; microprocessor based
- ii) Accuracy: $\pm 2\%$ of reading.
- iii) Linearity: less than $\pm 1\%$ of span or 1 ppm, whichever is greater.
- iv) Repeatability: less than $\pm 1\%$ of span or ± 1 ppm, whichever is greater.
- v) Span drift: less than $\pm 2\%$ of full scale of range used or ± 1 ppm, whichever is greater, per week;
- vi) Zero drift: less than $\pm 1\%$ of span or ± 1 ppm, whichever is greater, per week.
- vii) Response time: < 3 s from entry of the sample into the analyser to attaining 90% of the final reading
- viii) Signal output: 4 - 20 mA;
- ix) Status signal outputs shall be provided and linked to the DCS.

x) Ambient operation conditions: 5 - 60 °C.

Automatic pressure compensation. IP54 enclosure protection class. Accessories like mounting accessories, automatic calibration kit, etc shall be provided

7.9.17 Smoke Density Measurement

Optical transmissometer type microprocessor based/solid state system with an accuracy of +/- 2% FS, response time of 90% within 5 seconds having features like auto zero calibration and correction, auto span calibration and window check. IP67 or equivalent degree of protection for enclosure. Output shall be isolated 4-20 mA DC linear signal. Air purge system with air blower shall be provided.

7.9.18 Mercury Analyzer

Microprocessor based with LCD display, programmable through local keypad and handheld terminal. Continuous duty type, Response time < 90 seconds, Sensitivity drift < 3 % within the maintenance interval, relative to measuring range full scale , Enclosure IP54 , Analog outputs - 4-20mA isolated , 4 relay contacts, 50 V, 5 A, LCD display, 110 V AC power supply. All Accessories Required For Completeness & Integration With CEMS system like SS304 Mounting brackets , Interconnecting cables, Interconnecting tubes and fittings , Name plate / metal tag , All installation hardware , Air purge system with air blower, filter and pre-cleaner etc shall be supplied

7.9.19 ANALYSER PANEL

The analyzer panel shall be of enclosed freestanding type construction with back doors. The sheet steel used in both these panels shall be 2 mm thick Doors – Back opening, twinleaf doors with chrome plated flush handles. Louvers with mesh at bottom shall be provided.

Gland plate	Removable
Cable entry	Top or side
Sample line, Drain line entry, exhaust lines	Sample and exhaust - line top entry; Others – side.
Gasket	Neoprene
Earthing Bus bar	Copper, flat strip
Terminal blocks	2.5 mm 2, screw type
Ingress protection	IP54 min. of IS2147
Cooling Fan	Required for dry panel at top
Lifting lugs	SS (with out paint) at panel top

Cables	Flexible Multi stranded tinned copper conductor, size 1.5 mm ² .
Cable routing	PVC channels. Analog & digital signals shall be routed separately.
Sample line routing	Aluminum trays
Cable termination	Tinned copper lugs
Name plate	Anodized aluminum

Vendor shall provide the vibration dampers for all the panels

7.10 TESTS AT MANUFACTURER'S WORKS

- 7.10.1. The tests at Works shall include electrical, functional tests in accordance with the appropriate clauses of relevant codes and standards and approved drawings / specifications and in addition any test called for by the Owner or the CONSULTANT to ensure that the system being supplied fulfils the requirements of the Specifications.
- 7.10.2. All test certificates must be endorsed with sufficient information to identify the system or the associated equipment to which the certificates refer.
- 7.10.3. All instruments used for measuring performance parameters, shall have valid calibration certificates traceable to national / international standards.
 - a) Pressure indicators: Calibration, Hydro test (1.5 times max. Pr.)
 - b) Pressure switches: Calibration test/Hydro test/Contact rating test/Accuracy test/Repeatability
 - c) Pressure Transmitters: Calibration test/Hydro test/Leak test/Over range test/Accuracy test/Repeatability test
 - d) Differential Pressure Indicators: Calibration test/Hydro test/Leak test/Over range test/Accuracy test/Repeatability test
 - e) Thermometers: Calibration test/Material test//Accuracy test/Bore concentricity : $\pm 5\%$ of wall thick/Hydrostatic test for TW (1.5 times max. pr.).
 - f) Temperature switch: Calibration test/Material test//Accuracy test/Bore concentricity: 1.5% of wall thick/Hydrostatic test for TW (1.5 times max.pr.)/Contact rating test.

- g) Resistance temperature detector assembly: Calibration/Material test/Accuracy test/Bore concentricity test/Insulation test (<500 M at 500 V, DC) as per ISA, Hydro test for TW. Bore concentricity: $\pm 5\%$ of wall thick, Accuracy test
- h) Thermocouple assembly: Calibration/Material test/Insulation test (<500 at 500 V, DC) as per ISA, Hydro static test (1.5 times max. pr.) More concentricity $\pm 5\%$ of wall thick
- i) Temperature transmitters: Calibration test/Accuracy test/Ambient temperature error test
- j) Thermowells: Material test/Bore concentricity: $\pm 5\%$ of wall thick/Hydrostatic test for TW (1.5 times max.pr)
- k) Interposing relay: Functional test/temperature rise test/high voltage test/limits of operation test/insulation test
- l) Level gauges: Hydrostatic test/Material test/Seat leakage test/Ball check test
- m) Level switches (magnetic): Material test/Contact rating test/ Hydro test/Calibration test
- n) Flow switch: Material test/Hydro test/ (1.5-time max. pr)/function test
- o) Flow glasses: Material test/Hydro test/ (1.5 time max. pr)/function test
- p) Flow element: 100% Radiography test/Hydro test/Calibration test/IBR certificate
- q) Control valves: Hydrostatic test, Seat leakage test, CV test, Liquid penetration test, Calibration and Hysteresis test
- r) Note-1: These tests shall be witnessed by PURCHASER / CONSULTANT
- s) Position transmitters: Calibration/hysteresis and Accuracy test
- t) Electro Pneumatic converters: Calibration test/Accuracy
- u) Solenoid valves: Hydro test/Seat leakage test/CV test/coil insulation test
- v) Air filter regulators: Calibration test/Accuracy test
- w) Junction boxes: Test for degree of protection/Material test
- x) Compensating cable: Thermo-emf characteristic/Continuity test/Masurement on capacitance, inductance and loop resistance / insulation resistance /high voltage test as per latest IS/Tensile and elongation test/Oxygen index test /Any other test applicable.
- y) Liquid Analysers
Conductivity Analyser- Calibration test / Accuracy test

- i pH Analyser- Calibration test / Accuracy test
- ii Silica Analyser- Calibration test / Performance test
- z) System cabinets- Verification of degree of protection/Electrical tests as detailed under “Wiring, Terminations & Accessories”/Type tests & routine tests as per relevant Indian standards.

Notes:

- i For equipment not listed above, the tests shall be as per the approved QAP.
- ii All QAP of instruments shall submitted for review & approval during detail engineering.
- iii Test indicated above are the minimum requirement.

7.10.4. TEST AND INSPECTION REQUIREMENTS FOR DCS

Integrated Test at Manufacturer’s works for DCS (Factory Acceptance Test: On completion of manufacturing of the system, a complete integrated test of the system shall be carried out at Contractors works. The test shall be performed with the completely assembled system ready to perform all the functions as is expected to do while in actual service. The Contractor shall submit a detailed "Factory Acceptance Test Procedure" in line with the guidelines furnished herein for Owner / Consultant’s approval. Bidder shall provide simulation software for testing purposes.

7.10.5. SITE ACCEPTANCE TEST

Site Pre-commissioning Tests comprising the following to be conducted by Contractor at site:

- a) Calibration of monitoring and control equipment
- b) Integrated loop test wiring, Simulation input from site
- c) Trial Operation of the DCS / PLC system functioning.
- d) Performance Guarantee Test for I&C systems
- e) Availability Guarantee Test for DCS system
- f) Factory acceptance test for DCS / PLC based control systems.

7.11 TRAINING

- a) Comprehensive training programs for the system, including the controller, networks and Operator stations.

- b) Training of PURCHASER personnel (Engineers, Technicians and Plant Operators) in tuning, modification, operation and maintenance of DCS.
- c) Duration of training at site-2 Man Months
- d) Classroom Training-

ANNEXURE 1

OPERATION AND CONTROL CONCEPT AND INTERFACE AND HARDWARE REQUIREMENT

Sl. No.	Package / System description	Package Scope	Control System	Control / Operation/ Monitoring from		Interface with Master Clock	Remarks
				Local	CCR (DCS)		
1.	Turbine Control & Protection – system (Unitized)	BTG	Turbine Control & Protection Panel (TCP)	Yes	Yes	Yes	i) Redundant Bidirectional OPC communication link to Plant DCS ii) Few Hardwired signals (Protection/trip) to Plant DCS.

2.	Steam Generator & Auxiliaries (Unitized)	BTG	Plant DCS	-	Yes	Yes	Also Refer Table I
3.	Boiler Protection System (Unitized)	BTG	Plant DCS	-	Yes	Yes	
4.	CEMS (Continuous Emission Monitoring System) (Unitized)	BTG	Manufacturer's Proprietary Control System (MPCS)	MPCS HMI	Yes	Yes	i) Hardwired to Plant DCS for monitoring all signals
5.	Steam & Water Analysis System (SWAS) (Unitized)	BTG	Manufacturer's Proprietary Control System (MPCS)	Display on analyser	Yes	-	Hardwired to Plant DCS for monitoring all signals
6.	Electrostatic Precipitator (ESP) (Unitized)	BTG	Microprocessor based System/PLC	Yes	Yes	Yes	i) Redundant Bidirectional link to Plant DCS ii) Commands and status feedbacks are hardwired to (Limited few hardwired Signals only) Plant DCS.
7.	Fuel Handling System (Including Coal, Limestone and Biomass)	Others	PLC	-	Yes	Yes	iii) Redundant Bidirectional link to Plant DCS iv) Commands and status feedbacks are hardwired to (Limited few

	Handling system) (Common)						hardwired Signals only) Plant DCS.
8.	Ash Handling System (Including Powder Limestone and Bed Material Handling) (Common)	Others	PLC	-	Yes	Yes	v) Redundant Bidirectional link to Plant DCS vi) Commands and status feedbacks are hardwired to (Limited few hardwired Signals only) Plant DCS.
9;	Plant Water System (Common)	Others	PLC	-	Yes	Yes	vii) Redundant Bidirectional link to Plant DCS viii) Commands and status feedbacks are hardwired to (Limited few hardwired Signals only) Plant DCS.
10.	Cooling Tower (Unitized)	Others	Plant DCS	-	Yes	Yes	
11.	Compressed Air System (CAS) (Common)	Others	Manufacturer's Proprietary Control System (MPCS)/PLC	Yes	Yes	-	i) Redundant Uni-directional link to DCS i) The start, stop, load, unload and standby operation of the compressors shall be implemented in the Plant DCS.
12.	Black Start Diesel Generator (BSDG)	Others	Manufacturer's Proprietary Control System (MPCS)	Yes	Yes	Yes	i) Uni-directional redundant link to Plant DCS for Monitoring

	(Common)						ii) Few Critical Signals hardwired to Plant DCS for On/Off operation.
13.	UPS & DC System (Common)	BTG Vendor	Manufacturer's Proprietary Control System (MPCS)	Yes	Yes	-	i) Analog & Binary signals including Fault contacts are hardwired to Plant DCS
14.	Fire Alarm & Detection System (FADS) (Common)	Others	Manufacturer's Proprietary Control System (MPCS)	Yes	Yes	-	i) Redundant uni-directional link to DCS. ii) Hardwired contacts for Faults and critical signals to Plant DCS.
15.	Fire Protection System (FPS) (Common)	Others	Manufacturer's Proprietary Control System (MPCS)	Yes	Yes	-	i) Hardwired to Plant DCS for monitoring status signals ii) Redundant, Bi-directional Links to Plant DCS All interlock signals between HVAC & FPS MPCS shall be hardwired.
160.	Plant Electrical System (Generator, Generator transformer, LV/MV Switchgear)	BTG	Plant DCS	-	Yes	-	

Signals only for reporting to DCS shall be transferred on serial interface (Modbus Protocol). If there are any trips generated in DCS which cause a trip of equipment being controlled from PLC, such signals shall be hardwired.

ANNEXURE-II

- 1.0 This section covers the minimum requirements for the design and installation of a Foundation Fieldbus system based on the 31.25 kbps physical layer per ISA S50.02/AG-181/IEC61158. Specification shall be used in conjunction with the SPECIFICATION OF DISTRIBUTED CONTROL SYSTEM DCS. The Foundation Fieldbus portion covers:

Hardware associated with the FF H1 segment.
Operability issues associated with FF design.

1.1 **APPLICATION**

For details refer clause 7.5.2.1

1.2 **HARDWARE**

A typical Fieldbus segment consists of the following components -

- a Host system with controller, operator station, internal buses etc. & I/O module to connect field bus segment i.e Fieldbus interface card Redundant
- b Bulk Power Supply - Bulk VDC supply to Foundation Fieldbus Power Supplies Redundant

- c Foundation fieldbus power supply cum Conditioner - To feed required power to each segment Redundant
- d Diagnostic Module – For each FF Power Hub/Motherboard common for group of segment
- e Surge suppressor at Power Conditioner & inlet of FF JB.
- f Main Fieldbus segment cable to field.
- g Juntion Box/ Device coupler.
- h T—Terminators.
- i Spur cable- connecting main trunk cable to field instruments.
- j Fieldbus devices e.g., transmitters, transducers, positioner etc

1.3 **HOST SYSTEM & FIELD INTERFACE CARD**

- a As general practice, Control system in Fieldbus network is termed as HOST. For description refer “SPECIFICATION OF DISTRIBUTED CONTROL SYSTEM DCS
- b Field interface for DCS will be through Redundant Fieldbus I/O module H1 Card.

1.4 **BULK POWER SUPPLY (REDUNDANT)**

- a Bulk Power supply BPS feeds 24 VDC to Foundation Fieldbus Power supplies .
- b BPS shall be powered from UPS distribution panel by two separate, independent UPS circuits.
- c over current protection shall be provided for each feed supplying power to an individual or gang of FFPS.
- d It shall be possible to replace a failed power supply online .

1.5 **FOUNDATION FIELDBUS POWER SUPPLY (FFPS) WITH POWER CONDITIONER**

- a Redundant Fieldbus power supply with power conditioner shall be provided per segment.
- b FFPS shall be fed by redundant 24 VDC Bulk power supply unit by two independent fused circuit.
- c FFPS backplane shall have facility for connecting diagnostic module. Diagnostic module shall be for each FF Power Hub/Motherboard. Vendor shall provide suitable software/Hardware for segment diagnostics. In case diagnostic modules are interfaced to system through dedicated H1 interfaces then such interfaces shall be provided in addition to specified I/O requirement.

- d Fault in any of redundant module shall be annunciated in Host System. Common alarm for all FFPS in a cabinet may be used.
- e FFPS shall provide galvanic isolation for H1 segment.

1.6 **TERMINATOR, JUNCTION BOX, DEVICE COUPLER & SURGE SUPPRESSORS**

- a Each Fieldbus segment must have exactly two terminators. The wiring between the two terminators is defined as the trunk. All terminators located in the field shall be installed in a junction box. No terminators shall be installed in the FF devices. Repeaters shall not be used.
- b A Junction Box/Device Coupler is a physical interface between a Trunk and Spur, or a Trunk and a device. The number/type of device coupler in a JB is decided by number of instrument connected to a junction box.
- c Surge protection device shall be provided in Trunk out from Power Conditioner & incoming of JB.

1.7 **NO OF DEVICES PER SEGMENT**

1.7.1 **No of devices per segment are as below-**

- Type A : Critical : One control loop & remaining monitoring loop (Max 6 Nos of device per segment)
- Type B: Non critical: Two control loops & remaining monitoring loop (Max 8 Nos of device per segment)
- Type C: Monitoring loop: Max 8 Analog Input per segment

1.7.2 PID control : In DCS Controller

1.7.3 LAS capable : DCS FF H1 Interface card /Field Devices PRIMARY & SECONDARY LAS SHALL RESIDE IN H1 CARD

1.7.4 Each Fieldbus segment shall support multiple backup Link Active schedule .

1.7.5 Segment Diagnostic Module : One per FF Power Hub/Motherboard Per group of segment

1.7.6 Instrument Cable : ISA 50.02 "A" Type cable

1.7.7 Wiring Polarity : + Signal = White

- Signal = Black

Drain/Shield = Bare tinned copper conductor

1.7.8 Wiring polarity shall be maintained throughout the segment design and installation.

1.7.9 Square root extraction : Field device

1.8 SEGMENT DESIGN PHILOSOPHY

The number of possible devices connected to one Fieldbus segment shall be limited by the limitations of FF and the layout of the plant.

1.9 SEGMENT DESIGN POINTS:

1.9.1 All control i.e. PID, Split range, Cascade, interlock shall reside in Host controller.

1.9.2 Loop execution time: As per DCS specifications

1.9.3 Segment topology- Fieldbus installation shall use tree-, individual spur-, combination topology, but daisy chain topology i.e. routing the trunk directly through each device shall not to be used.

1.9.4 The following criteria shall also to be considered during segment design:

- a Type of loop i.e process critical, time critical, Non Critical loop.
- b Area classification & concept applied for Hazardous area.
- c Cable length of segment cables trunks" and "spurs".
- d "Bus software load", limitations of signal transfer rates on the bus and number of usable function
- e Voltage drop -Fieldbus devices may be powered either from the segment bus, or locally powered, depending on the device design.
- f Circuit analysis shall be carried out for each Fieldbus segment to determine the operating voltage at each device. The calculated voltage at the device shall exceed the devices minimum voltage rating by 4 volts, 6e.g. Minimum Vdc required by device = 9 volts, therefore the calculated minimum voltage seen at the device shall be 13 Vdc. The calculated voltage at each device shall be shown on the Instrument Segment Diagram Power consumption of the individual devices
- g The total current draw from all devices on the segment must not exceed the rating of FFPS Foundation Fieldbus Power Supply. The segment design must take into account.

- Total device quiescent current draw + 10mA extra for data transmission
- One spur short circuit fault i.e. ~50 mA additional current draw.
- 25% additional current load over and above that calculated

1.9.5 All final control elements shall have configured fail safe on loss of segment communication.

1.9.6 For Fieldbus Foundation, 4 pair cable shall be used between control system & Field. Out of 4 pair 3 pair shall be used & balance one pair shall be considered as spare. Hence there can be 3 Junction Box associated to this multipair. On similar lines, the fourth port of every FF card shall be spare

1.10 **HOST REQUIREMENTS**

1.10.1 **Host FF Interoperability**

- a All FF Host systems shall have completed host interoperability support testing at foundation Fieldbus facilities .FF host systems shall support all features specified in the HOST.
- b A letter of conformance to the Host interoperability system test shall be provided to verify test completion and feature support.
- c The Host system supplier shall have an interoperability test setup to ensure that all third party devices used in the project have been successfully tested and certified with their system
- d As far as possible, each type & make of instrument will be forwarded for Host interoperability test during FAT.
- e For Instruments not available during FAT, control system supplier shall establish communication at site. It will be control system suppliers responsibility for establishing communication with “FF” certified instruments.

1.11 **HOST CONFIGURATION**

- a FF Host must have configuration tool capable of on line & offline configuration. The configuration tool shall have multi-user & multi-instance capability
- b Internal mirror or shadow function blocks used by control systems to map FF function blocks to internal proprietary function blocks must be completely transparent to the Configurator and operator. Single, unique and

independent function block and parameter tag names must be used for both configuration and operation. Duplicate shadow blocks / parameters with tag names different from FF block / parameters are not acceptable.

- c Vendor shall indicate host configuration tool capability in offer.
- d Host shall have auto addressing facility i.e. downloading addresses to device from DCS.

1.12 **HOST FF FEATURE INTEGRATION**

All host FF functions, including engineering, configuration, maintenance, and operational display functions, shall be integrated into a single, seamless host system. Engineering, configuration, maintenance and operational features shall apply consistently and seamlessly to conventional analog/discrete, Smart HART IO, bus based IO, FF etc. Separate software tools, displays or procedures - specific for FF and different from conventional are not acceptable.

1.13 **HOST-TO-DEVICE REVISION DOWNLOAD CAPABILITY**

Hosts shall have the capability to download software revisions to foundation Field bus devices.

1.14 **Host FF Operating Tools-FF features required for integration include:**

- a FF function block operation, including use of data quality, status, windup and bad value indication and mode switching, must be supported by, and transparently integrated into the control system operation and operating displays. Differences in operation or displays between FF devices or loops and conventional loops are not acceptable.
- b FF process alarms and device alerts must be supported by, and integrated into the control system. Differences between conventional and FF alarm management and alarm displays are not acceptable.
- c FF trend data via trend objects shall be supported by the host control system and transparently integrated into real-time and historic trends displays.

1.15 **. Host Commissioning and maintenance Functions**

- a The Host shall be capable of commissioning, setup, and maintaining all FF devices. The function must be integrated into the Host and available from Host workstations. The following functions shall be supported.
 - Add a new FF device to a segment. Add a future FF device to a segment through use of placeholder templates.
 - Move FF devices from / between offline, spare, standby, commissioned, and mismatch states and manage all address changes transparently. Manual address changes shall not be required.
 - Simple and complex commissioning functions including transmitter range changes, zeroing, and control valve positioner setup.
 - Support for DD methods and menu's wizards for all maintenance functions to walk technicians through the necessary maintenance procedures.
 - Provide specific maintenance displays, organized in a logical manner, for all FF devices using English language descriptors and definitions with access to all parameters. Screens shall not use lists of FF function block parameters.
- b Vendor shall provide simulation software for segment checking
- c It is the responsibility of system vendor to communicate and calibrate any make of FF transmitters registered with Foundation of FF and maintain these devices from their PRM.

1.16 **Asset management systems**

Asset management systems, separate from the host operator / engineering workstations, may be used to manage and display real-time and historical diagnostic & maintenance information. However, it may not replace commissioning and maintenance function integrated into the host as described above.

1.17 **Spare Philosophy**

Spare philosophy shall be as per guidelines given DCS specification document however it shall cover following points in addition. The spare capacity of FIM shall take in to for VCRs, FF function block i.e.

- Min 40% spare capacity for no of VCR's per segment calculation to be based on VCR's per device.
- Min 40% spare FF function blocks per controller.

Vendor to Indicate-

- Max No of FIM's per controller.
- Max No of segments per FIM.
- Max Number of devices supported per FIM.
- Max No of VCR's per segment.
- Max No of FF Function block per controller.

1.18 FACTORY ACCEPTANCE TEST (FAT)

Vendor to follow related guidelines given DCS specification Document

1.18.1 For any Fieldbus logic not tested during FAT, either because logic simulation is not available or all Fieldbus devices cannot be connected, and then the untested Fieldbus logic must be tested during SAT.

1.18.2 The following test shall be conducted for each segment:

Each FF H1 Interface Card segment 6port, including spares, shall be operationally tested by live connection of at least one Fieldbus device. The Fieldbus device shall be connected to the terminal block designated for the field wiring.

1.18.3 The following tests shall be conducted

- a A complete functional test shall be conducted for one-of-each FF device used on this project i.e. Both third-party and control system vendor products. This test will include, but is not limited to, plug-and-play interconnectivity to host system; configured fail-safe operation, verify access to all device function blocks, and actual device operation, 6e.g. stroke valves / MOV's, simulate process inputs for transmitters, etc.7
- b The test shall include configuration, calibration checks and setup for each type of FF device. Examples are changing RTD sensor types, configuring and calibration check of transmitter span, zeroing P & DP transmitters, zeroing elevation on DP level transmitters, setup & calibration of new positioner on a control valve, MOV setup, AOV setup etc. The intent of this requirement is to verify the ease of access to calibration wizards and setup procedures via the host system.
- c All calibration and setup procedures, for each device, shall be demonstrated to Client/. Each procedure shall be documented in detail by the vendor and approved by Client.

- d Vendor shall develop a redundancy fail-over test procedure for the H1 interface cards and Fieldbus power supplies. The test shall verify that automatic fail over shall not cause an upset, i.e. I/O signal bumps, loss of operator view, mode changes etc.. All FF interface cards and FFPS shall be tested. Client shall approve the fail-over test procedures. Online replacement of failed redundant module shall also be demonstrated.
- e Vendor shall conduct complete test on each FF diagnostic module and associated software/hardware and demonstrate its ability to detect all segment faults as per module specifications.
- f Site deputed engineer shall have min 2 years experience in Foundation Fieldbus supplied system.

1.19 SITE ACCEPTANCE TEST (SAT)

The FF SAT test shall contain the same scope as covered in the FF FAT.

ANNEXURE-III

Drive control Philosophy

SL. NO.	SIGNAL DESCRIPTION	I/O TYPE	REMARKS
A	DDCMIS / PLC INTERFACE FOR UNIDIRECTIONAL HT DRIVE		

SL. NO.	SIGNAL DESCRIPTION	I/O TYPE	REMARKS
A	DDCMIS / PLC INTERFACE FOR HT/LT DRIVE		
a	Ready to start (RTS)	DI	Permission for start command
b	Run Feedback	DI	
c	Trip/healthy	DI	
d	Emergency stop (Field)	DI	Emergency push button feedback (of LCS)
e	Local / Remote	DO	Local or remote selection from
f	Start command	DO	Start Command (pulse signal)
g	Stop Command	DO	Stop command (shall be NC)
h	Current	AI	
i	Voltage (if any)	AI	
B	DDCMIS / PLC INTERFACE FOR VFD DRIVE		
a	Ready to start (RTS)	DI	Permission for start command
b	Run Feedback	DI	
c	Trip/healthy	DI	
d	Emergency stop (Field)	DI	Emergency push button
e	Local / Remote	DO	Local or remote selection from
f	Start command	DO	Start Command (pulse signal)
g	Stop Command	DO	Stop command (shall be NC signal from DCS/PLC)
h	Current	AI	
i	Voltage	AI	
j	RPM Feedback	AI	
k	Speed reference	AO	
C	DDCMIS / PLC INTERFACE FOR BIDIRECTIONAL DRIVE (With Integral Starter)		
a	Ready to start (RTS)	DI	Permission for start command
b	Run Feedback	DI	
c	Trip/healthy	DI	
d	Emergency stop (Field)	DI	Emergency push button
e	Open limit switch feedback	DI	
f	Close limit switch feedback	DI	

SL. NO.	SIGNAL DESCRIPTION	I/O TYPE	REMARKS
g	Open Torque switch feedback	DI	
h	Close Torque switch feedback	DI	
i	Local / Remote	DO	Local or remote selection from
J	Start command	DO	Start Command (pulse signal)
k	Stop Command	DO	Stop command (shall be NC)
l	Current	AI	
m	Voltage (if any)	AI	
n	Position Feedback (Position Transmitter 4 - 20 mA)	AI	
D	DDCMIS / PLC INTERFACE FOR SOLENOID DRIVE (Single coil)		
a	Energise or De-Energise	DO	
b	Open limit switch feedback	DI	
c	Close limit switch feedback	DI	
E	DDCMIS / PLC INTERFACE FOR SOLENOID DRIVE (Double coil)		
a	Energise	DO	
b	De-Energise	DO	
c	Open limit switch feedback	DI	
d	Close limit switch feedback	DI	
F	DDCMIS / PLC INTERFACE FOR PNEUMATIC CONTROL		
a	Command to I/P converter	AO	
b	Position Transmitter	AI	
c	Open limit switch feedback	DI	
d	Close limit switch feedback	DI	
e	Command to Solenoid valve	DO	Wherever applicable

Note:

- Other than the above I/Os, iMCC Relay at all the feeders and similarly, soft communication shall be considered in case of VFS.
- Soft signal data shall be for monitoring purpose only.
- Stop signal shall be considered as “NC” during normal condition as well as running condition. If Stop command will be given of in case of any tripping, then signal will be “NO” as a pulse signal.

I. DDCMIS / PLC INTERFACE WITH SWITCHBOARD

SL. NO.	SIGNAL DESCRIPTION	I/O TYPE	REMARKS
SL. NO.	SIGNAL DESCRIPTION	DCS / PLC SIGNAL TYPE	REMARKS
A	DDCMIS / PLC INTERFACE FOR HT SWITCHBOARD		
a	HT TIE FEEDER (WITH SYNCHRONIZATION)		
1	Feeder Dead Bus Close	DO	
2	Feeder Synchro Close	DO	
3	Feeder Trip	DO	
4	Feeder Trip Selected	DO	
5	Feeder selected in Auto Mode	DO	
6	Feeder selected in Manual Mode	DO	
7	Breaker ON	DI	
8	Breaker OFF	DI	
9	Master trip relay operated	DI	
10	Breaker Available (Breaker in service, Spring charged, Control on remote, Trip circuit healthy, Master Trip Relay Reset)	DI	
11	DC Supply Failed	DI	

SL. NO.	SIGNAL DESCRIPTION	I/O TYPE	REMARKS
12	Breaker Auto Transfer Failed	DI	
13	Breaker Auto Transfer Inhibited	DI	
14	Bus bar under voltage	DI	
15	Phase load current	Soft	SWGR to DCS / PLC
16	Voltage	Soft	SWGR to DCS / PLC
17	KW	Soft	SWGR to DCS / PLC
b	HT INCOMER FEEDER		
1	Feeder Dead Bus Close	DO	
2	Feeder Synchro Close	DO	
3	Feeder Trip	DO	
4	Feeder Trip Selected	DO	
5	Breaker ON	DI	
6	Breaker OFF	DI	
7	Master trip relay operated	DI	

SL. NO.	SIGNAL DESCRIPTION	I/O TYPE	REMARKS
8	Breaker Available (Breaker in service, Spring charged, Control on remote, Trip circuit healthy, Master Trip Relay Reset)	DI	
9	Protection Operated	DI	
10	DC Supply failed	DI	
11	Phase load current	Soft	SWGR to DCS / PLC
12	Voltage	Soft	SWGR to DCS / PLC
13	KW	Soft	SWGR to DCS / PLC
c	HT TRANSFORMER FEEDER (DRY TYPE)		
1	Feeder Close	DO	
2	Feeder Trip	DO	
3	Breaker ON	DI	
4	Breaker OFF	DI	
5	Master Trip Relay Operated	DI	
6	Breaker Available (Breaker in service, Spring charged, Control on remote, Trip circuit healthy, Master Trip Relay Reset)	DI	
7	Winding Temperature High	DI	
8	Phase load current	Soft	SWGR to DCS / PLC

SL. NO.	SIGNAL DESCRIPTION	I/O TYPE	REMARKS
9	Voltage	Soft	SWGR to DCS / PLC
10	KW	Soft	SWGR to DCS / PLC
e	HT TIE FEEDER (WITHOUT SYNCHRONIZATION)		
1	Feeder Close	DO	
2	Feeder Trip	DO	
3	Breaker ON	DI	
4	Breaker OFF	DI	
5	Master trip relay operated	DI	
6	Breaker Available (Breaker in service, Spring charged, Control on remote, Trip circuit healthy, Master Trip Relay Reset)	DI	
7	DC Supply Failed	DI	
8	Bus bar under voltage	DI	
9	Phase load current	Soft	SWGR to DCS / PLC
10	Voltage	Soft	SWGR to DCS / PLC
11	KW	Soft	SWGR to DCS / PLC
f	HT BUS COUPLER		
1	Feeder Dead Bus Close	DO	
2	Feeder Synchro Close	DO	
3	Feeder Trip Selected	DO	

SL. NO.	SIGNAL DESCRIPTION	I/O TYPE	REMARKS
4	Feeder Dead Bus close inhibit	DO	
5	Feeder selected in Auto Mode	DO	
6	Feeder selected in Manual Mode	DO	
7	Feeder Trip	DO	
8	Breaker ON feedback	DI	
9	Breaker OFF feedback	DI	
10	Breaker Available (Breaker in service, Spring charged, Control on remote, Trip circuit healthy, Master Trip Relay Reset)	DI	
11	Master Trip Relay Operated	DI	
12	DC Supply-1 Failed	DI	
13	DC Supply-2 Failed	DI	
g	BUS PT		
1	Bus VT Fuse failure	DI	

SL. NO.	SIGNAL DESCRIPTION	I/O TYPE	REMARKS
2	DC Power supply failed	DI	
B	DDCMIS / PLC INTERFACE FOR LT SWITCHBOARD		
a	LT TRANSFORMER INCOMER FEEDER		
1	Breaker ON Command	DO	
2	Breaker OFF Command	DO	
3	Breaker ON	DI	
4	Breaker OFF	DI	
5	Master trip relay operated	DI	
6	Breaker Available (Breaker in service, Spring charged, Control on remote, Trip circuit healthy, Master Trip Relay Reset)	DI	
7	Breaker tripped on U/V	DI	
8	Phase load current	Soft	MCC to DCS / PLC
9	Voltage	Soft	MCC to DCS / PLC
10	KW	Soft	MCC to DCS / PLC
b	LT INCOMER FEEDER FROM UPSTREAM PMCC/PCC		

SL. NO.	SIGNAL DESCRIPTION	I/O TYPE	REMARKS
1	Breaker ON Command	DO	
2	Breaker OFF Command	DO	
3	Breaker ON	DI	
4	Breaker OFF	DI	
5	Master trip relay operated	DI	
6	Breaker Available (Breaker in service, Spring charged, Control on remote, Trip circuit healthy, Master Trip Relay Reset)	DI	
7	Phase load current	Soft	MCC to DCS / PLC
8	Voltage	Soft	MCC to DCS / PLC
9	KW	Soft	MCC to DCS / PLC
c	MCCB OUTGOING FEEDERS		
1	MCCB ON	DI	
2	MCCB OFF	DI	
3	MCCB TRIPPED	DI	

SL. NO.	SIGNAL DESCRIPTION	I/O TYPE	REMARKS
d	LT BUSCOUPLER		
1	Feeder Dead Bus Close	DO	
2	Feeder Synchro Close	DO	
3	Feeder Trip Selected	DO	
4	Feeder Dead Bus close inhibit	DO	
5	Feeder selected in Auto Mode	DO	
6	Feeder selected in Manual Mode	DO	
7	Feeder Trip	DO	
8	Breaker ON feedback	DI	
9	Breaker OFF feedback	DI	
10	Breaker Available (Breaker in service, Spring charged, Control on remote, Trip circuit healthy, Master Trip Relay Reset)	DI	
11	Master Trip Relay Operated	DI	
12	DC Supply Failed	DI	

CHAPTER-8

CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS

8.0 CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

8.1 BTG ISLAND

- The intent of the specification is for Civil, Architectural & Structural steel erection works for BTG island area excluding Chimney. The works are to be executed within the boundaries of proposed 2x30MW CGPP.
- The technical specification covers the technical requirements for the supply / Construction / installation of complete Civil/ Structural works as applicable. The works shall have to be carried out below and above ground level. Broad scope of work is specified herein in subsequent clauses.
- The work to be performed under this specification consists of planning, design, engineering including all incidental works not shown or specified but reasonably implied or necessary for the engineering of the present scope of work all in strict accordance with the specifications, including revisions and amendments thereto as may be required.
- The scope of work under this part of specification consists of design, preparation of detailed drawings and documents for all structural steel building / structures, preparation of GA drawings & layout drawings under the scope of contract, all in strict accordance with the specifications, including revisions and amendments thereto as may be required during the execution of the work in the BTG island area excluding chimney. Preparation of fabrication drawings shall be in the scope of the CONTRACTOR.
- Supply, Fabrication & Erection of the technological structures like EOT Crane for TG, other crane & hoists for BTG auxiliaries, Boiler, ESP, Duct and Duct supports etc. shall be in the Bidder's scope.
- Contractor shall ensure the correctness of details in the fabrication drawings and submit to Owner to proceed with fabrication/ erection. All inserts and anchor bolts required as per Contractor's design drawings shall be supplied by the OWNER. Contractor shall also check and supervise the correctness of placement of inserts/anchor bolts during construction before concreting.
- Design & preparation of Good for Construction (GFC) Drawings for Civil RCC works in the BTG island area will be done by OWNER/ OWNER's engineer. Contractor to provide the necessary loading data (including Foundation loading data for each equipment) for all the structures, Steel tanks, pumps, equipment etc. The necessary baseplates, shim plates etc. required, shall be supplied by the Contractor. Grouting works shall be done by Contractor under the supervision of the OWNER. However, if any special grouts required for specific reasons / functional requirement of the equipment / tanks the same shall be provided by Contractor.

- The scope of supply, fabrication and erection of steel structure (excluding technological structures) above ground (other than RCC works) shall be in OWNER's scope. The design of such steel structures shall be as per relevant IS codes for the worst combination of forces such as bending moment, axial force, shear force and torsion. Basic Wind speed and seismic zone of the project site shall be as per project information attached with this specification. Wind and seismic forces shall not be considered to act simultaneously. Criticality of erection / maintenance loads shall also be checked separately in combination with other simultaneously occurring loads for possible design loading.
- For all building and structures, necessary layout and details are to be developed by the Contractor keeping in view the statutory & functional requirements of the plant and facilities and providing enough space and access for operation, use and maintenance. Certain minimum requirements are indicated in this specification for guidance purpose only.
- The bidder shall inspect the site, examine, and obtain all information required and satisfy himself regarding the site conditions necessary for detail engineering. Ignorance of the site conditions shall not be accepted by the Owner as basis for any claim for compensation or extension of time.
- The submission of a bid by the Bidder will be construed as evidence that such an examination was made and any later claims / disputes regarding to the price quoted shall not be entertained or considered by the Owner on account of ignorance of prevailing site conditions.
- SURVEY DATA - It is the responsibility of the Bidder to verify the various features on his own before submission of bid.

8.1.1 STATUTORY REQUIREMENT

The contractor shall comply with the latest applicable statutory rules. Contractor shall obtain approval of Civil/Structural/Architectural drawings from concerned authorities before starting construction activities.

8.1.2 DOCUMENTS TO BE SUBMITTED BY BIDDER WITH PERTAINING TO WORKS

- (a) Layout drawing locating all buildings, structures, facilities roads, temporary site office, etc. with their plan dimensions based on the latest Plot Plan.
- (b) A report on foundation proposed for various structures, buildings and facilities based on the geotechnical investigation data furnished by **Owner**. Allowable safe bearing capacity for open foundation, depth of foundation, need for pile foundations, type, length and capacity of piles, if piles are proposed, soil improvement if any required, special precaution against aggressive soil etc., shall also be covered in the report.

- (c) General arrangements / architectural drawings for all buildings and structures showing dimensions, levels, plans, sections, elevations, materials proposed, types of framing, wall / cladding, floors, roofs, types of finishes etc.
- (d) Detail design criteria proposed to be adopted for each building, structures, foundations, facilities etc.
- (e) List of software proposed to be used in various areas for analysis, design, drafting etc. with their sources and validation report for software.
- (f) Design calculations for all structures including buildings, foundations, roads, storm water drains inside etc.
- (g) Architectural, Structural & services GA drawings and Good for Construction (GFC) drawings for all types of structures and buildings.
- (h) Structural Fabrication drawings shall be submitted for reference.
- (i) As-built drawings / documents and deviation list from good for construction (GFC) drawings. All drawings shall be fully corrected to comply with the actual "as built" site conditions, signed from all concerns and submitted to Owner after commissioning of the project for record purpose.
- (j) The codes and standards mentioned in the specifications shall be the latest as on the day of award of contract of the works unless otherwise specified. Contractor shall be responsible to inform to the Owner/Owner's Engineer in case of any revisions/re affirm/amendment in the relevant codes and standards after the date of award of contract within 30 days of the issue of such revision/re-affirm/amendment of the code/ standard. Owner / Owner's Engineer may approve use of the earlier code/ standard if the revisions do not materially affect the statutory requirements of the project or do not impact safety practices. It is not the intent to specify herein all the codes and standards required for the satisfactory completion of work. It is understood that all the pertinent codes and standards shall form part of this specification whether explicitly indicated or not.
- (k) All deviations from bid document shall be furnished in the format given in the specification document. Deviations furnished elsewhere in the bid other than at the place titled "Deviations" shall not be considered as deviations.
- (l) Any exclusions from the scope mentioned or implied in these specifications, shall be clearly mentioned by the Bidder in a section titled "EXCLUSIONS" and only these shall be considered as exclusions. All work, other than this, shall be in the scope of this contract and shall be executed by the Contractor at no extra cost.

8.1.3 LIST OF FACILITIES AND BUILDINGS IN BTG AREA

- (a) Steam Turbine Generator building (STG)
- (b) Electrical switchgear cum Control room
- (c) Boiler Bunker / ESP/ Duct supporting structures / Power Cycle pipe supporting structures.
- (d) Boiler Elevator supporting structure including cladding.
- (e) PA/SA/ID fan foundations
- (f) ESP Control Building
- (g) Steam generator area paving
- i. Miscellaneous plant buildings, consisting of but not limited to
 - a) Emergency Diesel generator building

It is not the intent to specify herein all the works in the scope of this contract. The scope also includes all other buildings, structures and works necessary which are not specifically mentioned here but required for engineering under present scope of work are deemed to be included in the scope of the Bidder. The works shall conform to high standards of design and engineering. Design and engineering shall conform in every respect to all international standards / local regulations governing such works.

8.1.4 BRIEF DESCRIPTION OF BUILDING AND STRUCTURES

STEAM TURBINE GENERATOR BUILDING

- i. Turbine building framing shall be of structural steel with moment connection framing in the transverse direction and bracing in the longitudinal direction.
- ii. Service and maintenance bays will not have any intermediate floors; however, a walkway with handrails shall be given along the wall at the operating floor level to observe the TG erection operation. Floors shall be provided as per Mechanical requirements. All floors in the TG building shall have RCC floors over steel framing.
- iii. Crane capacity and crane rail level shall be fixed based on the equipment to be lifted and the method of lifting generator stator. At crane girder top flange level, a crane walkway shall be provided in line with Factory rules. Access shall be provided to crane walkway through staircase from operating floor in addition to cage ladder at two ends. The bottom level of roof framing will be decided by the crane clearance required duly taking into account clearance required for mounting light fixtures. Roofing shall consist of in-situ RCC slab of minimum 50 mm thickness from top of trough of metal deck laid to a slope of 1 in 100, constructed over permanently

colour coated galvanised M.S trough metal sheet of approved profile supported on steel purlins and trusses.

- iv. Cladding shall be of brick wall supported on steel wall beams, up to a height of 3000 mm above ground level. Walls in front of transformers shall be of adequate thickness and height to satisfy “fire rating” as per NFPA/ TAC regulations. Cladding beyond the above level shall be with permanent colour coated, sandwiched, insulated metal sheets.
- v. Windows shall be in anodised aluminium framework using 6 mm thick wired glass. In areas where windows are fixed to metal cladding, windows shall be fixed type and in accessible areas sliding windows shall be provided. Doors on external walls shall be double plate flush steel doors. For equipment entry into the service bay specially designed steel sliding, cum folding rolling shutters shall be provided with appropriate operating mechanism. Provision shall be made for the easy removal of the condenser tubes by providing a rolling shutter/removable cladding as required.
- vi. Staircases protected on all sides with fireproof enclosure shall be provided to satisfy NFPA regulations or local authority guidelines. All the doors leading to the inside of the powerhouse from staircase shall be automatically closing fireproof doors satisfying NFPA regulations. Access to the staircase shall be given to T.G. building roof. A Passenger lift shall also be provided in the Steam turbine building.
- vii. Roof shall be provided with treatment using high solid content liquid applied urethane based elastomeric membrane DFT 1500 microns, as per ASTM C836 and C898. Cement concrete tiles / clay tile over cement mortar bed shall be provided over waterproofed area to a width of 1000 mm where movement of personnel is anticipated. UPVC pipes min 100 Dia NB conforming to standards shall be provided to drain off the rainwater from roof. They shall be suitably hidden from the facade.
- viii. The minimum thickness of structural RCC floor shall be 150 mm above the steel floor beams flange for the intermediate floors with 50 mm floor finish which will be applied later for conventional shuttering system or 175mm above steel floor beams flange if troughed type permanent shuttering is used.
- ix. All the intermediate floors shall be provided with proper drainage. A catch pit with C.I. grills shall be provided near the internal column in a regular pattern and the floor shall be sloped towards the catch pit by varying the thickness of the bedding concrete for the floor finish. Catch pits shall be at the same coordinate for all floor levels. UPVC pipe shall be provided to carry the drainage down. The pipes shall be clamped on to the intermediate column. Sumps shall be provided on the ground floor to receive the water. Proper drainage arrangement shall be provided on the ground floor by means of RCC gravity channels with M.S. grating on top.

The drainage shall be led to separate sumps from where the water shall be pumped to plant drainage arrangement. Around equipment liable to frequent drainage, concrete kerbs shall be provided to isolate the area and water shall be led through sump and channels to the floor drainage system. Oil water separator shall be provided as required to isolate oil from the drainage water where the water is mixed with oil.

- x. In the operating floor, the design live load shall be painted on the floors prominently showing the extent of the area where such loading is permitted.
- xi. Wherever openings are provided in the floor for handling of equipment using EOT cranes such openings shall be covered with gratings provided over removable steel beams.
- xii. Expansion joint (if required) shall be provided in the building to satisfy the requirements of codes.
- xiii. Foundations for major equipment like generator and boiler feed pump shall be mounted on properly designed vibration isolation system if so, specified in the Mechanical section of this specification. However, the foundation shall be isolated from the building framework.
- xiv. All structural steel work shall be given paint as per painting specification attached elsewhere.

ELECTRICAL SWITCH GEAR CUM CONTROL ROOM

- i. The control building shall be an RCC/steel framed structure, aesthetically designed with in-situ RCC slabs and elevator for approaching all the floors. Services housed on the various floors shall be as per the enclosed GA drawings. Most of the areas except for the area on the ground floor shall be air conditioned and shall be provided with a false ceiling. The false ceiling in the conference room, control room and computer room shall be of colour coated aluminium ceiling system and in other areas false ceiling may be of gypsum board.
- ii. Cladding shall be of brick wall with plastering and painting
- iii. Main entrance to control room shall be through aluminium glazed double leaf swing door of adequate size and one single panel door shall also be provided. Separate rolling shutter entry shall be planned for panel movement with a hatch and lifting beam. Main door to switch gear room shall be steel sliding door having adequate size to admit switchgear. There shall be a minimum of two fireproof doors to the switch gear room. No windows shall be provided for switchgear rooms and control rooms.

- iv. An auxiliary transformer yard with fencing and gate shall be provided adjoining the building. Building cladding adjoining transformer yard shall be made sufficiently thick to satisfy fire rating as per CEA/TAC/NFPA regulations.
- v. Staircase area shall be protected from fire as per NBC/ TAC/NFPA regulations.
- vi. Partition between control room and adjoining rooms shall be of glazed aluminium with 300 mm high brick wall at bottom for toe protection. Doors shall be single leaf glazed aluminium doors for all cabins. For movement of panels suitably sized double leaf aluminium glazed doors shall be provided. In other area cladding shall be of brick wall. Battery room shall be provided with PVC doors in PVC framing.
- vii. Toilets shall be provided at the switchgear room and control room levels. Toilet floors shall be sunk, and floor provided with damp proofing treatment and shaft shall be provided to route the soil pipe. All openings in the floor for switchgear and other panels shall be sealed with fireproof material after cables are connected.
- viii. False flooring shall be provided in the control room, electronic cubicle room and the computer room. The floor slab in these areas shall be sunk.

STEAM GENERATOR / ESP / DUCT SUPPORTING STRUCTURE

- i. Criteria for designing the steel structure is described elsewhere in this volume
- ii. Types of foundation for the structures shall be based on the subsoil condition and recommendation based on detailed geotechnical investigation. In addition to foundations for structure other major foundations in the area those for PA/SA/ID fan foundations. The above foundation shall be designed with Vibration isolation system.

BOILER AND BUNKER BAY FOR COAL, LIMESTONE & BED MATERIALS

- i. The framing shall be of structural steel. This shall be designed as a moment connection framing in the transverse direction and braced in the longitudinal direction. This structure primarily supports bunkers, feeders and tripper arrangement.
- ii. This shall be a steel framed structure with bracing in the longitudinal direction as well as at gable ends. Roofing shall be permanently colour coated galvanised trough shaped sheeting 1.0 mm thick and side cladding shall be of similar sheeting but 0.6 mm thick. Bottom 3000 mm high cladding shall be of brick/masonry. The rainwater gutter shall match the sheeting provided and RW down take pipe shall be UPVC pipe conforming to standards.
- iii. The extent of the feeder floor shall be decided by the Bidder based on maintenance requirements. The feeder floor will be of RCC supported on structural steel framework.

Handrails shall be provided on all the sides. A steel staircase shall be provided for access to the feeder floor from the ground floor. Access shall be provided to the feeder floor from the boiler elevator.

- iv. Framework for supporting the bunker shall be provided above the feeder floor based on geometry of the hopper.
- v. The bunker feeding conveying floor shall be immediately above the bunker. This floor shall be of RCC supported on structural steel framework.
- vi. The Bunker roof shall be of RCC supported on permanently colour coated metal sheeting over structural steel framework. Alternatively, tripper roof can be of permanent colour coated metal deck sheet over structural steel framework. The tripper roof supports bunker ventilation / dust supporting structure. An RCC parapet or steel handrail shall be provided for the tripper roof. An access stair shall be provided from tripper floor to roof in each unit.
- vii. In addition to the above, framing arrangement for structural steel platform at various levels around the bunker shall be provided with proper access ladder, for poking, striking and attending to air cannons.
- viii. Bunker feeding floor shall be given access through Boiler staircase / elevators.
- ix. Bunker supporting structure is normally left uncladded up to the bottom of tripper floor. For tripper floor up to 3000 mm above finished tripper floor level, brick wall shall be provided. Above this level permanent colour coated galvanised trough sheet cladding shall be provided. Fixed steel windows with 6 mm thick wired glass shall be provided in the tripper house as per requirements for conveyor gallery.
- x. Roof slab shall be sloped to one side to permit easy drainage. Roof shall be provided with treatment using high solid content liquid applied urethane based elastomeric membrane DFT 1500 microns, as per ASTM C836 and C898. Cement concrete tiles / clay tile over cement mortar bed shall be provided over waterproofed area to a width of 1000 mm where movement of personnel is anticipated. Rainwater down take pipes of UPVC conforming Standards shall be provided.
- xi. All structural steel work shall be given paint as per painting specification attached elsewhere.

STEAM GENERATOR ELEVATOR SUPPORTING STRUCTURE

- i. Capacity and number of the elevators shall be as stipulated elsewhere. The elevator supporting structure shall be of structural steel braced in both directions. Plan bracings shall

be provided at all the landing locations. Where landing locations are far apart, plan bracings shall be provided at least at every 8 m center.

- ii. The elevator shaft shall be constructed with colour coated insulation sandwiched metal cladding system supported on structural steel work. Lift pit shall be of RCC. Ground floor entry shall be kept about 500 mm above general graded / paved level with a ramp for approach. A sump for drainage and Aluminium ladder shall be provided in the lift pit.
- iii. The machine room floor shall be of RCC with 300 mm kerb wall all round. Roof also shall be of RCC construction with permanently colour coated galvanised MS trough metal sheet decking. Roof shall be sloped to one side for drainage purpose.
- iv. Side cladding for the machine room shall be of sandwiched metal cladding as specified for lift cage. Adequate window shall be provided for admitting natural light. Adequate / designed monorail with equipment hatch in the machine room floor shall be provided to lift heavy machinery. Steel staircase shall be given to the M/C room from last landing. Landing levels are generally governed by the floor levels in the Boiler structure. In addition, landing shall be provided at feeder floor and tripper floor levels. Structural steel walkway shall be provided from the elevator landing platform to these floors.
- v. Windows in the M/C room shall be of steel glazed type using 6 mm thick wired glass. Door shall be of flush welded hollow steel type. All structural steel work shall be painted as per specification described elsewhere.

STEAM GENERATOR AREA PAVING

- i. The entire steam generator area from the Electrical bay up to the end of chimney shall be provided with RCC paving over rubble soling.
- ii. Paving shall be carefully planned such that maintenance access roads minimum 4 m wide to all major equipment are available. This area shall be designed for heavy loads similar to design of roads. Such approach road shall be provided to the S.G. elevator also to enable handling of equipment at higher level during maintenance. Such roadways shall be clearly identified with kerbs / painting. All drain / trench covers in these areas shall be designed to withstand truck loading.
- iii. The drainage of the entire STG area shall be properly planned. A network of RCC drains with RCC cover with slotted holes or MS grills shall be provided covering the entire area which leads the storm water to the peripheral drains, which in turn will lead to plant drainage system. Leaked process water and water with ash/coal contamination shall be suitably segregated and led to pits from where it shall be pumped to ETP. Where open drains are not

permitted underground pipes may be provided in which case at all junctions and ends proper manholes shall be provided to permit periodic cleaning of the pipes. All structural steel columns base plate are below paving level, it shall be provided with encasing to a height of minimum 200 mm above paving level. The maximum paved level in S.G. area shall be kept a minimum 100 mm below the finished ground floor level in Turbine building area.

8.1.5 GENERAL REQUIREMENT OF BUILDING / STRUCTURES

- a) The design of buildings, structures etc. shall take into account requirements for operation and maintenance of all equipment and its users. The buildings shall have good architectural features. The surrounding areas shall be properly micro levelled and graded.

b) ARCHITECTURAL CONCEPT FOR BUILDINGS

The architectural design concept of buildings shall be evolved considering the functional, technical 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. To achieve the above objective Bidder shall employ a qualified architect to carry out all designs and hold all other architectural responsibilities for the project.

The Bidder shall obtain and be conversant with all laws, by-laws and regulations of local and Statutory Bodies as applicable to the project. The architectural concept evolved shall also take care of these requirements. The Bidder shall provide the drawings and documents for such statutory approvals.

c) ROOF ACCESS

All roofs shall be provided with access through a staircase/ cage ladder. A minimum 1000 mm wide access path shall be provided with tiles to approach equipment on the roof.

d) PLATFORMS AND WALKWAYS

Platforms, stairways, and ladders shall be provided to permit personnel access to equipment and components. Components that require access to perform operations, surveillance, maintenance, or adjustment shall generally be accessible from a permanent floor or platform. Other components with less frequent access shall be generally accessed with the use of mobile ladders, scaffolding, or other temporary means. Platforms and/or walkways shall connect pits and low-lying areas with the main functional levels of the Plant.

Platforms and walkways shall be a minimum of 900 mm wide. All platforms shall have kick plate of 100mm high x 6mm thick for protection for personnel around periphery. It shall be

adequately sized and supported for personnel and material loadings as necessary. The platforms and walkways details for major equipment as per manufacturer's design.

A continuous walkway minimum 750mm wide and at least 500 mm wide at column locations shall be provided along the crane girder level with handrails on both sides of the building. Approach to EOT crane shall be ensured by Cage ladder or staircase.

e) STEEL STAIRS

All steel staircases, except fire escape staircases, shall normally have minimum clear width (back to back of stringer) of 1000 mm, minimum 250mm tread width and maximum riser of 180mm. Number of riser in each flight shall not exceed 15. Channels (minimum MC200) shall be provided as stair stringers. Treads shall be of Chequered plate/grating, with suitable nosing, and spaced equally.

All stair treads shall be galvanized steel grating, 25 mm x 6mm load bearing bar, cast abrasive nosing.

Fire escape staircases shall be provided as per NFPA guidelines.

f) 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 45 deg. Ladders shall be of minimum 450 mm clear width with 65mm x 12mm with 20mm diameter rungs spaced at 300 mm (maximum).

Safety cages shall be provided for vertical ladders as per OSHA standards and cages shall be tied into the handrails of lower levels. The top step of vertical ladders shall be level with the platform and the horizontal gap between the top rung of the ladder and the platform shall not exceed 75mm.

g) RCC STAIRS

All stairs shall have a maximum riser of 180 mm and a minimum tread of 250 mm. However, for service building, admin building, and other public buildings riser shall be limited to 150 mm and tread width of 300 mm. Minimum width of stairs shall be 1250 mm generally. All stairs normally shall have not more than 15 risers in one flight. Aluminium angle nosing with minimum 50X25X3 angle or PVC nosing shall be provided for edge protection of RCC stairs. Fire escape staircase shall be as per the local fire regulations authority/ TAC/ NFPA guidelines.

h) 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 MS pipes as per international standards galvanised using 750 gm/sq. m of zinc. Handrails for platforms, walkways and projections 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 protected horizontal opening. In such a case spacing shall not exceed 1800 mm center to center of posts. Handrails shall be shop fabricated for specific locations and bolted to the erected structural steel. For platforms at an elevation of more than 30 m, three rail system with top rail at 1500 mm shall be adopted. 100 mm wide and 6 mm thick toe guard shall be provided at landings and flat locations.

For RCC stairs, handrails with 20 mm square MS bar balustrade with suitable MS flat & aluminium / Teakwood handrail shall be provided in general unless specifically mentioned elsewhere in the specification.

i) 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 at least L 50x50x6 with lugs for edge protection e.g. all round 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.

j) GRATING

Grating will be of welded rectangular steel bar type with min. thickness 32mm with 32mm x 5mm main bars on not more than 30mm bar spacing and 100mm cross bar pitch. Heavy duty grating shall be used for areas with vehicle and forklift access. All grating shall be hot dipped

galvanized. Areas exposed to chemical attack shall have Fiberglass Reinforced Polyester (FRP) grating with FR gray grit top.

Note: Cutting/welding of grating banding bars on site will not be allowed except on unforeseen cases which shall be discussed with quality team and subject to Owner's approval.

k) ANCHOR BOLTS AND 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.

Insert plates shall be designed / checked for shear and bending moment. All lugs shall be checked for tension. Bond strength of concrete shall also be checked. Lugs using steel bars shall preferably be fillet welded to the plate to transfer full strength of the lug. Preferably lugs shall be of square bar type.

l) VERTICAL HEADROOMS

All accessible areas shall be provided with minimum clear headroom as indicated in Chapter-4, General Requirement.

m) 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 watertight using PVC ribbed water stops with central bulb. However, kicker type (externally placed) PVC water stops may be used for the base slabs and in other areas where it is required to facilitate concreting. The minimum thickness of PVC water stops shall be 6 mm and minimum width shall be 225 mm. At other joints these shall be 150 mm wide.

Two-part poly sulphide sealant conforming to international standards or any other sealing material as approved by Owner/ Owner's Engineer shall be used for sealing of joints in contact with water. For other cases, bitumen sealing compound can be used. Preformed bitumen impregnated fiber board conforming to standards shall be used as joint filler.

n) BRICK MASONRY AND PARAPET WALL

All masonry works shall be designed in accordance with international codes and regulations as applicable. Structural design of load bearing, and non-load bearing walls constructed with solid or perforated burnt clay bricks or fly ash bricks shall be in accordance with criteria specified by applicable codes and standards.

Thickness of wall shall be as per Indian standard code of practice.

Damp proofing course shall be provided at plinth level as per standards.

All up stands and parapet walls on roof shall be of RCC construction, minimum height of parapet walls shall be 900 mm and thickness 125 mm

o) FLOOR DRAINAGE

For all buildings and areas, suitable arrangements for draining out water collected from equipment blow downs, leakage, floor washing, firefighting, 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 minimum 40 mm thick grating covers. In areas where heavy equipment loads would be coming, precast RCC covers shall be provided in place of steel grating. 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.

p) 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. The gradient shall be made by screed concrete of 50 mm minimum thickness. Roof drainage system shall consist of roof drain heads, rainwater down take pipes and fixtures. The system shall be designed to handle design requirements for the specific site and shall be in accordance to stipulations of international standards. Roof drains shall conduct water to storm drains through down take pipes.

Rain water down take pipes shall be UPVC pipe conforming to standards.

q) SUMPS

In the 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 drains.

r) WATER PROOFING OF UNDERGROUND STRUCTURES

All underground structures like basements, pump houses, water retaining structures etc. shall have plasticizer cum waterproofing cement additives conforming to standards. In addition, limits on permeability as given in codes shall also be met with. The concrete surface of these structures in contact with soil shall be provided with a minimum of two coats of bituminous painting of grade 85/25 conforming to standards for water / damp proofing. Chemical injection grouting from inside shall be adopted as per approved manufacturer's specification at the construction joints.

s) ANTI TERMITE TREATMENT

Preconstruction termite proofing treatment shall be done as per IS: 6313 Part 2 under foundations, floor including required peripheral area outside plinth for all applicable structures.

t) PLINTH LEVEL

Finished Ground floor level (plinth level) of all buildings and power houses shall be minimum 300 mm above the formation level/grade level.

All cable vaults shall be located above ground level i.e. cable vaults shall not be provided as basements in the buildings.

Finished floor levels of Boiler area / transformer area yard paving shall be kept 100 mm lower than the finished floor level of turbine building.

u) FIRE AND SAFETY REQUIREMENTS

All the applicable statutory rules pertaining to the country, 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.

Provisions of safety, health and welfare according to Factories act shall be complied with design stage. These shall include provision of continuous walkway (minimum 750 mm wide) 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 room etc.

An adequate number of fire escapes shall be provided in a building. Fireproof doors, number of staircases, fire separation walls, lath plastering on structural steel member (in fire prone areas) shall be made according to the recommendation of TAC/NFPA. All masonry firewalls shall be minimum 345 mm thick and RCC firewall shall be minimum 200 mm thick.

8.1.6 LOADS AND LOAD COMBINATIONS

In general, different loading conditions have to be considered for the design of the plant and other structures. Following loads shall be considered in the design:

- 1) Dead load (DL)
- 2) Live load (LL)
- 3) Dust load
- 4) Wind load (WL)
- 5) Seismic load (SL)
- 6) Dynamic load
- 7) Impact Load (IL)
- 8) Equipment loads (EL)
 - a. Equipment Dead Load (ELe)
 - b. Equipment Operating Load (ELo)
 - c. Equipment Test Load (ELt)
- 9) Construction load
- 10) Thermal Load/Friction load
- 11) Bundle Pull Load (if any)
- 12) EOT Crane, Monorail load (if any)
- 13) Earth pressure
- 14) Liquid pressure
- 15) Pipe Loads
- 16) Vibration Load

Permanent/Dead Loads (DL)

Dead load is the self-weight of the structure and the weight of all materials permanently fastened there to or supported on the structure thereby, such as fireproofing, finishes, pipes, insulations and walkways, weight of empty equipment, ducts, trays and vessels. Dead loads shall be considered as specified in I.S. 875 (Part 1). Unit weight to be considered for various materials shall be as follows:

Sr. No.	Material	Unit weight
1	Reinforced concrete	25 kN/m ³
2	Plain cement concrete	24 kN/m ³
3	Structural steel	78.5 kN/m ³
4	Concrete block masonry	24 kN/m ³
5	Brick masonry	20 kN/m ³
6	Bulk unit weight of soil	18 kN/m ³
7	Fully saturated soil weight	21 kN/m ³
8	Aerated Autoclaved concrete block (AAC)	6 kN/m ³
9	6 mm thick chequered plate	0.55 kN/m ²
10	25 mm Thick Grating	0.55 kN/m ²
11	Handrail	0.15 kN/m
12	Ladder	0.40 N/m

Live Loads (LL)

Live load shall be the maximum load expected by the intended use or occupancy and consists of the following loads:

- Persons, portable machinery and tools
- Materials temporarily stored during maintenance such as moulds, finished goods, raw material and scrap material.
- Materials normally stored during operation.

Live loads shall be uniformly distributed/concentrically applied over the horizontal projection of the specified area. Distributed live load is applied to all areas except directly under equipment. Collateral load accounts for piping and miscellaneous utilities and is applied to all areas.

The following live loads shall be the minimum considered in structural design as specified in IS: 875 (Part 2) unless noted otherwise.

Loading Area	Minimum Load	Concentrated Loads
	Intensity (kN/m ²)	(kN)
Roof	Max of 1	10.0
Staircase	Or 25% of roof self-weight	-
Storage Areas for heavy goods, control & MCC Room	5	-
	10	4.5
Principal Walkways & working Platforms	5	-
Access Platforms, Walkways	2.5	4.5
Office area	2.5	4.5
Laboratory	3	-
Handrails	0.75 kN/m Linear load	0.9 kN shall be applied in any direction on the top rail
Toilets and bathrooms	2	-
False ceiling	0.75	-
Compressor/ Generator operating level floors including platforms	7.5	4.5
Crane walkways	2.5	-
	(for crane girder and auxiliary girder design)	
	5	-
	(for walkway member design)	
Visitor Gallery	5	-

Hung load for electrical, ventilation, AC, piping works etc. will be considered as per process requirement.

Chute loading on floor supporting beams will be considered as per load data indicated in Mechanical GA drawing.

Where actual load is more than the load given in the above table, design shall be based on actual loadings. For various mechanical handling equipment, which is used to transport goods to storage,

workshop etc., the actual load coming from the use of such equipment shall be ascertained and design should cater to actual loading.

Roof Dust Loads

Floor dust loads: Uniformly distributed load of 1 kN/m² will be considered for areas where there is likelihood of accumulation of dust on floors.

Roof Dust Loads: Dust load will be considered in a selective manner depending on the project requirement. Dust load of min. 0.5 kN/m² on roof will be considered in areas where there is possibility of accumulation of dust on roof. Dust load will be taken over and above the uniform live loads specified in IS Codes.

Wind Load (WL)

The structures shall be designed to withstand the forces of wind pressure, assumed in any horizontal direction with no allowance for the effect of shielding by other adjacent structures, in accordance with the appropriate provisions of IS: 875 (Part 3).

Basic Wind speed at 10m height (m/sec)	$V_b = 44$	CL. 6.2 of IS:875 Part-3
Design Wind Speed at any height: (m/sec)	$V_z = k_1 * k_2 * k_3 * k_4 * V_b$	Clause 6.3
Where. k_1 = Probability factor		I.S.875 Part 3 Table1
k_2 = Terrain height & structure size factor		Cl. 6.3.2.1 of IS875 Part 3
Terrain category: All the structures fall under category – 2 type of terrain (Open terrain with well scattered obstructions having heights generally between 1.5 to 10m). To calculate the value of k_2 , table – 2 of IS: 875 Part 3 shall be referred considering terrain category – 2.		
k_3 = Topography factor = 1.0		Clause 6.3.3.1
k_4 = Importance factor for the cyclonic region	= 1.0	Clause 6.3.4

Design Wind Pressure at any height:	$p_z = 0.6 \times V_z^2$	N/m ²	Clause 7.2
Note – As per IS: 875 (Part 3), pressure for buildings less than 10m high shall be reduced by 20% for evaluation stability and design of the framing.			Clause 6.3
Design Wind Pressure at any height	Maximum of, 1. $p_d = K_d \cdot K_a \cdot K_c \cdot p_z$, 2. $p_d = 0.70 p_z$	N/m ²	Clause 7.2
Where, K_d = Wind Directionality factor			Clause 7.2.1

Based on the above wind pressure and exposure of the building as per IS: 875 Part 3, further load calculations will be carried out with respect to profile of the structure.

Seismic Load (SL)

All structures & foundations shall be designed to resist the effects of earthquakes in accordance with IS 1893 (Part 1) for infrastructure building such as canteen etc. and IS 1893 (Part 4) for main plants, pipe rack, chimney, compressor building, Substation etc. and for elevated/ground supported liquid tank IS 1893 (Part 2). All structures shall be designed for Design Basis Earthquake (DBE). Detailed dynamic analysis shall be done based on the category of the structure.

Seismic Parameters:

Seismic design forces shall be determined based upon the following parameters.

DESCRIPTION / ITEM	APPLICABLE	REMARK
Seismic Zone	II	For Kansariguda, Rayagada, Orissa
Zone Factor, Z	0.1	As per Annexure A of IS1893(Part 4):2015

The Spectral acceleration coefficient for rock and soil sites, S_a/g , is considered as per Annexure B of IS1893 (Part 4):2015 for Type II (Medium soil) .

Category of str.	Importance Factor, I	Reduction Factor, R	Type of Analysis

As per Table 6 of IS1893(Part 4):2015	As per Table 3 of IS1893(Part 4):2015	As per Table-4 of IS1893(Part 4):2015	As per Cl 10 of IS1893(Part 4):2015

Item	Value	Reference
Design Spectrum	The design horizontal seismic coefficient (A_h) $= (Z/2) (S_a/g) / (R/I)$ Part	Clause No: 6.4.2 IS: 1893 (1)
Design Seismic Base Shear	$V_B = A_h W$	Clause No: 7.6.1 IS: 1893 (Part 1)

Contribution of permanent dead loads and live loads as specified in IS: 1893 (Part 1) shall be considered while calculating nodal masses. Imposed load on the roof shall not be accounted in the calculation of nodal masses.

Damping ratio coefficient shall be as per Cl 7.2.4 of IS1893-1:2016 as follows:

The value of damping shall be taken as 5 % percent of critical damping irrespective of the material of construction, namely steel, reinforced concrete, masonry, or a combination thereof of these three basic materials.

Design acceleration due to earthquake:

Horizontal acceleration values of the spectra are obtained from IS: 1893 Part 4. The horizontal seismic co-efficient $A_h = (Z/2) * (I/R) * (S_a/g)$. Seismic parameters Z, I, R and S_a/g are obtained as per IS1893(Part 4):2015.

Combination of responses due to multi component seismic acceleration:

Since lateral load resisting elements are oriented along two mutually orthogonal horizontal directions, the structures shall be designed for two component earthquakes (One horizontal and vertical). For Horizontal earthquake load, structure shall be designed for the effects due to full design earthquake load in one horizontal direction at a time, and not in both directions simultaneously.

When lateral load resisting elements are not oriented along mutually orthogonal horizontal directions, Structure shall be designed as per Clause No.6.3.2.2. I.S. 1893 Part.1.

Effect due to vertical earthquake shaking shall be considered as per clause No. 6.3.3.1 IS 1893 (Part 1); the design vertical force shall be calculated for vertical ground motion as detailed in clause No. 6.4.6 IS 1893 (Part 1).

When both horizontal and vertical seismic forces are considered, load combination specified in Clause No.6.3.4 IS 1893 (Part 1) shall be considered.

When response from the three earthquake components is to be considered (three directional earthquake ground shaking), the response due to each component may be combined using the assumption that when maximum response from one component occurs, the responses from other two components are 30% each of their maximum. All possible combinations of three components including variations in sign shall be considered. Refer clause no. 6.3.4.1 IS 1893 (Part 1) for set of combinations of earthquake load effect.

Storey Drift Limitation:

The storey drifts in any storey due to the minimum specified design lateral force, with partial load factor of 1.0 shall not exceed 0.004 times the storey height as per IS 1893 (Part 1), clause no. 7.11.1.

Regular and Irregular Configurations:

Buildings with simple regular geometry and uniformly distributed mass and stiffness in plan and in elevation, suffer very less damage than building with irregular configurations. All efforts shall be made to eliminate irregularities by modifying architectural planning and structural configurations. Limits on irregularities and special requirement given in Table 5 and 6 as per IS 1893 (Part 1) clause 7.1 should be followed.

Increase in permissible stresses:

When earthquake forces are included, the allowable bearing pressure in soils shall be increased as per Table 1 of IS 1893 (Part1), depending upon type of foundation and the type of soil. For determining type of soil for this purpose, soil shall be classified in 4 types as given in Table 2 of IS 1893 (Part1).

Hydro dynamic forces on liquid retaining structures:

Hydro dynamic forces exerted by liquid on tank wall during earthquake shall be considered in the analysis in addition to hydro static forces. These hydro dynamic forces, namely convective and impulsive forces are evaluated with the help of spring mass model of tanks. For load combination with seismic load, the amount of liquid considered in the tank shall be normal liquid level under service condition only. For tank full as well as empty conditions, tank shall be analysed as per IS 1893 (Part 2).

DYNAMIC AND VIBRATION LOADS

Vibration load means vibration force by heavy machinery i.e. TG, Mill, PA, SA & ID Fans, surge load of catalyst, etc. which act on the structure. Rotating parts shall be considered as vibrating mass. For rotating machinery, the Manufacturer's design criteria shall be considered.

PREVENTION FROM VIBRATION BASED ON DYNAMIC ANALYSIS

The foundation and structure of reciprocating machine and/or equipment having provable vibration shall be designed to prevent vibration and resonance through dynamic analysis. The design shall be in accordance with DIN 4024 or equivalent standard, and/or by the limitations stipulated by the equipment manufacturer.

The foundation for rotary machine without remarkable vibration such as less than 200 kW and minor sized reciprocating machine, etc., may be designed in accordance with the following static and experimental method:

- The weight of foundation concrete of minor sized reciprocating machine shall be more than 5.0 times of total machine weight with motor.

The weight of foundation concrete of centrifugal pump, etc. shall be more than 3.0 times of the total machine weight with motor.

Vibratory Loads: If equipment which causes vibration is supported on floors the effect of vibration will be considered together with the direct loads. In the absence of impact data from the equipment manufacturers design of supports for vibratory equipment may be made as per the following recommendations wherever applicable:

Motor and similar balanced rotating equipment:

- Vertical impact - 25% of the weight of the equipment

Resonance in Structure: Structures supporting equipment like motor and similar balanced rotating machines, reciprocating machines, jaw/cone crushers, roll crushers, ball mills, draft fans, pumps, vibrating screens and feeders, conveyer galleries, etc. will be designed to avoid resonant frequencies.

Structures supporting vibratory/reciprocating equipment will be designed so as to obviate occurrence of resonance. The ratio of applied frequency to natural frequency will not lie within the range 0.7 to 1.5.

Notional Horizontal Forces:

All practical structures contain imperfections such as lack of verticality and straightness of members. To take into account of this, the lateral load resisting system of all structures should be capable of resisting notional horizontal forces with a minimum of 0.5% of the factored dead and imposed loads applied at the same level as the vertical loads. A minimum notional lateral pressure of 0.5 kN/m² will be used if this gives a higher lateral load than 0.5% of factored dead and imposed load. This pressure should be applied to the enclosing elevation of the structure. No further partial load factor need be applied. The notional horizontal forces will be assumed to act in any one

direction at a time and will be applied at each roof and floor level or their equivalent. The notional horizontal forces need not be applied when considering overturning, pattern loads, in combination with other applied horizontal loads or with temperature effects. They need not be taken to contribute to the net reactions at the foundations. If the specified loads from overhead travelling cranes already include significant horizontal loads, the vertical crane loads need not be included when calculating notional horizontal forces.

Equipment Load (EL):

Equipment Loads can be divided in following types:

- Empty
- Operating
- Test
- Exchanger loading

Equipment loads along with attached piping and platform shall be taken as given in mechanical loading data.

Equipment dead load (ELe):

This shall mean the weight of equipment during erection and exclude the weight of internal fluids, solids within equipment, platforms, insulation and piping attached to the equipment. Equipment empty load shall be considered as per the details provided by the equipment manufacturer.

Equipment operating load (ELo):

This shall mean the weight of equipment during normal operating conditions including the weight of internal fluids, solids within equipment and all materials permanently attached to the equipment such as platforms, piping and insulation.

Equipment test load (ELt):

This shall mean the weight of equipment, piping during hydrostatic testing after erection / installation including the weight of water within the equipment piping and all materials permanently attached to equipment such as platforms, insulations and piping. Equipment test load shall be considered as per the equipment manufacturer's data.

Bundle Pull Loads

The bundle pull design load need not exceed the total weight of the exchanger. Bundle pull load need not be combined with wind or earthquake loads. Total bundle pull shall be considered on fixed pedestal alone. (Note: Unless otherwise not given by mechanical loading data sheet.)

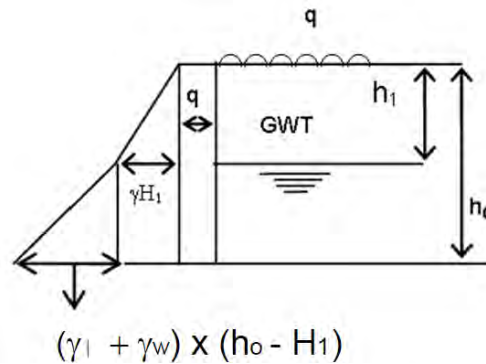
Bundle Pull shall mean the force needed to remove the tube bundle of heat exchanger. The pulling force shall be applied to a fixed point along the centre line of the bundle even when jacks are provided on the exchanger.

Total bundle forces for exchangers mounted at grade on concrete pedestals shall be resisted by the fixed support only. However, to maintain uniformity of sizing and reinforcement both pedestals shall be kept same.

Pulling force for exchangers mounted on the structure shall be applied to the framed structure and foundation when externally pulled.

Earth Pressure (EP)

Earth pressure at rest, acting on basement, trenches and pits shall be calculated from the following equations:



a) Above ground water level

$$P_v = \gamma h_0 + q \text{ (T/m}^2\text{)}$$

$$P_h = K_o P_v \text{ (T/m}^2\text{)}$$

b) Below ground water level

$$P_v = \gamma h_1 + q + \gamma_l (h_0 - h_1) + \gamma_w (h_0 - h_1) \text{ (T/m}^2\text{)}$$

$$P_h = K_o (\gamma h_1 + q + \gamma_l (h_0 - h_1)) + \gamma_w (h_0 - h_1) \text{ (T/m}^2\text{)}$$

Where,

P_v = Vertical soil pressure (T/m²)

P_h = Horizontal soil pressure (T/m²)

γ = Unit weight of soil (T/m³)

h_0 = Soil depth from grade surface (m)

q = Distributed load on ground surface (T/m²)

h_1 = Underground water level from grade surface (m)

γ_l = Submerged weight of soil in water (T/m³)

γ_w = Unit weight of water (T/m³)

K_o = Ratio of horizontal to vertical pressure = $\tan^2 (45^\circ - \phi/2)$

ϕ = Internal friction angle = 30°

Active and passive earth pressure acting on retaining wall shall be calculated from Coulomb's or Rankin's earth pressure equation.

Liquid Pressure (LP)

Liquid pressure shall be calculated by using the following equation:

$$P_1 = \gamma h_1 \text{ (T/m}^2\text{)}$$

Where,

P_1 = Liquid pressure (T/m²)

h_1 = Depth from Liquid surface (m)

γ = Unit weight of liquid T/m³

Load for Pipe and Cable Racks

For designing the pipe rack superstructure and foundation the following loads shall be considered.

- **Vertical loading:**

The vertical loading shall be as per the inputs provided by the piping, electrical & instrumentation discipline. In calculating the actual weight of pipe, the class of pipe, material content and insulation, if any, shall be taken into consideration. Insulation density shall be taken as per the inputs from piping discipline. In case of gas/steam carrying pipes, the material content shall be taken as 1/3rd

volume of pipe filled with water. The total actual weight thus calculated shall then be divided by the actual extent of the span covered by the pipes to get the uniform distributed load per unit length of the span. To obtain the design uniformly distributed load over the entire span, the above load shall be assumed to be spread over the entire span.

However, minimum loading for any pipe rack shall not be less than 1.25 kN/m^2 . In case, the calculated loading is higher than 1.25 kN/m^2 , this shall be rounded off to the nearest multiple of 0.25 (i.e. 1.50, 1.75, 2.0 kN/m^2)

In absence of data, pipe operating loads (other than gas & steam pipes) up to 300mm diameter shall be considered as 0.8 kN/m^2 (empty weight) & 1.7 kN/m^2 as water filled weight. Beyond 300mm diameter individual point loads as per piping inputs shall be considered.

Where consideration of uplift or system stability due to wind or seismic load is required, 60% of the design gravity loads as an "all pipes empty" load condition shall be considered.

- **Friction force:**

Friction loads caused by hot lines sliding across the pipe support during start up and shutdown are assumed to be partially resisted through friction by nearby cold lines. Therefore, in order to provide for a nominal imbalance of friction loads acting on a pipe support, a resultant longitudinal friction load is applied at each level.

If thermal loads (such as produced by temperature changes in piping, equipment and structures) results in friction between equipment and supports (exchangers) or piping and supports, the friction force shall be taken as the operating load on the support multiplied by the applicable friction coefficient μ given in the following table:

Surfaces	Friction coefficient (μ)
PTFE (Teflon) to PTFE (Teflon)	0.10
Stainless steel to PTFE (Teflon)	0.10
Steel to steel	0.30
Steel to Concrete	0.35

If the friction coefficient is unknown, a friction coefficient of **0.30** shall be considered.

- **Anchor and guide force (thermal load):**

The Anchor or Guide Forces in longitudinal and transverse directions shall be as per piping inputs. Steel beams subjected to above-mentioned horizontal anchor forces shall be designed for torsion arising from the anchor forces.

Alternately suitable framing arrangement shall be made to eliminate torsional effect on steel beam.

In the absence of loads provided by Pipe Stress & Support group, 7.5% and 10% of the pipe total weight shall be used as anchor load and guide load respectively acting at midspan of each bent. Pipe rack designs shall be rechecked, when actual pipe loads, friction and anchor loads are known from Plant Design & Piping group.

- **Cable Tray/Ducts and Walkway Loads:**

The estimated actual load from electrical trays and instrumentation ducts shall be considered at the specified locations, together with walkways, if provided. A minimum vertical cable tray load of 1.0 kN/m² per tray layer shall be used for electrical/instrument trays.

- **Wind Loads:**

To calculate wind load on the pipes in the transverse direction of pipe rack, a projected height equal to (diameter of largest pipe including insulation (m) +10% of width of pipe rack (m)) shall be considered. This projected height multiplied by the spacing of the portals shall be considered the effective area for calculating the wind load on each portal. The wind load in transverse direction shall be considered as point loads acting at the ends of the transverse beams.

Wind load on structural members shall be calculated in addition to the wind loads on the pipes as mentioned in the above point.

Force coefficient, "C_f" for wind load on pipes shall be considered as 0.7

Wind load on cable trays in transverse direction shall be calculated considering a projected height of (Height of tray (m) + 10% of the width of the pipe rack (m)). The force co-efficient, "C_f" for the cable trays shall be considered as 2.0.

- **Vibration Load:**

Frames, structures and foundations for machinery or equipment causing the vibrations shall be designed to limit vibrations to an acceptable level. It shall be designed such that whether they are independent or part of the building, it shall not only safely carry the loads for such items but also prevent resonance. Further, refer machine/ equipment foundation design criteria.

- **Temperature Load**

Maximum ambient temperature 46.6 degree centigrade and minimum ambient temperature 3 degree centigrade. Temperature analysis is required for the RCC structures having length longer than 45 m (as per clause 19.5.1 of IS456 :2000) without expansion joint and 180m for steel structures without expansion joint (Cl. 3.10.3 of IS 800).

- **Traffic Loads**

The design of slabs on grade and other structural elements shall consider the effects of vehicle loads. Slabs on grade accessible to heavy traffic such as large earthmoving machinery, shall as a minimum be designed for an axle load of 450 kN. Slabs on grade where access is limited from large machines shall be designed for an axle load of 100 kN. Construction loading shall be carefully considered and allowed for in terms of design load as well as in considerations of age (strength) of concrete subjected to these loads.

Bollards, fencing and other access limiting structures shall be installed for operational security, and control of construction access. Impact loads shall be assessed for specific risks and operational criteria. A commonly adopted design load of 25% of vehicle weight is recommended in the absence of other information.

In storage areas forklifts with a minimum total weight of 7.0 t and in areas only affected by forklift loads in case of repair purposes a minimum total weight of 3.5 t shall be considered. Traffic loads are tabulated below.

Description	In storage areas
Permissible total weight	70 kN
Nominal pay load	25 kN
Static load per axle	65 kN
Track width	1.0 m
Overall width	1.2 m
Overall length	3.4 m
Bearing area per wheel	0.2 mx 0.2 m
Uniformly distributed equivalent load	20 kN/m ²

Horizontal impacts on load-bearing columns and walls of buildings which are exposed to the danger of collision with road vehicles:

- **Impact by truck:** Horizontal loads shall be 100 kN at a height of 1.2 m above ground.

- **Impact by a fork-lift truck:** Horizontal loads shall be 5 times the permissible total weight at height of 0.75 m above ground.

The impact load need not be taken into consideration for the calculation of the foundations.

- **Thermal Loads**

Thermal expansion and contraction as a result of operational or ambient factors can result in restraint forces acting on the structure. These restraint forces are commonly due to the friction between the supporting structure and equipment and piping. The frictional restraint loading shall be assessed for the operational loads on the support, multiplied by an appropriate friction factor. Friction factors to be adopted for design purposes shall be as follows:

- Uncorroded steel to steel 0.30
- Steel to concrete 0.35
- Teflon to Teflon 0.10

- **Spillage Loads**

The design loading shall take account of potential spillage from conveyors and feeders where these are installed. The design shall allow for spillage loads of 5 kPa unless a higher value is required by the approved Design Standard. Walkways and platforms subject to spillage loads shall be designed for the live load or the spillage load, whichever is the greater.

- **Other Loads**

Following loads shall also be considered in the design:

- Pressure loads, such as resulting from the use of expansion joints in piping.
- Dynamic loads, such as resulting from rotating equipment and from surging fluids in piping and equipment. Data for performing dynamic calculations shall be obtained from equipment vendor.

- **Miscellaneous Loads**

Following possible additional loads shall also be considered in the design:

- Loads related to reaction and resistance forces of compensators.
- Loads related to nozzle forces from piping on vessels and equipment.
- Loads resulting from non-uniform foundation settlement.
- Loads related to collected leaked out liquids.
- Buoyancy due to groundwater or leaked out liquids.

- Reserves for future extensions.
- Loads related to creeping and shrinkage.

Load Combinations

Each element of a building or structure shall be provided with sufficient strength to resist the most critical effects resulting from the following combination of loads.

LOAD CONDITION	LOAD COMBINATION
FOR FOUNDATION SIZING:	
OPERATING	DL + LL
	DL + LL + ELo
	0.9*DL ± WL
	0.9*DL ± SL
	DL + LL ± WL
	DL + LL + ELo ± WL
	DL + ELo ± WL
	0.9 * (DL + ELo) ± WL
	DL + LL ± SL
	DL + LL + ELo ± SL
	DL + ELo ± SL
	0.9 * (DL + ELo) ± SL
ERECTION	DL + ELe ± WL
	0.9 * (DL + ELe) ± WL
TESTING	DL + ELt ± WL
	0.9 * (DL + ELt) ± WL
FOR CONCRETE DESIGN: LIMIT STATE OF COLLAPSE	
OPERATING	1.5 * (DL + LL)
	1.5 * (DL + LL + ELo)
	1.2 * (DL + LL + ELo ± WL)
	1.5 * (DL + ELo ± WL)
	0.9 * (DL + ELo) ± 1.5 * WL
	1.2 * (DL + ELo + LL ± SL)
	1.5 * (DL + ELo ± SL)
	0.9 * (DL + ELo) ± 1.5 * SL
ERECTION (considering 10 years wind)	1.5 * (DL + ELe ± WL)
	0.9 * (DL + ELe) ± 1.5 * WL

LOAD CONDITION	LOAD COMBINATION
TESTING (considering 10 years wind)	1.5 * (DL+ ELt ± WL)
	0.9 * (DL + ELt) ± 1.5 * WL
FOR CONCRETE DESIGN: LIMIT STATE OF SERVICEABILITY	
SERVICEABILITY	1.0 * (DL + LL)
	1.0 * (DL ± WL)
	1.0 * (DL+ ELo) + 0.8 * (LL ± WL)
	1.0 * (DL+ ELo) + 0.8 * (LL ± SL)
FOR STRUCTURAL STEEL DESIGN: LIMIT STATE OF STRENGTH	
LOAD CONDITION	LOAD COMBINATION
OPERATING	1.5 * (DL + LL + ELo)
	1.5 * (DL + ELo+WL)
	1.2 * (DL + LL + ELo ± WL)
	0.9 * (DL + ELo) +1.5 * (± WL)
	1.5 * (DL + ELo + SL)
	1.2 * (DL + ELo + LL ± SL)
	0.9 * (DL + ELo)+1.5 * (± SL)
ERECTION	1.5 * (DL + ELe ± WL)
	1.5 * (DL + ELe)
	1.2 * (DL + LL)
	0.9 *DL + 1.2*LL
TESTING (considering 10 years wind)	1.5 * (DL+ ELt ± WL)
	1.5 * (DL + ELt)
EARTHQUAKE LOAD (APPLICABLE AS PER CL. 12.2.3 OF IS800:2007)	1.2 * (DL + ELo) + 0.5 LL ± 2.5 SL
	0.9 * (DL + ELo) ± 2.5 (SL)
FOR STRUCTURAL STEEL DESIGN: LIMIT STATE OF SERVICEABILITY	
SERVICEABILITY	1.0 * (DL + LL + ELo)
	1.0 * (DL + WL)
	1.0 * (DL + SL)
	1.0 * (DL + ELo) + 0.8 * (LL ± WL)
	1.0 * (DL + ELo) + 0.8 * (LL ± SL)

Abbreviations

DL= Dead Load

LL= Live Load

WL= Wind Load

SL= Seismic Load

Elo=Equipment Load Operating

Ele= Equipment Load Erection

ELt= Equipment Load Testing

Following points shall be noted while doing the load combinations:

- For crane load combinations clause no. 6.4 of IS:875 part 2 shall be followed.
- Earthquakes are not likely to occur simultaneously with maximum wind.
- Erection and testing will not be done in full wind speed conditions.

For loading conditions applied to two or more items of equipment supported by a common structure, variable effects such as weight of contents, wind load (when considering shielding) and thermal reactions of piping shall be based on compatible conditions.

When hydrostatic pressure testing of equipment is required at site and more than one vessel, etc. is supported by one structure, the structure shall be designed on the basis that only one vessel will be tested at any one time, and that the others will be empty.

Maintenance loads shall be considered in design, but shall be limited to reasonable combination of operations, i.e.

- a) In designing a structure with more than one maintenance load, consideration shall be limited to one crane or trolley load.
- b) In designing skeleton frame-type structures, maintenance loads shall be combined with reduced wind effects, i.e. 50% wind.

SERVICEABILITY

Limiting Deflection

- The limiting permissible horizontal deflection for steel structure/building shall be as specified in Table-6, IS 800: 2007.
- The limiting permissible vertical deflection for RCC members shall be as per IS 456,

The storey drift in any storey due to the minimum specified design lateral force, with partial load factor of 1.0 shall not exceed 0.004 times storey height. For RCC structures, under transient wind load the lateral sway at the top shall not exceed 0.002 time the height of the building.

Plant Buildings Clad or Unclad (without cranes)

Sway due to wind shall not exceed the lesser of:

- 1) (Building frame center-to-center of columns) / 250
- 2) Height / 200

APPLICABLE SOFTWARE

- STAAD.Pro
- AutoCAD
- MS Office
- Acrobat writer or similar
- TEKLA
- REVIT
- Navisworks

8.1.7 DESIGN PHILOSOPHY OF RCC & STEEL STRUCTURE

Type of cement

Cement used in all types of concrete work (RCC, PCC & Plum Concrete) shall be Ordinary Portland Cement of Grade 43 & Grade 53 as per IS 269 respectively (U.N.O) or Portland Pozzolana cement conforming to IS 1489 or Sulphate resistant Cement conforming to IS12330.

Concrete Mix - Reinforced Cement Concrete (RCC) & PCC:

- Unless noted otherwise reinforced concrete conforming to IS: 456 shall be used with 20mm downgraded crushed stone aggregate. The site is assigned “Severe” environmental exposure condition in view of coastal environment.
- The minimum grade of concrete shall be M30 for all structures unless noted otherwise.
- Plain and lean cement concrete of grade M10 shall be provided under all RCC foundations.

a) Environmental exposure condition for all concrete	Severe

i) Grade of plain concrete used as Blinding Concrete, Lean Concrete, Mud mat,	M10
ii) Grade of plain concrete used as structural concrete	M20
iii) Grade of reinforced concrete for Super structure and substructure including Piling	M30
iv) Grade of plain concrete used as structural fill below foundations	M15
b) Grade of concrete for RCC flooring at plinth / paving / grade slab	M25

Reinforcement bars

Reinforcement shall be High Yield Strength Deformed (HYSD) Thermo Mechanically Treated (TMT) steel bars of grade Fe 500D, conforming to IS: 1786 shall be used.

Grouting

Non-shrink free flow ready mix grout shall be used for under pinning work below base plate of columns. Grouting for equipment foundations shall be as per recommendations of equipment supplier.

Type and grade of grouting for structural columns and equipment bases shall be as indicated. Crushing strength of the grout shall generally be one grade higher than the base concrete for all bases except major equipment foundations. In case of major equipment bases it shall be minimum 2 grade higher than foundation concrete grade. Minimum grade of grout shall be M 40.

Nominal thickness of grouting shall be at least 50mm for building columns and pedestals of major equipment. For secondary posts, stair and ladder base, etc. grouting shall not be less than 25mm thick.

Minimum cover to main reinforcement

Minimum clear cover to reinforcement shall be considered as followed:

Foundation Slab/ Base Slab	Bottom	75mm

	Top & Sides	50mm
Pile Cap	Bottom	100mm
	Top & Sides	50mm
Piles	Sides	75mm
Columns and Pedestals	All sides	50mm
Beams (Plinth beams and other beams)	Top & Bottom	50mm
	Sides	30mm
Slab (Roof slab, floor slab, etc.)	Top & Bottom	25mm
Retaining walls and pit walls	Outside face in contact with earth	50mm
	Free face	40mm
Liquid retaining structure	Face in contact with liquid	50mm
	Face in contact with earth	50mm

Minimum cover to main reinforcement shall be maximum of Table No.16 & table No.16A (Severe condition) of IS 456 unless noted.

Minimum cover to the foundation bolts

Minimum distance from the centre line of foundation/anchor bolt to edge of the pedestal shall be the maximum of the following:

- Clear distance from the edge of the base plate/base frame to the outer edge of the pedestal shall be minimum 50mm.
- Clear distance from the face of pocket to the outer edge of the pedestal shall be 75mm.
- Clear distance from the edge of the sleeve or anchor plate to the edge of pedestal shall be 75mm.

- Minimum edge distance from concrete face to center of bolt shall be the concrete cover as per project standard for un-torqued bolts and 6 x bolt Dia or cover whichever is more for torqued bolts. The anchor plate shall have minimum concrete cover in all cases.

Minimum thickness of structural concrete elements

The following minimum thickness shall be followed:

RCC work	Minimum thickness (mm)
Footings	300
Precast trench Cover	75
Floor/ Roof slab walkway and canopy slab	150
Cable/ pipe trench and base slab	150
Parapet	100
Liquid retaining/ leak proof structure wall and base slab	175
Underground pit/ Reservoir (below ground water table) Walls & Base Slab.	200
Underground pit (above ground water table) Walls & Base Slab.	200

Minimum height of pedestals

The minimum projection of pedestals supporting any steel structure/stanchion bases shall be 300mm for structures and that for indoor structure it shall be 150mm above the high point of pavement/ finished grade/finished floor level whichever is higher. The maximum projection of pedestals for staircase/ladder shall be 200mm.

Minimum bar spacing

Minimum and maximum bar spacing for Foundations, Slabs, Stirrups for beams, ties for columns, pedestals, Walls etc. shall be 100 mm and 300 mm respectively. Bar spacing shall be provided in multiples of 25 mm.

Foundations

General

Pressure of soil and the safe bearing load of piles shall be increased as permitted in IS: 1893 (part 1).

Uplift of foundation

- In the design of underground pits, sumps, trenches, tanks etc. the upward pressure of water, where applicable, shall be taken as the full hydrostatic pressure applied over the whole area.
- Ground water table shall be assumed to be at ground level for calculating the hydrostatic pressure. Any other upward load shall also be included in the design.
- No Loss of Contact is permitted.

Stability of foundations

Foundations shall be checked for stability against overturning, sliding & uplift. While checking stability, the following shall be considered.

Stability against Overturning: Minimum Stability Ratio i.e., Factor of safety required against overturning (MR/MO) both being calculated at the leading edge of the foundation considering all forces and moments. Overturning moment shall be restricted to the worst load case combination. Allowable factor of safety against overturning shall be considered as 1.5 for tank foundation.

Stability against Sliding: The resistance to sliding shall be calculated from the following, where applicable: -

1. Foundation / soil friction
2. Passive soil resistance to the side of the foundation
3. Passive soil resistance of soil bearing against keys

Type of Structures	Minimum factor of safety against overturning		Minimum factor of safety against sliding		% Weight of Overburden over projected plan area of footing
	DL+LL With wind or seismic	DL+LL Without wind or seismic	DL+LL With wind or seismic	DL+LL Without wind or seismic	

All Buildings/ Structures/ Equipment in Units	1.4	1.2	1.4	1.4	100
Pipe Rack (Offsite)	1.4	1.2	1.4	1.4	50
Flood Light Mast	1.4	-	1.4	-	50
Retaining Wall	1.4	1.2	1.4	1.4	100

Stability against Uplift: Minimum factor of safety against UPLIFT shall be 1.2 for all structures. (Note: In case of sumps, lining weight shall not be included). Beneficial load of backfill can be included only in circumstances where it will never be removed.

Tank Foundation:

- Type of foundation and pertinent details thereof to be adopted for tanks (viz. ring wall foundation) shall be designed as per tank loading data. Tank foundations shall be adequately designed and constructed for tank inside dyke. Tank foundations shall be designed to sustain the forces at the tank bottom within permissible settlement under operation & hydrostatic test condition. The tank bottom shall be covered with asphalt sand anticorrosive layer.
- The tank settlement (at tank centre and periphery) shall be evaluated as per tank diameter and height of the tank for hydro-test condition as per available soil data and foundation system adopted. The tanks resting on sand pad, foundation shall be subjected to slow stage loading during hydro testing.
- The following are the permissible settlements for tank foundations:
Differential settlement at diagonally opposite points during hydrotesting shall be as per requirements indicated in API 650 Clause.7.3.6.6.

For gravity loading, allowable net bearing capacity of soil shall be based on the following settlement criteria:

Tank Type	Allowable settlement (mm)
Ring Wall Foundations for Floating roof storage Tanks (edge settlement)	50mm

Ring Wall Foundations for Cone roof / Dome roof storage tanks (edge settlement)	50mm

Dyke wall

- The dyke wall around the tanks shall be RCC wall. The dyke wall shall be designed with proper foundation as per design requirement.
- Pipes crossing dyke wall from tank farms shall be in sleeves & are concealed with hydrocarbon resistant material.
- At least two stairs / crossovers shall be provided at each dyke for approach to tank farm from different directions as per general arrangement drawing.
- Appropriate crossovers shall be provided on firewalls at suitable locations.

Design Criteria for Liquid Retaining Structures

(IS: 3370 (Part 1 & 2) – 2021 & IS: 456 -2000)

- Check for buoyancy effect when empty tank is totally submerged in saturated soil up to ground level. Factor of safety against uplift / buoyancy shall be 1.2. (CL.7.2 b of IS3370 (Part1):2009)
- All liquid retaining/storage/conveying structures shall be designed assuming liquid up to full height of wall irrespective of provision of any overflow arrangement.
- The design shall be Limit state design as per Cl.4.4 of IS3370 (Part2):2009
- Calculation of Crack width due to Temperature and moisture shall be done as per Annex A of IS3370 (Part 2):2009
- Calculation of Crack width in mature concrete shall be done as per Annex B of IS3370 (Part2):2009
- For particularly aggressive environment, such as the 'severe' category, the assessed surface width of cracks should not in general, exceed 0.1 mm. (CL.35.3.2 of IS456:2000)

Equipment foundation

- Mechanical equipment foundations shall satisfy the requirements of IS: 2974 and any other parameters as per machine vendors.
- Foundation block extensions supporting auxiliary equipment requiring rigid positioning with respect to the main equipment shall be detailed to act integrally with the block.
- Design shall be carried out such that amplitude of vibration during normal operation or other critical conditions shall not exceed the allowable amplitude specified by the equipment manufacturer or IS: 2974 (part 4), whichever is more stringent.

- The above design criterion may be omitted for centrifugal pumps and fans and other minor rotating equipment weighing less than 1 ton or if the mass of the rotating parts is less than 1/100th of the mass of foundation installed directly on concrete foundation provided that the weight of foundation is not less than 3 times of the equipment weight. In such cases, dynamic analysis is not necessary.

Machine foundations shall satisfy the following requirements:

- a) Minimum reinforcement as per requirements of IS: 2974 (part 4) shall be provided unless required otherwise by design.
- b) All units of the foundation system, except foundation raft shall be provided with symmetric reinforcement on opposite faces, even if not required by design considerations.
- c) No common raft shall be designed for set of machines.
- d) The soil stress below foundations under dead loads shall not exceed 80% of the allowable soil bearing capacity, or safe load on pile, for static loading. The eccentricity of load and foundation area shall be less than 5% for block foundation and 3% of frame foundation.

Design Of Structural Steel

Specific Design Data

The design of structural steelwork shall incorporate loading conditions applicable to the specified equipment being supported. Temporary loading conditions that may occur during equipment erection shall also be considered.

Type of construction

- a) This design basis is directed mainly to the use in structures of hot rolled steel sections, plates and tubular shapes.
- b) Fabrication of structural steelwork by shop welding is preferred. Field connections shall be bolted as far as possible.

Material

Structural Steel:

Rollled steel sections and plates up to 20mm thickness will be semi killed/killed, and conform to IS-2062:2006 Grade E-250(Fe-410W), Quality A. Plates above 20 mm thickness will be killed and conform to IS2062:2006 Grade E-250(Fe-410W), Quality B.

Higher grade steel [E300 / E350] can also be adopted for economy in design, meeting serviceability requirements. UB/ UC/ IPE/WPB sections, now rolled in India, will also be used in addition to Indian Sections [MB/MC]

Chequered plates will conform to IS:3502/ E-250-A, IS-2062:2006. All plates 40mm thick and above used in crane girders and similar dynamically loaded structures will be of UT grade. Plates below 40mm thick for such application will be ultrasonically tested. Crane rails will conform to IS: 3443. Steel Tubes will conform to grade Yst 310 of IS: 1161. Hollow steel sections will be hot formed and will conform to Grade Yst 310 of IS: 4923. All structural steel will be free from rust, scales, laminations, cracks, fissures and other surface defects.

To minimise wastage, wide plates (2000mm to 2500mm wide) are preferable for crane girders over 2000 mm depth.

Abrasion resistant steel liner plates will be TISCRAU upto 12mm thick and SAIL HARD for more than 12mm thick.

Bolts And Nuts:

All bolts and nuts will conform to IS:1363 or IS:1364 as applicable. Nuts will have property class conforming to IS:1367 compatible to the property class of the mating bolts. High strength structural bolts and nuts will conform to IS: 3757 and IS:6623 respectively.

Washers:

Plain washers will conform to IS:2016 unless otherwise specified. Each nut will be provided with one washer. Taper washers conforming to IS:5372 and IS:5374 will be used for channels (MC) and I-beams

(MB) respectively. Washers for high strength structural bolts and nuts will conform to IS:6649. An additional double coil helical spring washer conforming to IS:6755 will be provided for bolts carrying dynamic or fluctuating loads and those in direct tension.

Roof And Side Sheeting:

In general roofs and walls of structural buildings will be covered with pre-colour coated galvanized profiled sheets of 0.5 TCT and matching FRP translucent or polycarbonate transparent sheets of minimum 2mm thickness on walls. Additional FRP/polycarbonate sheets of minimum 2mm thickness on roofs matching with the profile of the pre-colour coated sheets, will be used for buildings. Suitably designed safety guard, made of structural steel will be used below FRP/polycarbonate sheet on roof in order to avoid accident due to breakage of FRP/polycarbonate sheets during roof maintenance.

Roof and side walls of conveyor galleries will be covered (as per process requirement) with Pre-Colour Coated sheets with a provision of gap of 300 mm below roof. Side cladding will be terminated at 150 mm from top of floor level for ventilation.

Adequate provision for natural light inside conveyor gallery will be made through side walls by providing translucent sheets (FRP sheets as per IS: 12866-latest). Every sixth sheet on side wall will be FRP sheet of thickness 3mm and will be staggered on opposite wall.

Minimum Thickness of Metal:

The minimum thickness of structural steel elements will be in accordance with IS 800 and subject to following minimum requirements.

Gusset plate	:	8 mm
Base plate	:	20 mm
Stiffener plate for base plates	:	8 mm
Flange plates for plate girder	:	20 mm
Web plates for plate girder	:	10 mm
Stiffeners for webs of plate girder	:	8 mm
Bracing member	:	ISA 50 x 50 x 6
Handrail post	:	32NB (medium)
HR top rail	:	32NB (medium)
HR mid-rail	:	32NB (Medium)
HR toe guard	:	FS 75 x 6 mm
Chequered plates	:	6 mm o/p
Grating flats	:	5 mm

Minimum thickness of structural members other than gratings and chequered plate directly exposed to weather and inaccessible for painting and maintenance will be 10 mm.

Following norms may be adopted while selecting the thickness of gussets in braced and latticed members.

The selection of thickness of gusset shall be based on following guidelines

SI No	Unfactored force in member-P kN		Gusset Thickness
1	$P \leq 200 \text{ kN}$	:	8 mm
2	$200 \text{ kN} < P \leq 400 \text{ kN}$	:	10 mm
3	$400 \text{ kN} \leq P \leq 750 \text{ kN}$	:	12 mm
4	$750 \text{ kN} \leq P \leq 1000 \text{ kN}$	:	16mm
5	$P \geq 1000 \text{ kN}$	:	20mm

Sealed tubes and sealed hollow box sections used for external construction exposed to weather will not be thinner than 4mm and for construction not exposed to weather will not be thinner than 3.2mm. Where structures are not readily accessible for maintenance the minimum thickness will be 5mm.

Structural Design

- The structural design shall be in accordance with IS 800 by limit state design. While designing the structure, attention should be given to Section 12 of the IS 800 dealing with design and detailing for earthquake loads.
- The structural column and connections shall be checked for additional load combinations with seismic load as given in Cl. 12.2.3 of IS 800.
- For special concentrically braced frames (SCBF) the compressive and tensile strength of bracing member should comply with Cl. 12.8.2.3 and Cl. 12.8.2.4 of IS 800.
- Top support beams of pipe rack frames shall be framed into the columns, with the columns extended above the top of the beam so that stubs are provided where future expansion is required. The length of the stub shall not be less than 250 mm.
- Clearance from Piping and Equipment: Framing members, including column and bracing, should clear vessels, piping, and / or related attachments, insulation and supports by a minimum 75 mm both vertically and horizontally.
- Plan bracing members which are part of seismic load resisting system (SLRS) shall be plastic sections. Tee section (or cut Tee section from I-section) shall be preferred for plan bracings. Bracings which are not part of SLRS need not be plastic sections. For definition and details of SLRS refer to Section 1 of Annexure-1. Tee section Interaction ratio shall be limited to 0.7 to accommodate the effect of additional moment due to eccentricity.

- g) A-Bracings or inverted A-Bracings are to be avoided. When A-bracings or inverted A-bracings are provided, they shall be designed as per AISC 341. As per code, when these bracings are provided, zipper columns or strengthening of horizontal beam will be required.
- h) Unbraced length of the X-brace in each orthogonal direction may be taken as half the entire length of the brace provided the two segments of each diagonal are col-linear and there is flexural continuity at the bracing intersection.

CONNECTIONS

Welding will be used for shop fabrication and joints. For site connections, welding or high strength bolts will 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 will be used. IS: 816 and IS: 9595 will be followed for welding of structures.

All normal bolted connections will have bolts of minimum 16 mm dia. Erection bolts will be black bolts of minimum 16 mm dia.

The minimum size of fillet weld will be 6 mm. Main structural elements will be welded continuously.

Connections for structural steel members will be designed to withstand the following minimum forces, or the actual force as per analysis. Actual design forces will be indicated in the design drawing.

Structural Member	Section Type	Design force for Connection
Truss members	All sections	Full tensile strength of the member
Horizontal Bracing member	All sections	Full tensile strength of the member
Vertical bracing member	All sections	Full tensile strength of the member
Beam – shear connection	Rolled section	60% of web shear capacity of the beam
	Built-up section / Plate girder	80% of web shear capacity of the beam
Beam – moment connection	All sections	Full moment capacity of the beam

Column – splices	All sections	All work will be full strength. Field splicing will be done with web and flange cover plates for full strength. In 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.

COLOUR COATED METAL SHEETING WORK

For floor decking, troughed permanently colour coated metal decking sheet, shall conform to the following.

Steel with zinc coated to class Z275 with minimum bare metal thickness of 0.8mm of grade G250 as per AS1397 / grade SS255 as per ASTM A653M / grade S250GD as per EN 10326.

For roofing & side cladding, troughed permanently colour coated sheets (internal or external) shall conform to the following.

Steel with aluminium-zinc alloy coated to class AZ150 with minimum bare metal thickness of 0.5mm of grade G350 as per AS1397 / grade SS340 class 4 as per ASTM A792M / grade S350GD as per EN 10326.

PAINTING

Following painting system shall be adopted for structural steel works:

PAINTING OF STEEL SURFACES (OTHER THAN THOSE EMBEDDED IN CONCRETE)

Painting of main Structural steel considering Polluted Coastal atmosphere for the proposed plant shall be with paints as per the following:

<u>Station Building & Mill & Bunker Structure, Boiler Supporting & ESP Structures, Miscellaneous Covered Structures</u>			
Primer Coat	Inorganic Zinc silicate primer	minimum 1x75 = 75 micron Dry Film Thickness - DFT	300 micron
Intermediate (Under) coat	High build micaceous iron oxide epoxy (HB MIO Epoxy)	minimum 1x75 = 75 micron DFT	
Final (Top) Coat	High build Epoxy Poyamide (Pigmented)	minimum 2x75 = 150micron DFT	
Intermediate (Under) coat	HB MIO Epoxy	minimum 2x75 = 150 micron DFT	
Final (Top) Coat	High build Epoxy Polyamide (Pigmented)	minimum 2x75 = 150 micron DFT	
<u>Pipe & Cable Racks and Miscellaneous Open Structures</u>			
Primer Coat	Inorganic Zinc silicate primer	minimum 1x75 = 75 micron DFT	250 micron
Intermediate (Under) coat	HB MIO Epoxy	minimum 1x75 = 75 micron DFT	
Final (Top) Coat	Aliphatic Polyurathene UV Resistant	minimum 2x50 = 100 micron DFT	

SURFACE PREPARATION

The surfaces shall be blast cleaned to near white metal surface (Sa 2 ½) i.e., 2nd quality (requiring at least 95% of the surface completely cleaned) as given in BS 4232. For blast cleaning shot blasting shall be used.

PAINTING OF SEAL PLATES, STEEL DOORS & WINDOWS, VENTILATORS, LOUVERS, ROLLING SHUTTERS, GRATINGS & HANDRAILS

- (i) Primer: - Red oxide zinc chromate primer conforming to IS 2074, (minimum 2x35=70 micron DFT)
- (ii) Finish (Top) coat: - Synthetic Enamel Paint (conforming to IS 2933) (minimum 2x25= 50 micron DFT)
- All rust and scales shall be removed by scrapping/rubbing by emery paper or by brushing with steel wire brushes. All dust and dirt shall be thoroughly wiped away from the surface. If the surface is wet, it shall be dried before priming coat is undertaken.
- All gratings shall be cleaned to Sa 2 ½ finish of Swedish standard SIS - 05 - 5900 and shall be hot dip galvanised at the rate of 610 Gms / Sq. m. All handrails and ladders shall be galvanised at the rate of 610 Gms / Sq.m as per IS : 4736.

PAINTING OF STEEL SURFACES EMBEDDED IN CONCRETE

- For the portion of Steel surfaces embedded in Concrete, the surface shall be prepared by Manual Cleaning and provided with Primer Coat of Chlorinated Rubber based Zinc Phosphate Primer of Minimum 50 Micron Dry Film Thickness (DFT).
- All threaded and other surfaces of foundation bolts and its materials and during execution of civil works, the dried film of coating shall be removed using organic solvents

GUIDELINES FOR STAIRCASE, LADDERS, HANDRAIL & GRATING

- Steel staircases for main approaches to operating platforms shall have channels provided as stringers with minimum clear width of 700mm and slope not exceeding 45°. Treads shall be minimum 300mm wide made of grating (with suitable nosing) spaced equally to restrict the riser between 150 to 200mm. Staircase head room height shall be minimum 2.1m.
- Ladders shall be provided with safety cages when the top of the ladder is more than 3.0 m above the landing level. Safety cages shall start 2.1 metres above the lower landing level. Ladders shall be of 450mm clear width with 20mm diameter MS rungs spaced at 300mm (maximum). Ladders shall preferably be vertical. In no case shall the angle with the vertical exceed five degrees.
- MS Gratings shall be minimum 25 mm deep and maximum span of grating shall be 1200mm. Deflection shall not be more than 6mm or span/200, whichever is lesser.
- For RC staircases, tread shall be 300mm without nosing and riser shall be 150mm. Staircase head room height shall be minimum 2.1m.

- Maximum number of steps per flight shall not be more than 12. Only in exceptional cases, the maximum number of risers may be limited to 15.
- Tread and Risers shall not be varied within a flight.
- To the extent possible same rise and tread shall be maintained for all the flights in the staircase.
- The stairway shall be cleared of pipe, ducts and cable routing.
- Stair landing width shall not be less than width of stairs.
- In case of steel grating for steps, deflection due to point load at edge shall be checked particularly for parallel type grating.
- Providing risers in landing area shall be avoided.

8.1.8 Standard Drawings for structural steel

Standard drawings will be provided to the successful bidder for their final detail design and drawings.

8.1.9 Standard Drawings for concrete works

Standard drawings will be provided to the successful bidder for their final detail design and drawings.

8.1.10 Conflict between codes and standards and specification and vendor drawings/ documents

Criteria whichever is stringent to be followed

CHAPTER-9

PRE-OPERATIONAL AND START UP REQUIREMENTS

9.0 PRE-OPERATIONAL AND START UP REQUIREMENTS

The pre-operational commissioning & acceptance tests shall be carried out according to the procedures in conformity with internationally accepted standards, codes upon approval from Owner / Owner's Engineer.

The following acceptance testing shall be carried out by the Bidder after mechanical completion as laid out in this TECHNICAL SPECIFICATION:

- a. Pre-operational check and Initial Functional Tests
- b. Functional Tests (Shall be performed with blend of coal and various proportion of biomass)
- c. Reliability Run
- d. Performance Tests to prove Plant Performance Guarantees (Shall be performed with 100% Coal)
- e. Any other Tests to prove guarantees such as emissions guarantees, material consumptions and noise levels.

9.1 MECHANICAL COMPLETION

The pre-operational and check out tests as well as the initial functional tests shall be successfully completed prior to the Notice of Mechanical Completion to the Owner as a pre-condition to carrying out the Performance Tests for any unit.

9.1.1 Pre-operational and Checkout tests

The objective of the pre-operational and check out tests is to demonstrate that the construction phase of the systems and equipment comprising the Works are complete and that the applicable unit is ready for the turnover to the start-up and commissioning staff. All relevant pre-operational and checkout tests shall be performed to satisfy this objective. Such tests shall include, but not be limited to, the following:

SL. NO	DESCRIPTION
1.	Inspection of systems for completeness
2.	Hydrostatic tests
3.	Lockout / Tag out and Authority control procedure
4.	Power Receiving check and tests
5.	Tests on all inter—tripping circuits between the Power Facility and the transmission System (test procedure shall be specific)
6.	Tests on all communications and RTU dispatching system
7.	Switchgear checks and tests

SL. NO	DESCRIPTION
8.	Calibration of plant instruments (test procedure shall be specific)
9.	Valve sequence checks
10.	Alignment checks (test procedure shall be specific)
11.	Motor phase rotation checks and tests
12.	Circuit continuity checks
13.	Relay/computer sequence checks and tests (test procedure shall be specific)
14.	Interlock checks and tests (test procedure shall be specific)
15.	DCS checks and loop tests (FAT/SAT check lists are sufficient)
16.	Boiler protection interlocks (fuel pressure drop, drum level drop etc.) (test procedure shall be specific)
17.	Turbine protection interlocks. (Turbine over speed, vacuum drop etc.) (test procedure shall be specific)
18.	Generator protection interlocks (loss of excitation etc.,) (test procedure shall be specific)
19.	Safety trip checks and tests (test procedure shall be specific)
20.	Pressure Relief / Safety Valves Shop Test Report Prior to Installation
21.	Power Transformer checks and Test
22.	DC checks and test (test procedure shall be specific)
23.	UPS checks and Tests (test procedure shall be specific)
24.	Station Clock checks
25.	Air system checks and tests
26.	Coal handling system checks and tests
27.	Underground Earth System check and measurements
28.	Package Equipment Test (test procedure shall be specific)

9.1.2 The hydrostatic test shall include all the pressurized parts of the boiler, the steam/water piping, heat exchangers and condensers, and shall be carried out in the presence of the Owner and representatives of relevant Public Sector Entities and Insurance Agencies.

9.1.3 The test procedure shall be in accordance with the Contract and all applicable, internationally accepted codes and standards, and Good Engineering Practice. The test procedures to be submitted for the pre-operational and Check-out tests need not be very specific; rather, a general overview and description of the tests to be performed will be sufficient, unless otherwise indicated in the table above.

9.2 INITIAL FUNCTIONAL TESTS

9.2.1 Initial functional testing of all essential supporting auxiliary systems and common services shall be completed before first ignition of each boiler including:

- Fire protection tests
- Communications systems
- De-mineralized water quality test
- Fuel oil supply system.

9.3 FUNCTIONAL TESTS

9.3.1 The functional tests shall be successfully completed, and it shall be proven that each unit is capable of safe operation as a pre-condition to carrying out the Reliability Run for any such unit.

9.3.2 The test procedures to be submitted for the functional test need not be very specific; rather, a general overview and description of the tests to be performed shall be sufficient.

9.3.3 All systems and components of each unit shall undergo functional testing that is witnessed by the Owner during initial operation to verify satisfactory operation and compliance with the performance guarantee parameters.

9.3.4 The functional tests may commence following the issuance to the Owner of Notice of Mechanical Completion. All such functional tests shall be documented to provide a “base line” condition of the Power Facility for use of the Owner’s O&M staff. At the same time, a record of any design or construction defects or deficiencies that need to be corrected shall be made. The document templates shall be approved by the Owner in accordance with the Contract.

The functional tests shall include:

SL. NO	DESCRIPTION
1.	Safety valve testing
2.	Safety trip
3.	Turbine Governor operation, low lube oil pressure tests and over speed tests
4.	Generator open and short circuit test including Generator heat runs test
5.	Automatic voltage regulator tests
6.	Load rejection tests
7.	Unit control tests (Automatic boiler control test)

SL. NO	DESCRIPTION
8.	Unit turn down tests (for coal firing)
9.	Function group testing
10.	House Loading test (Island Mode test)
11.	Generator Synchronizing
12.	DCS tuning
13.	Load Vibration Tests
14.	Unit Cold Start-Up Tests
15.	Unit Hot Start-Up tests
16.	Ramp rate tests
17.	Steady operation at 50% Load (or minimum load)
18.	Steady operation at 75% load
19.	Steady operation at 100% MCR
20.	Unit shutdown test
21.	Transient Operation and Process Tuning (ex: Turbine / Boiler follow)
22.	Noise Measurement
23.	Liquid Effluent Survey
24.	Emergency Change-over of Auxiliaries (except out in standby BFP pump)
25.	Flue Gas Emission Monitoring and test
26.	AGC test with dispatch center
27.	Switchgear operational tests
28.	Voltage phasing checks
29.	Tests on all inter-tripping circuits between the Power Facility and the transmission system
30.	Turbine bypass operation
31.	Other tests required to demonstrate the Power Facility safety and shutdown systems.

9.3.5 Emission testing is required to verify that each unit will be in compliance with all environmental requirements. Emissions testing shall be completed prior to commencing the Performance Guarantee Tests. Gaseous emissions tests shall be conducted in the stack by a qualified third party. The applicable Air Emissions Testing Procedure will be used in the determination of test results. In the event that such testing indicates a greater amount of air emissions than the guaranteed amounts the Contractor shall submit a plan and schedule to Owner for approval, outlining the corrective measures necessary to bring the air emissions in compliance with the guaranteed values. Contractor may then proceed with the required Performance Guarantee

Tests. The testing may proceed provided that the air emissions do not exceed the levels achieved during the Emissions Test and that all the equipment in the unit or plant (as the case may be) shall be operated as described in the applicable testing procedures during such testing.

9.4 RELIABILITY RUN

- 9.4.1 After the functional tests, the plant will be on reliability operation. During the reliability run, the Bidder will be allowed to make minor adjustments as may be necessary, provided that such adjustments do not interfere with or prevent the commercial use of the plant or result in significant reduction of output or increase of the heat rate of the units.
- 9.4.2 The duration of the 'Reliability Run' of each unit will be spread over a period of seven (7) days at full load or any other load intimated by the Owner/Owner's Engineer based on process plant demand on automatic mode and without any interruption attributable to Bidder.
- 9.4.3 Should any failure (other than of an entirely minor nature) due to or arising out of faulty design, materials, or workmanship (but not otherwise) occur in any item of the plant, sufficient to prevent commercial use of the plant, the reliability test period of seven (7) days will recommence for that item after the defect has been remedied by the manufacturer. The onus of proving that any failure is not due to faulty design, materials and workmanship will lie with the Bidder.
- 9.4.4 A 'reliability run' report comprising observations and recordings of various parameters measured in respect of the 'reliability run' will be prepared and submitted to the Owner / Owner's Engineer. The report will have recordings of all details of interruptions that occurred, adjustments made, and any repairs done during the 'reliability operation'.
- 9.4.5 Should any failure or interruption in any portion of the tests due to or arising from faulty design, materials, workmanship, omissions, incorrect erection, or inadequate instructions by the Bidder's supervisors, sufficient to prevent safe commercial use of the plant occur, the reliability run test at the particular load will be considered void and the reliability test will recommence after the Bidder has remedied the cause of the defect.
- 9.4.6 The 'reliability run' will be considered successful, provided that each item of plant can meet the above requirements.
- 9.4.7 Upon the completion of 'reliability run', as soon as practicable, or at such time as may be otherwise agreed to by the parties concerned, the Bidder shall notify in writing to the Owner / Owner's Engineer that the plant is ready for performance tests.
- 9.4.8 At the end of the reliability test run, the performance guarantee test shall be conducted by the Bidder and the performance report shall be submitted to the Owner.

- 9.4.9 Before taking over of the plant by the Owner, performance related parameters shall be optimally tuned by the Contractor to the satisfaction of Owner and thereby, all the system and auto control loops shall run satisfactorily for at least one month at varying loads without disturbing any adjustment. Any assistance required from the system OEM shall be taken for the satisfactory functioning of the system. During this period, supervision and maintenance of the system shall be the scope and responsibility of Contractor.

9.5 PERFORMANCE TESTS

- 9.5.1 Following the successful completion of the reliability test of each unit, the Performance Tests shall be performed (for each boiler at a time) described herein and any further tests required by the Owner to demonstrate that the performance of the Power Facility and the units comply with the requirements specified in performance guarantee Schedule.
- 9.5.2 The performance test for each unit shall be done in line ASME PTC.
- 9.5.3 The performance test will be conducted at site by the Bidder in presence of Owner/Owner's Engineer. The tests will be commenced after the 'Plant'/'Equipment' has attained stable operation at the successful completion of functional test.
- 9.5.4 The performance test results will be corrected based on correction curves furnished by the Bidder for variation in the specified test conditions from that of the specified design conditions. The Bidder will furnish all necessary performance correction curves to be ratified by the Owner/Owner.
- 9.5.5 Bidder will furnish procedures for all site performance tests six (6) months in advance and these procedures will be sent to Owner/Owner's Engineer for approval.
- 9.5.6 The Owner reserves his right to appoint an independent inspector at his own cost as his representative to discuss the test programme, to approve the instrumentation, to witness the tests and to analyse the test results.
- 9.5.7 The performance tests will be carried out to prove the guarantees and the unit characteristics as indicated below on the basis of principles enumerated herein. The purpose of the performance tests is not only to check whether the plant meets the guaranteed performances but also provide a full mass, heat and energy balance for the whole plant which will serve as reference to evaluate the plant performance in future over the plant life.
- 9.5.8 The performance test procedure, including the definition of the calculation method to be used, the instrumentation to be installed, the instrument accuracy classes, the areas of responsibility and the items which specifically require preparation and agreement will be submitted by the Bidder for review and approval by the Owner / Owner's Engineer during detail engineering phase. Schematics identifying the guarantee test instrumentation will be submitted along with

procedure. It will be ensured that necessary test points and spool pieces are installed during the detail engineering phase and also identified in process and instrumentation drawings.

- 9.5.9 The performance test instruments will be of precision type with instrument accuracy limits as required and defined in the applicable performance test codes such that measurement uncertainty does not exceed the values agreed to by the Bidder in the Schedule of Performance Guarantees.
- 9.5.10 All test instrumentation for the performance tests as required will be supplied by the Bidder on loan basis. Data loggers on loan basis will be used extensively for the performance tests. All costs associated with the supply, calibration, installation and return of the test instrumentation / data loggers / computers etc. are deemed to have been included in the contract price. The test will be in accordance with those specified or as per agreed performance test codes. Batch calibration will not be accepted.
- 9.5.11 The performance test results will be reported as computed from the performance test observations with corrections for site conditions, variations in fuel, etc. and test conditions.
- 9.5.12 Reporting of Test Results
- i. Within two weeks after the conclusion of the performance test and unit characteristics tests, the Bidder will submit a test report to the Owner/Owner's Engineer:
 - a. In the case of a performance test, whether the unit 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.
 - b. In case of a unit characteristics tests, the level of performance achieved with respect to the desired levels of performance.
 - ii. The report(s) will include as a minimum, the following:
 - a. Description of the test procedures
 - b. Standards that were used
 - c. Instrumentation details and calibration
 - d. Full schematic diagrams with indication of instrument test location and identification tag of same.
 - e. Test logs and summary of test readings used for performance calculations
 - f. Full set of correction curves
 - g. Computation of test results.

- h. Computations to prove measurement uncertainty is within acceptable limits.
 - i. Conclusions of performance tests
 - iii. Within fifteen (15) days of receipt such test report(s), the Owner will submit a notice to the Bidder, stating either:
 - a. That Owner concurs with the information provided in the Bidder's test report(s) and provide a written notice to the Bidder accepting the results of the tests., or
 - b. That Owner disputes some or all of the information provided in the Bidder's test report(s), the areas being disputed, and the levels of performance being disputed. The Bidder and Owner / Owner's Engineer will meet within fifteen (15) days of the receipt of the Owner's notice at a mutually acceptable location to review and discuss the dispute.

9.5.13 Notice Of Tests

The Bidder shall give a notice of 21 days to the Owner/Owner's Engineer after which he shall commence the tests promptly for each unit.

CHAPTER-10

PLANT PERFORMANCE GUARANTEE REQUIREMENTS

10.0 PLANT PERFORMANCE GUARANTEE REQUIREMENTS

PERFORMANCE GUARANTEE PARAMETERS

The purpose of this section is to define the criteria for plant performance guarantees, the basis for guarantees, the obligation for performance test of the facility and acceptance criteria for demonstration of performance guarantees by Main Plant Bidder. The Heat & Material Balance diagram attached along with this specification has been provided for reference only.

10.1 Guarantees under Liquidated Damages

- Steam Generator output at 100% BMCR for performance coal and for all coals in the range as specified in Chapter-2.
- Gross STG power output at 100% TGMCR with design cooling water temperature and 0% cycle make-up
- Plant auxiliary power consumption at 100% TGMCR
- Plant gross cycle heat rate at 100% TGMCR with design cooling water temperature and 0% cycle make-up

10.2 Plant Subject to Rejection if guaranteed values for the following parameters are not met after correction.

- SO₂ emission at stack – Guaranteed value
- NO_x emission at stack – Guaranteed value
- Dust concentration at ESP outlet – Guaranteed value
- Noise level for each equipment – Guaranteed value

10.3 Guarantees under correction

10.3.1 Plant capability

- Maximum rate of loading
- Maximum step load change
- Capability for maintaining own house load on full load throw-off
- Vibration level
- Surface temperature of thermal insulation at 30 °C still ambient air

10.3.2 Boiler & Accessories

- Steam generator efficiency

- Quality of steam from boiler outlet at 100% BMCR with any combination of specified fuel
- Unburnt combustibles as % of fly ash & bottom ash
- Superheater (SH) outlet temperature control range of 50% BMCR to 100% BMCR
- SH spray water quantity at 100% BMCR
- Total dissolved solids in steam leaving SG drum and silica in steam leaving final superheater
- Zero leakage at TAPH
- Minimum stable load of SG without oil support
- Flue gas temperature at TAPH outlet
- Combustor temperature
- Cyclone efficiency
- Ash cooler outlet temperature for bed ash
- Deaerator O₂ & CO₂ removable capability
- Demonstration of Boiler operation at rated parameter with 100% firing of each fuel specified
- Electrical and I&C System
- Trip of each major equipment, including demonstration of auto operation of standby equipment, to be developed and mutually agreed upon in the testing procedure. Auto runs back capability in case of equipment failure to be demonstrated.

10.3.3 Steam Turbine & Accessories

- Turbine cycle gross heat rate at 100% TGMCR with 0% makeup and design cooling water temperature.
- TG VWO gross output with 0% makeup and design condenser cooling water inlet temperature
- Turbine Generator gross output at 100% TGMCR with 0% makeup and condenser cooling water inlet temperature
- Performance of CEP and condenser air evacuation equipment
- Temperature rise across condenser at TGMCR and design cooling water temperature
- Performance of oil purifier
- Pressure drop in cooling water across condenser at 100% TGMCR

10.3.4 Generator

a) Maximum generator temperature rise at full load at rated conditions:

- i) Stator windings
- ii) Rotor windings
- iii) Stator iron core in contact with insulated windings
- iv) Stator iron core not in contact with insulated windings

b) Ratings:

- iii) Generator maximum continuous rating (MW)
- ii) Generator short circuit ratio
- iii) Generator Capacitive MVAR rating

c) Excitation system:

- i) Excitation system response ratio
- ii) Field forcing capability (in time)
- iii) AVR sensitivity

d) Generator efficiency

LIQUIDATED DAMAGES

- In respect of items guaranteed under "Liquidated Damages", the Bidder shall guarantee the values (inclusive of design, manufacturing and all other tolerances). The performance test results shall be reported as computed from the performance test observations, with corrections for calibrations. No additional allowances for errors in measurement are permissible. The Bidder shall make every effort practicable to correct the deficiencies subject to the price reduction before any settlement is considered by the Owner. Should the performance test results deviate from the guaranteed values the Bidder shall correct his equipment at no extra cost to the Owner and repeat the performance tests within a reasonable period as agreed to with the Owner. If, however, the Bidder fails to meet the guarantee values, liquidated damages will be levied as per factors indicated in table below.

Sl. No.	Particulars	Price Reduction Factor	Value (Rs. in Lakhs)
1	For every 1 t/h decrease in steam flow at superheater outlet at 100% SGMCR	Penalty factor	50
2	For every 1 kW shortfall in STG output at rated steam parameters at generator terminals at 100% TGMCR	Penalty factor	1.2
3	Plant auxiliary power consumption at 100% TGMCR	Penalty factor	3
4	For every 1 kCal/kWh increase in guaranteed weighted plant gross heat rate	Penalty factor	24

- Test results shall be reported as computed from Performance Test observation with corrections if test conditions vary from guarantee conditions. No additional allowances for errors or tolerances are permissible.
- In case of retesting a just and equitable proportion of the costs to which Owner may be put by the repetition of the tests, like cost of labour, fuel etc. having regard to the extent that the Bidder is responsible for unit having failed to pass the tests shall be deducted from the contract price or charged to Bidder.

PERFORMANCE CORRECTION

- In respect of items guaranteed under “Correction”, the Bidder shall fulfil the guaranteed values and in the event the guaranteed values are not met Bidder shall make every effort practicable to correct the deficiencies within the reasonable time period mutually agreed with the owner. In case the Bidder fails to meet the guarantees, the equipment is liable to be rejected and in case of such an option, the Bidder shall replace the equipment with one that shall meet the guaranteed values without any additional cost to the Owner.

CHAPTER-11

PROJECT MANAGEMENT, SCHEDULE AND MONITORING

11.0 PROJECT MANAGEMENT, SCHEDULE & MONITORING

11.1 OVERALLPROJECT SCHEDULE

The Main Plant Package shall be executed to ensure the completion (declaration of commercial operation) of the Captive Power Plant, unit-1 & 2 shall be 24 months & 27 months from the date of issue of Notice to Proceed (NTP) to the Bidder.

The Bidder shall accordingly plan the schedule for completion of the entire works and submit the detailed project network schedule to the Owner/Owner's Engineer. The Bidder is expected to meet the agreed completion period failing which Liquidated Damages for delays will be levied on the Bidder for every week of delay, as described in General Conditions of Contract (GCC) of this specification.

11.2 PROJECT MONITORING

11.2.1 The Bidder shall prepare a L2 Project Schedule using latest version of Primavera clearly indicating the following: -

- a) Work Breakdown Structure.
- b) Major milestones of Project,
- c) Input required from Owner/Owner's Engineer.
- d) Project Engineering/ Procurement and Construction/Commissioning activities.
- e) Project Critical path.
- f) All the critical deliverables (Engineering/Procurement/Construction)

All schedules shall be furnished to Owner/Owner's Engineer in editable format in the original PRIMAVERA (XER) and PDF file format in which the schedule was prepared.

11.2.2 Owner will review and comment on each schedule, and upon agreement with the Contractor of any necessary changes, will accept the schedule.

11.2.3 Contractor shall not change the planned portions of schedules without prior notification to Owner along with justification and reasons thereof.

11.2.4 The schedules shall be periodically updated to reflect the activities completed and any rescheduling of balance activities.

11.2.5 Owner's review of any schedule does not relieve the Contractor of any obligation to complete the work in a timely manner.

11.3 COMPREHENSIVE SCHEDULES

11.3.1 The Contractor shall submit the comprehensive project schedule complying with all the points mentioned in above clause No. 11.2.1 and also the below mentioned points within 15 days after the issue of NTP to the Owner /Owner's Engineer for their review and approval.

- a) Engineering schedule indicating all the deliverables their submission dates.
- b) Material Delivery schedule for entire project with highlighting the long lead items.
- c) Project Construction/Erection schedule along with Construction resources deployment plan/Histogram for entire project.

11.3.2 The planning, scheduling and monitoring including resource scheduling and monitoring shall be carried out using Primavera latest version project management software.

11.3.3 The schedule shall be updated and submitted to the Owner/Owner's Engineer at least twice each month. The schedule will include all incomplete work and all work to be completed in the next three months as per the original schedule. The updates shall show actual progress and any proposed changes in the schedule of the remaining work.

11.3.4 Detailed network 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 details satisfactory to Owner/Owner's Engineer.

11.3.5 Appropriate time shall be allocated for the approval of the documents by Owner /Owner's Engineer and the same shall be indicated in the network schedule.

11.3.6 Other project activities necessary to control the work under this Contract shall be included as mutually agreed to by the Contractor and the Owner/Owner's Engineer.

11.4 DETAILED START-UP SCHEDULE

The Detailed Start-up Schedule shall include a schedule of all required tests and shall be based on a Start-up Requirements Network. The Detailed Start-up Schedule shall show all sub-system package construction completion activities, consistent with the Overall Contract Schedule, followed by pre-operational start-up, testing, initial operation, trial operation, unit characteristic tests and performance guarantee tests

11.5 ALTERATION OF THE PROJECT SCHEDULE

No material alteration to the Programme shall be made without the approval of the Owner/Owner's Engineer. However, Contractor may make alterations to the Programme without the approval of the Owner / Owner's Engineer being required where such alterations are consistent with the key milestone dates set out in the Schedule and do not affect the overall Project schedule.

11.6 REVISION OF PROGRAMME

- 11.6.1 If the progress of the Scope of Supply or any other part of the Works does not conform to the Project Schedule, the Owner /Owner's Engineer may instruct the Contractor to revise the programme.
- 11.6.2 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 or any part of the work at any time in the reasonable opinion of the Owner /Owner's Engineer is too slow to secure completion of the works within the Time for Completion or any extended date , the Owner/Owner's Engineer may so notify the Contractor in writing and the Contractor shall thereupon take such steps as are necessary and the Owner/Owner's Engineer may approve in order to accelerate the progress of the Scope of Supply or part thereof or any part of work so as to achieve completion of each section within 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.

11.7 REPORTING AND CO-ORDINATION

- 11.7.1 During the design, engineering and manufacturing, supply, erection, testing and commissioning stages the Contractor shall submit the weekly/fortnightly/Monthly progress report to Owner/Owner's Engineer on the progress of works by them and their Sub-Contractors of all plant and materials required for the execution of the works. Work Progress shall be updated by the bidder through agreed communication protocol (i.e., IPMS (Integrated Project Management System)/Equivalent).
- 11.7.2 Bidder shall submit the daily progress reports during the construction phase, the format of the same shall be mutually agreed to by the Contractor and the Owner/Owner's Engineer.
- 11.7.3 Contractor shall submit monthly updates comparing the Work completed against the milestone schedule in tracking GANTT or if Contractor's performance is not in compliance therewith, more frequently as requested by Owner / Owner's Engineer. If Contractor's performance of the work is not in compliance with the Milestone Schedule, without restricting any other rights or remedies of Owner/Owner's Engineer 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.
- 11.7.4 Milestones to be achieved so that they could be verified physically. Computation of progress of the Contractor shall use weighted value concept. 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. Billing schedule shall be mutually agreed during Order placement / KOM.

- 11.7.5 Contractor shall comply with the Milestone Schedule and to attend/participate in progress, site co-ordination or special purpose meetings. The commencement and completion of each task to be performed shall be clearly designated. If requested by Owner/Owner's Engineer, representatives of Vendors of major materials shall also attend each such meeting.

11.8 ACCESS FOR PROGRESS MONITORING

The Owner/Owner's Engineer or his nominated representatives 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 with intimation to the Bidder.

CHAPTER-12

BIDDER'S SUBMITTALS

12.0 BIDDER'S SUBMITTALS

12.1 Information to be furnished by Bidder along with bid

The Bidder shall submit the following drawings / data / information along with his offer:

- 12.1.1 The Key Information covering Bidding Company name, Bidder's proposal number and date, and confirmation to all the schedules.
- 12.1.2 Performance Guarantee Data
- 12.1.3 Completely filled-in Bidder's technical data as per Attachment-1.
- 12.1.4 List of Recommended Spares (2 years)
- 12.1.5 List of special tools/tackles
- 12.1.6 List of Deviations/Clarifications
- 12.1.7 Sub-vendor list
- 12.1.8 Quality Assurance Plan
- 12.1.9 Mandatory Spare parts list with prices filled up against each item.
- 12.1.10 Proof document for Provenness criteria
- 12.1.11 Project Completion Schedule
- 12.1.12 Flow diagram clearly indicating the Scope and Terminal Points
- 12.1.13 Write-up on the technical features of the equipment/systems offered.
- 12.1.14 Utility Consumption List
- 12.1.15 Electrical Key Single Line Diagram
- 12.1.16 Construction power requirement
- 12.1.17 Electrical Load List
- 12.1.18 Performance Correction Curves
- 12.1.19 P&ID for all systems and sub-systems.
- 12.1.20 Plot Plan indicating all building/structures.
- 12.1.21 General arrangement & cross section drawings of TG buildings/structures indicating all major equipment and its locating floors , control room, maintenance facilities etc.

- 12.1.22 SG area including bunker & feeder arrangements, ESP and various equipments floor wise, PRDS stations, spray control stations, fuel oil burners, soot blowing area, handling facilities and all heating surfaces
- 12.1.23 Plant automation Configuration drawing indicating redundancy at all levels and all hardware components.
- 12.1.24 Start-up & loading curves for cold, warm and hot start up
- 12.1.25 A comprehensive write-up or brochure on the details of manufacturing and testing facilities in the shop of manufacture for the equipment being offered.
- 12.1.26 Detailed design criteria for civil & structural design to be adopted for each building, structures, foundations, facilities etc.
- 12.1.27 Experience list for similar type of equipment supplied, which should indicate the name of customer, date of ordering, date of commissioning, Equipment parameters and quantities supplied.
- 12.1.28 Information forms in commercial Volume.
- 12.1.29 List of Master Documents/Drawings (MDL) for detailed engineering. The Bidder shall submit the required detailed engineering drawings/ documents as per the requirement of overall Project Schedule.
- 12.1.30 Heat Balance Diagrams: Following Heat balances complete in all respects to be computed & furnished. Pressure (in bar), temperature (in Deg C), enthalpy (in kcal/kg) and flow (in tonnes/hr) to be indicated at all required locations to facilitate manual checking by the Owner / Owner's Engineer.
 - (a) 100% TMCR STG output (Guaranteed output)
 - (b) STG VWO condition
 - (c) 80% STG output
 - (d) 60% STG output
 - (e) 10 MW Generation with Zero process steam
 - (f) Minimum STG output
- 12.1.31 House load operation of STG unit with bypass in operation
- 12.1.32 All supporting docs to be provided to consultant for reviewing Technological structures.

Note: The above documents are essential for technical evaluation/scrutiny of bidder's proposal and must be submitted with the proposal otherwise the bidder's offer will be treated incomplete and will be liable for rejection.



Client – Hindalco Industries Ltd
Project - Aditya Alumina Refinery
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TECHNICAL SPECIFICATION FOR MAIN PLANT SYSTEM

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ATTACHMENTS



Client – Hindalco Industries Ltd
Project - Aditya Alumina Refinery
TCE.13833A-ME-6002-6001, Rev-R0



TECHNICAL SPECIFICATION FOR MAIN PLANT SYSTEM

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13.0 ATTACHMENTS



Client – Hindalco Industries Ltd
Project - Aditya Alumina Refinery
TCE.13833A-ME-6002-6001, Rev-P0



TECHNICAL SPECIFICATION FOR MAIN PLANT SYSTEM

Page 1 of 1

Attachment-1 TECHNICAL DATA SHEET



OWNER : HINDALCO INDUSTRIES LIMITED

CONSULTANT : TATA CONSULTING ENGINEERS LIMITED

PROJECT NAME : DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA

SPECIFICATION NO. : TCE.13833A-ME-6002-6001

DOCUMENT : TECHNICAL DATASHEETS

BIDDER : M/s.

	Rev.	DESCRIPTION	DATE	PREPARED	CHECKED	APPROVED

SCOPE OF SUPPLY, TERMINAL POINTS AND EXCLUSIONS								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13833A	
SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
SECTION - I, GENERAL & COMMON								
1.01	Project execution plan.		Required					
1.02	Project scheduling, management, progress metrics and reporting.		Required					
1.03	Basic Engineering of all equipment and equipment systems							
1.04	Environment, health, safety and security plan and management.		Required					
1.05	Detailed Design & Engineering		Required					
1.06	Erection of Equipment, Piping and all Instruments shall be as per approved vendor documents and Owner's given document / specification .							
1.07	Purchase specifications and equipment procurement.		Required					
1.08	Sub-Vendor's drawings reviews and approval.		Required					
1.09	Procurement, shop testing and certificates.		Required					
1.10	Packing, transportation, transit insurance, delivery to site, unloading, & storage at site.		Required					
1.11	Temporary storage, fabrication & assembly yard.		Required					
1.12	Onsite handling and installation.		Required					
1.13	Painting and preservation including requisite number of nitrogen cylinders		Required					
1.14	Corrosion protection.		Required					
1.15	Project QA and QC plan and management.		Required					
1.16	As built drawings and Engineering Data Base.		Required					
1.17	O&M Manuals.		Required					
1.18	Training of Owner's personnel.		Required					
1.19	3D Model		Required					
1.20	Hydro-test, dry out, chemical cleaning, steam blowing activities including temporary arrangements (i.e silencer)		Required					
1.21	Emissions monitoring & environmental testing services (including third party contracting) used during performance and compliance testing.		Required					
1.22	Pre-commissioning tests, functional tests, start-up, commissioning and testing.		Required					
1.23	Test instruments for performance tests as required on returnable basis		Required					
1.24	Trial Run, Reliability run and performance guarantee tests along with test instruments.		Required					
1.25	Spare parts for start-up and commissioning, two (2) years O&M spares.		Required					
1.26	Special tools and tackles for installation and maintenance.		Required					
1.27	Supply of lubricants, chemicals & consumables up to handing over of the plant to the Owner after successful completion of Acceptance tests.		Required					
1.28	Disposal of the excess materials after commissioning and handing over.		Required					
1.29	Construction of all temporary facilities and services associated with this work and dismantling the same after completion of work.		Required					
1.30	HSE studies and Risk Assessment.		Required					
1.31	All statutory clearances and approvals, safety related permits including liaison and coordination work with the respective local regulatory authorities. Applicable fees shall be borne by Customer.		Required					
1.32	Arrangement of permits & licenses from local authorities		Required					
1.33	All transportation logistics permits		Required					
1.34	All hazardous, explosive material handling & waste management permits		Required					
1.35	Compliance to all local laws and regulations		Required					
1.36	All lifting and handling equipment to facilitate the handling of all equipment during erection/maintenance/overhaul during the plants lifetime							
SECTION - II, MECHANICAL SYSTEM AND EQUIPMENT								
2.01	Two (2) nos. internally controlled extraction cum condensing type steam turbine generator along with lube oil & control system with oil centrifuge, Electro-hydraulic governing system, TG integral piping and drain connections, turbine flash tank, water cooled condenser, air evacuation system, condensate extraction pumps, deaerators, boiler feed pumps, auxiliary steam system, , make-up water system, low pressure dosing system and associated auxiliaries.		Required					

SCOPE OF SUPPLY, TERMINAL POINTS AND EXCLUSIONS								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13833A	
SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
2.02	Two (2) nos. circulating fluidized bed (CFB) combustion type boiler including Superheaters (including mechanical and electronic safety valves, drains, start up vents, air release valves, nitrogen connections, sampling connection, desuperheating spray system) Economizer with recirculation piping (as required), air & flue gas system (including primary air fans, secondary air fans and induced draft fans with all necessary ducting work, dampers and expansion joints), bunkers for fuel, bed material and limestone, feeding system, fuel oil storage and supply system, soot blowers (if required), sample coolers, electro-static precipitator, continuous & intermittent blow down tanks, high pressure dosing system, necessary interconnecting piping, valves, fittings, electrical and instrumentation.		Required					
2.03	All Pressure reducing desuperheating system (PRDS) and desuperheaters as mentioned in the specification		Required					
2.04	Complete power cycle piping system comprising main steam, boiler feed discharge, Deaerator, condensate, MP and LP extraction system, PRDS system etc., as well as integral piping system and low-pressure piping system with hangers and supports, valves and specialties, insulation etc., as required for the main plant within battery limit of Bidder. Electronic Relief valve shall be provided at each main steam header, MP steam header and LP steam header.		Required					
2.05	Complete spray water control system from BFP discharge for superheater attemperator and auxiliary steam desuperheating comprising of block valves, piping, valves, fittings, further pressure reducing station (if required) and instrumentation		Required					
2.06	Piping system for supply steam from LP process steam header to Deaerator including control valves, isolation valves, non-return valves, fittings, specialties, supports, instrumentation etc.		Required					
2.07	Condensate storage tank, condensate transfer pumps for cycle make up.		Required					
2.08	Steam and water sampling system		Required					
2.09	Instrument air and service air distribution system.		Required					
2.10	One (1) no. passenger elevator of 800 kg for TG building and One (1) no. of 1500 kg capacity passenger-cum-goods elevator common for boiler area shall be considered.		Required					
2.11	Design of pipe cum cable rack for the pipes/cables in BTG area. Provision shall be kept for other pipes/cables while designing the pipe cum cable racks.							
2.12	Galleries, walkways, platforms, hand rails, ladders		Required					
2.13	Condenser online tube cleaning system & Debris filters.		Required					
2.14	All other miscellaneous tanks as required for the main plant.							
2.15	One (1) No. 75/10 Tons EOT crane at STG building and Miscellaneous Cranes & hoisting equipment at other areas		Required					
2.16	AC & Ventilation system.		Required					
2.17	Complete thermal insulation, acoustic insulation and refractory for insulation as required for the boiler, turbine, piping and other equipment for personnel protection and prevention of heat loss.		Required					
2.18	Service water and potable water supply and distribution systems							
2.19	Boiler and turbine area sumps & sump pumpss.		Required					
2.20	Painting works including final touch up paints.		Required					
2.21	Acoustic insulation, refractory & cladding							
SECTION - III, ELECTRICAL SYSTEM AND EQUIPMENT								
3.01	Boiler Package associated Electrical.		Required					
3.02	STG Package including generator and associated Electrical.		Required					
3.03	ESP Package associated Electrical.		Required					
3.04	Segregated Phase Bus Duct (SPBD)		Required					
3.05	MV/ LV Axiliary Transformers		Required					
3.06	6.6 kV Unit Switchger Panel.		Required					
3.07	Power and Control Cables		Required					
3.08	415V Switchger, VFD and 415V MCC Panels		Required					
3.09	Elevator		Required					
3.10	DC System		Required					
3.11	UPS and ACDB		Required					
3.12	Illumination System		Required		Solar Light/ Tube in STG building (Green Power)			

SCOPE OF SUPPLY, TERMINAL POINTS AND EXCLUSIONS								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13833A	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
3.13	Cable Tray work		Required		Inside Batter Limit of BTG			
3.14	Earthing and Lightning Protection system		Required					
3.15	Blocak Start and Emergency Diesel Generator with associated Electrical.		Required					
3.16	Energy Management System		Required					
SECTION - IV, INSTRUMENTATION AND CONTROL SYSTEMS								
4.01	Distributed Control System (DCS) of uniform hardware complete with data highways, operator stations with LED screens & LVS, engineering workstations, historical storage unit, all other peripherals, interfacing with other plant control systems cabling etc. for operation / monitoring and control of main power plant.		Required					
4.02	Boiler Protection System /Burner Management System i.e protection & interlocks shall be TMR system or SIL 3 certified System. The SIL 3 certified safety system shall be of the same family as of DCS and shall reside on the plant data highway along with the DCS controllers. The same shall be implemented in independent controllers and shall be as per NFPA 85		Required					
4.03	Turbine integral control system shall be provided in hot redundant configuration and shall comprise of Turbine Governing system, Turbine Supervisory Instrumentation (TSI), and Automatic Turbine Run-up system (ATRS). Turbine Protection System i.e protection & interlocks shall be TMR system or SIL 3 certified System		Required					
	Vibration Analysis System for Steam Turbine							
4.04	Coal, Limestone and Ash Handling system shall be monitored and controlled from PLC based control system with soft link and critical signals hardwired with DCS		Required					
4.05	Other systems like the Compressed air system, Emergency DG set, Fire protection system, Fire detection & alarm system, etc. that are implemented in MPSC/PLC shall be interfaced with the Plant DCS through soft link and critical signals shall be hardwired.		Required					
4.06	Smart soot blower control (if required) shall be PLC based intelligent control system.		Required					
4.07	Dedicated microprocessor / PLC based system for the ESPs as described under the Electrical section of the specification. Hardwired signals and redundant OPC links to the DCS for monitoring of this system shall be provided		Required					
4.08	Details of control systems and hardware envisaged for the total power plant with interfacing requirements with plant DCS are detailed in subsequent, Annexure-1 (Operation and Control Concept and Interface and Hardware requirement).		Required					
4.09	Sequence of Events Recording system integral to the DCS and safety system with 1 ms resolution or better shall be provided		Required					
4.10	Wherever the same process parameter is used for both the safety system and the DCS, the corresponding field sensors shall be connected to the safety system and the input signal to the DCS shall come as hardwired outputs from the safety system to the DCS		Required					
4.11	The DCS and safety systems shall be provided unit-wise and independent set of controllers of these systems shall be provided for equipment / systems common to both units		Required					
4.12	The DCS based control system shall be interfaced to the GIS and AIS SCADA system. (refer electrical section for details) through redundant OPC links and hardwired signal exchange.		Required					
4.13	Historical data storage and retrieval system with redundant historians implemented with RAID-1 configuration.		Required					

SCOPE OF SUPPLY, TERMINAL POINTS AND EXCLUSIONS								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM: Main Plant System				ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13833A	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
4.14	DCS shall also implement the basic requirements of plant performance monitoring (Plant heat rate, SG efficiency, Auxiliary power consumption etc.) as per relevant ASME standard		Required					
4.15	DCS shall be provided with HART /Foundation field bus compatible I/O cards. For minimum requirements of Foundation Fieldbus system refer Annexure-II		Required					
4.16	1 no. of 70" LCD TV screen / unit interfaced to one of the OS of the DCS		Required					
4.17	Master Clock System (100% redundant) with associated time synchronisation equipment, cabling, slave clocks, etc. shall be provided		Required					
4.18	2 x 100% UPS supply (220V) for plant I&C loads (control systems including HMI, master clock system, VMS, CEMS, SWAS, field instrumentation etc) complete with its distribution. UPS and UPS power distribution to all I&C loads in Bidder's scope is included in the Bidder's scope. DC power requirement shall be derived by the Bidder from the UPS using appropriate redundant power supplies and diode ORing units. All distribution boards shall be provided with adequate (minimum 20% after commissioning) wired spare breakers. I&C equipment such as control systems including HMI, master clock system, VMS, CEMS, SWAS (except chillers), field instrumentation (incl. flame scanners, drum level indicators, etc.) CCTV system, etc. shall be powered by the UPS		Required					
4.19	Control Desks and cabinets including Control room and equipment room panels, consoles, panels, cabinets, racks, chairs etc		Required					
4.20	All field Instruments and sensors including pipe mounted items, flow elements (FE) and accessories, final control elements like control valves, de-superheaters, control dampers and actuators etc		Required					
4.21	Foundation fieldbus-based transmitters with associated spur and field barriers, flow elements (FE) and accessories; final control elements like control valves, control dampers and actuators etc		Required					
4.22	Latest version of DD files shall be provided by Instrument vendor							
4.23	Foundation field bus field manager (with software).							
4.24	All HT drives shall be provided with bearing temperature & vibration monitoring for each bearing of drive motor & driven equipment and motor winding temperature monitoring. Vibration sensors shall be provided on X & Y directions on DE & NDE of drive & motor. Vibration sensors with transmitters shall be provided with 4-20mA output from field hardwired to DCS		Required					
4.25	Steam And Water Analysis System (SWAS) complete with sampling system and analysers & instruments		Required					
4.26	Continuous Emission Monitoring System (CEMS)		Required					
4.27	All junction boxes (Signal and power), transmitter racks (as applicable), cubicles, enclosures, local panels, marshalling panels, pneumatic and process hook up hardware and other erection materials and accessories including Earthing system (separate electronic and frame earth).		Required					
4.28	Canopy shall be provided for field instruments and all the Junction boxes (PJB, CJB and FF JB.)							

SCOPE OF SUPPLY, TERMINAL POINTS AND EXCLUSIONS								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13833A	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
4.29	Supply, laying & termination of all Instrumentation cables, Control cables, Compensating cables, Special cables, Pre-fabricated cable, Redundant Data Highways, foundation fieldbus cables etc., including the field cables for all types of applications, Control and power cable megger (before laying) etc.		Required					
4.30	Supply & installation of branch cable trays for connecting upto main/sub-main cable trays (branch cable tray within the battery limit) starting from field sensors/devices in Bidder's scope		Required					
4.31	Redundant communication with the refinery DCS (other's supply) shall be considered. The mode of communication shall be shared during detail engineering. Bidder shall consider two number (2) Ethernet communication modules (in the technical scope) and approx. 2 kms fibre optic cables along with cable trays for the same.							
4.32	Maintenance and erection tools and tackles		Required					
4.33	Essential spares		Required					
4.34	Inspection and testing for I&C system equipment		Required					
4.35	CONSUMABLES: All consumables required for Operation and Maintenance of the plant		Required					
4.36	Erection, Field Testing And Commissioning: The Bidder's scope includes Erection, pre-commissioning checks, testing, calibration and commissioning of all Instrumentation and Control system equipment for the complete power plant supplied under this contract to the complete satisfaction of the Owner. The scope includes provision of all necessary erection materials, consumables, tools and tackles, provision of calibration/testing equipment required for erection/testing/commissioning and handing over the same to Owner after completion of erection/testing/commissioning. Contractor's scope of work will also include any additional instruments supplied by other contractors/OWNER which is required for proper & satisfactory performance of the power plant (subject to mutual agreement with Owner regarding cost implication).		Required					
4.37	Engineering Documentation		Required					
SECTION - V, CIVIL								
5.01	The scope of work consists of design, preparation of detailed drawings and documents for all structural steel building / structures, preparation of GA drawings & layout drawings under the scope of contract in the BTG island area excluding chimney.	LOT	Required					
	Supply, Fabrication & Erection of the technological structures like EOT Crane for TG, other crane & hoists for BTG auxiliaries, Boiler, ESP, Duct and Duct supports etc. shall be in the Bidder's scope. Detail scope of work has been described in the chapter no. 8.		Required					
SECTION - VI, TERMINAL POINTS								
	MECHANICAL							
6.01	Fuel		At the inlet of fuel bunker					
6.02	Limestone		At the inlet of limestone bunker					
6.03	Bed Material		At the inlet of bed material bunker					
6.04	Fuel Oil		At fuel oil unloading tanker outlet connection. Minimum 10 m connection hose (with end connection) shall be provided by bidder at unloading tanker outlet.					
6.05	Bed Ash		At the bed ash cooler outlet flange including knife gate valve (KGV).					

SCOPE OF SUPPLY, TERMINAL POINTS AND EXCLUSIONS								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13833A	
SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
6.06	Fly Ash		Outlet flange of FA Hoppers with isolation valve (knife gate valve at the outlet of ESP hopper & plate gate valve for other hoppers)					
6.07	MP Process Steam		At CGPP boundary					
6.08	LP Process Steam		At CGPP boundary					
6.09	Make up water		at level control station of each make up water storage tank					
6.10	Return Condensate		At 4 nos of pipelines at a single area of CGPP boundary					
6.11	Boiler Initial Fill and Deaerator initial fill line		At one point (6 m away) near each boiler front row column.					
6.12	HP Chemical dosing system		The entire system is to be supplied by the BIDDER. DM water shall be supplied by Purchaser. The terminal point of dilution water (DM) supply to the solution preparation cum dilution tank shall be at one point (6 m away) near each boiler front row column.					
6.13	LP Chemical dosing system		The entire system is to be supplied by the BIDDER. DM water shall be supplied by Purchaser. The terminal point of dilution water (DM) supply to the solution preparation cum dilution tank will be at one point (6 m away) neareach boiler front row column.					
6.14	Instrument Air & service Air		At STG building respective air receiver tanks					
6.15	Condenser cooling Water		Supply and discharge CW water piping upto 1.5 meters beyond first row columns of TG building at each condenser					
6.16	DM cooling water for auxiliary equipment		Supply line: At one point (6 m away) near each boiler front row column. Return line: At one point (6 m away) near each boiler front row column.					
6.17	Service Water		At one point (6 m away) near each boiler front row column.					
6.18	CBD & IBD drains		At nearest drain trench					
6.19	Vents		One meter above the boiler house/ main plant building roof level					
6.20	Waste water		Waste water- To nearest trench of plant drain drain system Oils,chemicals- At one point					
6.21	Construction water supply		At one point inside tha plant. Details shall be discussed with successful Bidder.					
6.22	Construction Power Supply		Tap off from existing 6.6 kV switchgear system					
	ELECTRICAL							
6.23	Power Evacuation		Interconnection of 11kV Busduct to Generator Transformer.					
6.24	Aux. Power system		Interconnection of 6.6kV Power Cable to Unit and Station Transformer.					
6.25	Earthing system		Interconnection of BTG complete earthing system with the other package and switchyard earthing system.					

SCOPE OF SUPPLY, TERMINAL POINTS AND EXCLUSIONS								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM: Main Plant System				ATTACHMENT-1
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SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
6.26	Cable Tray System		Interconnection of BTG Package scope of cable tray with station cable tray system.					
6.27	Station Power system		At outgoing terminal of 6.6kV Breaker of Station Switch board.					
	CONTROL & INSTRUMENTATION							
6.28	Instrumentation and control cables between MCC/Switchgear/ Starter panel and Cabinets/Panels		Terminal Point-At bidder's cabinets/Panels Except for the equipment/drives for which the MCC/Switchgear/Starter Panel are by others.					
6.29	Instrumentation and control cables including special cables between Bidder supplied Systems & DCS		Terminal Point-At bidder's control system cabinets/Panels For equipment in bidders' scope which are controlled from DCS (by Bidder), all cables I&C /special cables etc upto control system are in bidders' s scope. Including corresponding cables, cable trays, conduits, etc					
6.30	Equipment's/Systems (by others) to be controlled by DCS		From Field termination cabinets by Cooling Tower vendor to Bidder's DCS. Including corresponding cables, cable trays, conduits, etc.					
6.31	Communication between control system (microprocessor based/PLC) (by others) and bidder's DCS.		Terminal Point- Control system cabinet (by others) All corresponding cables, cable trays, conduits, etc.in Bidders scope					
6.32	Time Synchronisation signals from Master Clock (by Bidder) to Control Systems by others as defined in, Annexure-1.		Terminal Point- At bidder's Master clock cabinet Bidder shall provide Time Synchronisation Signal (redundant) for each control system Microprocessor based). Accordingly, redundant receiver & cables to be considered by others. Type of signal required by other control systems shall be confirmed during detail engineering.					
6.33	Bulk power supply feeders of UPS (redundant) & Non-UPS Supply (240 VAC 50 Hz)		PDB at one point. Including corresponding cables, cable trays, conduits, etc.					
SECTION - VII, EXCLUSIONS								
7.01	Land for setting up the unit		To be Noted					
7.02	Supply of fuel, limestone, sand/bed material, startup oil		To be Noted					
7.03	Firefighting system		To be Noted					
7.04	Instrument air & service air compressors		To be Noted					
7.05	Ash handling system beyond terminal points		To be Noted					
7.06	Supply, Fabrication & Erection of all the structural works including foundation and associated RCC works for the TG Building, Service Building, Switchyard control building, ESP Control room buildings, Pipe & cable racks, RCC chimney with steel flue cans, Miscellaneous buildings etc. within the BTG island		To be Noted					
7.07	Design Engineering for foundations for all the structures / buildings, equipment etc. and other associated RCC work in the BTG area		To be Noted					
7.08	Soil Investigation		To be Noted					

SCOPE OF SUPPLY, TERMINAL POINTS AND EXCLUSIONS								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13833A	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
7.09	Topographical Survey		To be Noted					
7.10	Site Grading		To be Noted					
7.11	Workshop and workshop equipment		To be Noted					
7.12	Weigh bridge		To be Noted					
7.13	Storm water run off pond		To be Noted					
7.14	Laboratory equipment & furniture		To be Noted					
7.15	Generator Transformer, Unit Transformer and Station Transformer.		To be Noted					
7.16	Inytercom and PA System		To be Noted					
7.17	Fire detection and alarm system		To be Noted					
7.18	Station Power And Control Cable and cable tray		To be Noted					
7.19	Intercom and Public Address System		To be Noted					
7.20	Station Power And Control Cable and cable tray.							
7.21	Station illumination system							
7.22	Supply and installation of Turbo Ventilator							
NOTE: 1. The technical data sheets furnished are tentative and may undergo minor changes during detail engg. Stage without affecting the performance of the boiler.								
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REVISIONS	REV. NO.	P0	R0					TATA CONSULTING ENGINEERS LIMITED
	PPD_BY	RKS	RKS					
	CHD_BY	AM	AM					
	APD_BY	PSG	PSG					
	DATE	17-09-2024	25-09-2024					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
SECTION -1, BOILER								
1.0	Boiler Manufacturer		By Bidder					
2.0	Type of steam generator		Circulating Fluidized Bed (CFBC) combustion technology, natural circulation, single drum type					
3.0	No of Steam Generator		2					
4.0	Load below which oil support is required.		≤ 25%					
5.0	Solid separation technology		By Bidder					
6.0	Circulation Ratio		By Bidder					
7.0	Capacity at BMCR	tph	300					
8.0	Super heater (SH) outlet temperature control range	%	50% BMCR - 100% BMCR					
9.0	Sulphur capture process	-	Limestone dosing into furnace					
Fuels								
10.0	Fuel for load carrying		100% Indian Coal / 100% South African Coal / 100% Indonesian coal / any Combination of these fuels.					
11.0	Fuel for start up		Light Diesel Oil (LDO) or Bio-Diesel					
12.0	Fuel for performance guarantee		100% Indian Coal					
13.0	Alternate fuel		Biomass (Max 10%)					
14.0	Fuel bunkers		2 no. Coal Bunker for total 12 hours storage for each boiler 1 no. Biomass Bunker for 5 hours storage for each boiler					
15.0	Limestone bunker		1 no. for 24 hours storage for each boiler					
16.0	Bed Material / Sand bunker		By Bidder (minimum capacity shall be equal to thrice the bed material quantity required for initial start-up operation)					
17.0	Cylone efficiency		By Bidder					
Furnace Parameters								
18.0	Design Pressure	mmWC	By Bidder					
19.0	Maximum Pressure	mmWC	By Bidder					
19.0	Air pressure losses across the fluidised bed	mmWC	By Bidder					
20.0	Temperature of air entering air distributor	°C	By Bidder					
20.0	Combustor bottom temperature	°C	By Bidder					
21.0	Combustor middle temperature	°C	By Bidder					
21.0	Combustor top temperature	°C	By Bidder					
22.0	Refractory Dry out Oil Requirement	KL	By Bidder					
Performance								
23.0	100% BMCR rating (flow) of steam generating unit.	TPH	300					
24.0	Pressure at Superheater outlet	bara	70					
24.0	Temperature at Superheater outlet	°C	490					
25.0	Drum operating pressure	bara	By Bidder					
26.0	Feed water pressure at economiser inlet	bara	By Bidder					
26.0	Feed water inlet temperature	°C	160					
26.0	Indian coal consumption for 100% BMCR	TPH	By Bidder					
27.0	South African Coal Consumption for 100% BMCR	TPH	By Bidder					
27.0	Indonesian Coal Consumption for 100% BMCR	TPH	By Bidder					
28.0	Maximum Biomass Consumption for 100% BMCR	TPH	By Bidder					
29.0	Boiler efficiency at 100% BMCR with performance coal firing	%	By Bidder					
30.0	Excess air at TAPH inlet	%	By Bidder					
31.0	Flue gas temperature at ID fan outlet	°C	By Bidder					
32.0	Max Superheater Spray	TPH	By Bidder (for which coal to be mentioned)					
33.0	Auxiliary Power consumption	kW	By Bidder					
34.0	NOx emission at stack	mg/Nm3	≤ 100 at 6% O2 Dry Basis					
35.0	SOx emission at stack	mg/Nm3	≤ 100 at 6% O2 Dry Basis					
36.0	Dust concentration at Stack	mg/Nm3	≤ 30 at 6% O2 Dry Basis					
37.0	Mercury emission at stack							
38.0	Surface temperature of the thermal insulation	°C	≤50°C for ambient temperature of 30°C & still air condition					
39.0	Combustor outlet temperature	%	By Bidder					
40.0	Unburnt Combustibles in Bottom Ash	%	≤ 2%					
41.0	Unburnt Combustibles in Fly Ash	%	< 3%					
42.0	TDS in steam leaving steam drum	ppm	< 0.05					
43.0	Silica in steam leaving final superheater	ppm	< 0.01					
44.0	Powdered limestone consumption	TPH	By Bidder					
45.0	Sulphur capture efficiency	%	By Bidder					
46.0	Ca:S molar ratio	-	By Bidder					
47.0	Total ash generated	TPH	By Bidder					
Limestone Feeding System								
48.0	Size	mm	By Bidder					
49.0	Recommended sieve analysis		By Bidder					
50.0	Elevation of bunker(s)	m	By Bidder					
51.0	Type of powdered limestone feeders		Rotary Air Lock (RAV) feeder					
52.0	Number of powdered limestone feeders		By Bidders such that with N-1 feeders in operation with maximum sulphur capture is achieved at 150% BMCR under any fuel firing condition					
53.0	Type of limestone conveying system from bunkers to combustor/siphon seal		By Bidder					
54.0	Number and location of powdered limestone feed points		Maximum capture possible with N-1 feeders					
55.0	Elevation at which the powdered limestone is added	m	By Bidder					
Fuel Feeding System								

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
56.0	No of Bunkers	nos.	Two (2)					
57.0	Fuel storage capacity	hrs	18					
57.0	Fuel Size	mm	By Bidder					
58.0	Recommended sieve analysis		By Bidder					
58.0	Moisture	%	By Bidder					
59.0	Number of feeders per steam generator		100% BMCR shall be met with N-1 feeders for any fuel firing combination					
59.0	Type of fuel feeder		Gravimetric					
60.0	Fuel feed rate control							
	Type		VFD					
	Range		By Bidder					
61.0	Number of fuel feeding ports on combustor		By Bidder					
62.0	Number of fuel feeding ports on siphon return leg		By Bidder					
63.0	Minimum number of feeders required to maintain minimum load		By Bidder					
	Temperatures							
64.0	Gas temperature							
	Leaving furnace	°C	By Bidder					
	Entering high temperature superheater	°C	By Bidder					
	Entering low temperature superheater	°C	By Bidder					
	Entering economiser	°C	By Bidder					
	Entering air heater	°C	By Bidder					
	Entering ESP	°C	By Bidder					
	At stack entrance	°C	≤ 140					
65.0	Air temperature							
	Entering air preheater (PA/SA)	°C	By Bidder					
	Leaving air preheater(PA/SA)	°C	By Bidder					
	Entering windbox (PA/SA)	°C	By Bidder					
66.0	Feed Water temperature							
	Entering economiser	°C	160					
	Leaving economiser	°C	By Bidder					
	Drum							
67.0	Design pressure	bar (a)	By Bidder					
68.0	Design temperature	°C	By Bidder					
69.0	Internal diameter	mm	By Bidder					
70.0	Thickness (Shell/dish-end)	mm	By Bidder					
71.0	Material		SA 516 Gr 70 / SA 299					
72.0	Number of safety valves and set pressure		By Bidder					
	Economiser							
73.0	Design pressure tube	bar (a)	By Bidder					
74.0	Design temperature tube	°C	By Bidder					
75.0	Flue gas velocity at 100% BMCR condition	m/s	By Bidder					
76.0	Tube Material		SA 210 Gr C					
	Header Material		SA 106 Gr B					
77.0	Design pressure header	bar (a)	By Bidder					
78.0	Design temperature header	°C	By Bidder					
79.0	Header outer diameter /Tube	mm	By Bidder					
80.0	Thickness /Tube	mm	By Bidder					
81.0	Total Effective heating surface (water/gas side)	m²	By Bidder					
	Water Wall							
82.0	Number of water walls		By Bidder					
83.0	Design pressure tube	bar (a)	By Bidder					
84.0	Design temperature tube	°C	By Bidder					
85.0	Material		SA 210 Gr. A1					
86.0	Water Wall Headers		By Bidder					
87.0	Design pressure header	bar (a)	By Bidder					
88.0	Design temperature header	°C	By Bidder					
89.0	Number of headers	No.	By Bidder					
90.0	Material		SA 210 Gr A					
	Super heater Tubes and Headers (Each Superheater)							
91.0	Type (drainable/non-drainable)		By Bidder					
92.0	Design pressure	bar (a)	By Bidder					
93.0	Design temperature	°C	By Bidder					
94.0	Material		Up to 400°C : A106 Gr B / SA106 Gr B, A106 Gr. C / SA106 Gr C (For boiler feed discharge). Above 400°C up to 470°C :A335 Gr P11/12, SA335 Gr P11/12 Above 470°C up to 550°C : A335 Gr P22, SA335 Gr P22 Above 550°C: A335 Gr P91, SA335 Gr P91					
95.0	Total Effective heating surface	m²	By Bidder					
96.0	Design pressure header	bar (a)	By Bidder					
97.0	Design temperature header	°C	By Bidder					
98.0	Header Material		SA 335 P11/ P22 / P91					
99.0	Header Outside diameter	mm	By Bidder					
100.0	Header Thickness	mm	By Bidder					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
101.0	No of safety valves on main steam line and set pressure	No. / bar (a)	By Bidder					
	Air Preheater							
102.0	No. of air preheater (APH) per steam generator	No.	By Bidder					
103.0	Type		Tubular					
104.0	Tube O.D	mm	By Bidder					
105.0	Tube thickness	mm	By Bidder					
106.0	No. of tubes (per Block)	No.	By Bidder					
107.0	Total effective heating surface	m ²	By Bidder					
108.0	Hot end tubes module		Carbon steel					
109.0	Cold End tubes module		Corten A steel					
110.0	Half sleeves		Stainless steel (SS 321)					
	PA/SA/ID fans							
111.0	No. of fans per steam generator		Two (2)					
112.0	Type		Backward curved, aerofoil type Centrifugal fan.					
113.0	Manufacturer		Bidder					
114.0	Capacity	kg/s	By Bidder					
115.0	Margin on Capacity	%	40% over 2 x 50% capacity at BMCR condition based on worst coal firing, frequency of 50 Hz, temperature of maximum ambient plus 5 deg C					
116.0	Head	mmWC	Bidder					
117.0	Margin on Head		30% over 100% BMCR requirement at 50 Hz during worst fuel firing					
118.0	Design Temperature	°C	15°C above maximum flue gas temperature					
119.0	Draught loss at 100% BMCR	mmWC	By Bidder					
120.0	Fan Speed	rpm	≤ 1500 for PA/SA fans ≤ 1000 for ID fans					
121.0	Flow Control		Variable Frequency Drive					
122.0	Motor Rating	kW	Shall be 10% over the maximum power requirement by fan at test block condition with highest flue gas flow.					
123.0	Bearing Lubrication		Forced/ Splash lubrication for each bearing					
	Air Ducts							
124.0	Thickness (Cold Air/Hot Air)	mm	> 5					
125.0	Air Velocities		Cold air < 12 m/s Hot air < 14 m/s					
	Flue Gas Ducts							
126.0	Thickness	mm	>6 (10 mm at the bottom of the horizontal ducts between the TAPH outlet and ESP inlet)					
127.0	Gas Velocities		<14 m/s upto ESP <18 m/s after ESP					
	LP Dosing Sys team							
128.0	No. of Pumps		2 x 100%					
129.0	Pump Capacity	LPH	Bidder					
130.0	Solution Preperation tank capacity	m ³	Bidder					
131.0	Solution Dilution Tank Capacity	m ³	Bidder					
132.0	Separate skid for Ammonia & O2 scavenger dosing.		Required					
	HP Dosing System							
133.0	No. of Pumps		2 x 100%					
134.0	Pump Capacity	LPH	Bidder					
134.0	Pump Piston/Casing Material		Bidder					
135.0	Solution Preperation tank capacity	m ³	Bidder					
136.0	Solution Dilution Tank Capacity	m ³	Bidder					
	Soot Blowing System (if required)							
137.0	Steam Source		Low temperature super heater header and backup line form Auxiliary Steam header					
138.0	Steam pressure	kg/cm ² (g)	By Bidder					
139.0	Steam temperature	°C	By Bidder					
	SG convective section							
140.0	Type		Rotary and Retractable type Steam Soot Blowers					
141.0	Number of soot blowers		By Bidder					
142.0	Material of blower heads		By Bidder					
143.0	Duration of operation	min	By Bidder					
144.0	Operating pressure	kg/cm ² (g)	By Bidder					
145.0	Steam consumption rate per cycle	kg/hr	By Bidder					
146.0	Steam consumption per blower per cycle	kg/hr	By Bidder					
147.0	Total time required for one complete cycle of soot blowing operation	min.	By Bidder					
	Economiser and TAPH							

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
148.0	Type		Rotary and Retractable type Steam Soot Blowers					
149.0	Number of soot blowers		By Bidder					
150.0	Material of blower heads		By Bidder					
151.0	Duration of operation	min.	By Bidder					
152.0	Operating pressure	kg/cm ² (g)	By Bidder					
153.0	Steam consumption rate per blower	kg/hr	By Bidder					
154.0	Steam consumption per blower per cycle	kg/hr	By Bidder					
155.0	Total time required for one complete cycle of soot blowing operation	min.	By Bidder					
	Miscellaneous Data							
156.0	Design Life	years	25					
157.0	Operating Times							
158.0	Cold start							
	- Time from boiler start-up to baseload conditions, min	min	By Bidder					
159.0	Warm start							
	- Time from boiler start up to base load conditions, min.	min	By Bidder					
160.0	Hot Start							
	- Time from boiler start up to baseload conditions, min.	min	By Bidder					
SECTION -2, ELECTROSTATIC PRECIPITATOR								
1.0	Manufacturer							
2.0	Type		By Bidder					
2.0	Quantity	No	1 x 100% for each unit					
3.0	Overall dimensions(LxBxH)	m x m x m	By Bidder					
3.0	No. of gas stream / ESP		Two (2)					
4.0	No. of Transformers per field		One (1)					
4.0	No. of electric fields in series/ stream		By Bidder					
5.0	No. of Hoppers per field		One (1)					
5.0	Length to height ratio (Aspect ratio)	-	Not less than 1.5					
6.0	Specific collecting Plate area (Total collecting plate area / Total gas flow)	-	Not less than 150 m2/m3/sec					
6.0	Gas flow through the ESP i) Design Fuel ii) Worst Fuel		By Bidder					
7.0	Storage capacity of dust hopper	Hrs	8					
8.0	Collecting electrodes							
	Type		By Bidder					
	Material		Corten A steel					
	Type of Rapping system		By Bidder					
	Total number of rappers per unit		By Bidder					
	Maximum number of electrodes rapped by a rapper at one time		By Bidder					
	Time of one complete rapping cycle	min	By Bidder					
9.0	Discharge Electrode							
	Type		By Bidder					
	Material		SS 304					
	Type of Rapping system		By Bidder					
	Total number of rappers per unit		By Bidder					
	Percentage of electrodes rapped by each rapper	%	By Bidder					
	Time of one complete rapping cycle	min	By Bidder					
	Rapping of inlet screens		Required					
10.0	Electric heater							
	Type		By Bidder					
	Rating	kW	By Bidder					
	Number per Hopper		By Bidder					
11.0	Transformer rectifier, collecting & emitting rapping	No.	10 no. each as minimum					
12.0	Design pressure- Positive / Negative	mbar(a)	By Bidder					
13.0	Pressure drop across ESP	mmWC	By Bidder					
14.0	Temperature drop across ESP	°C	By Bidder					
15.0	Dust concentration at ESP inlet with worst fuel at 100 % BMCR	g/Nm ³	By Bidder					
16.0	Dust concentration at ESP outlet with worst fuel at 100 % BMCR							
17.0	- All the field in service	mg/Nm ³	By Bidder					
18.0	- One field out of service	mg/Nm ³	< 30					
19.0	Dust collection efficiency	%	By Bidder					
20.0	Power consumption at design condition	kW	By Bidder					
SECTION -3, STEAM TURBINE GENERATOR AND AUXILIARIES								
	General							
1.0	Model No & Make		By Bidder					
2.0	Quantity	No	2					
3.0	Type		Single cylinder, internal extraction cum condensing type, Tandem compound regenerative feed heating, condensing down exhaust,					
4.0	Steam turbine design code		IEC 45					
5.0	Speed of the turbine (Low speed /High speed with gear box)	rpm	By Bidder (Preferably 6000 RPM)					
6.0	TG MCR net Output	MW	By Bidder					
7.0	TG MCR Gross Output	MW	30 MW					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
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PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
8.0	TG VVO Output	MW	Minimum 105% of TGMCR					
9.0	No of stages	Nos	By Bidder					
10.0	Maximum Steam flow	th	By Bidder					
11.0	Steam parameters at Steam turbine							
	Main Steam Pressure	bara	66					
	Main Steam Temperature	°C	485					
	MP Extraction Pressure	bara	By Bidder					
	MP Extraction Temperature	°C	By Bidder					
	LP Extraction Pressure	bara	By Bidder					
	LP Extraction Temperature	°C	By Bidder					
	Exhaust pressure	bar	By Bidder with 34.6 deg.C CW inlet temperature and 5 deg.C temp rise in cooling water across condenser					
	Exhaust temperature	°C	By Bidder					
12.0	Quantity of DM Water Make-up% of Cycle		3% considering boiler blow down and 30 % of total process steam supply at 32 deg.C for design.					
13.0	Point of Introduction of Condensate (DM and Process return separate) Water to Cycle		Make up water storage tank (70% condensate return from process at max 130 deg.C)					
	<u>Governing System</u>							
14.0	Mode of governing		Nozzle or Throttle					
15.0	Type of governor		Electronic/Electro hydraulic					
16.0	Overspeed protection		By Bidder					
	<u>Lube Oil System</u>							
17.0	Main oil tank							
	Number		1 x 100% , each unit					
	Capacity	m3	By Bidder. The capacity shall be adequate to contain total volume in circuit plus sufficient space available above "High oil level" to accommodate oil in circuit which will flow back to the tank during unit trips.					
	Material		By Bidder					
18.0	Main lube oil pump	No						
	Qty & type		1x100%, Shaft driven, each unit					
	Capacity of flow	m3/h	By Bidder					
	Discharge pressure	kg/cm2(g)	By Bidder					
19.0	Auxiliary lube oil pump							
	Qty & type		1x100%, AC Motor driven, each unit					
	Capacity of flow	m3/h	By Bidder					
	Discharge pressure	kg/cm2(g)	By Bidder					
	Motor Rating	kW	By Bidder					
20.0	Emergency oil pump							
	Qty & type		1x100%, DC Motor driven, each unit					
	Capacity of flow	m3/h	By Bidder					
	Discharge pressure	kg/cm2(g)	By Bidder					
	Motor Rating	kW	By Bidder					
21.0	Control oil pump (if applicable)	No						
	Qty & type		1x100%, Shaft driven, each unit					
	Capacity of flow	m3/h	By Bidder					
	Discharge pressure	kg/cm2(g)	By Bidder					
	Motor Rating	kW	By Bidder					
22.0	Jacking oil pump							
	Qty & type		2x100%, One AC and One DC, each unit					
	Capacity of flow	m3/h	By Bidder					
	Discharge pressure	kg/cm2(g)	By Bidder					
	Motor Rating	kW	By Bidder					
23.0	Lube oil cooler							
	Qty & type		2x100% (1W+1S) , each unit, Shell & Tube type					
24.0	Lube oil filter							
	Qty & type		2x100% (1W+1S) , each unit, Duplex type					
25.0	Lube oil conditioning equipment							
	Qty & type		One Centrifuge for Each unit					
	Mode of operation		Continuous in bypass mode					
	Capacity of unit		20% of the system capacity					
	Water content in oil by volume at purifier outlet		Free of moisture					
26.0	Lube oil tank Vapour extractors		2x100% (1W+1S) , each unit, AC motor driven					
27.0	Overhead lube oil tank for emergency supply of oil		Required, 1 no					
28.0	Barring gear							
	Type		Hydraulic or AC motor driven					
	Speed of turbine during turning gear operation		By Bidder					
	Motor rating		By Bidder					
	Provision of Hand barring		Required					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
29.0	Weights							
	Name and weight of the heaviest piece to be handled during erection	t	By Bidder					
	Name and weight of the heaviest piece to be handled by the station EOT crane during maintenance	t	By Bidder					
	Material of Construction							
30.0	Lube Oil Cooler		SS 304					
	Shell		SS 304					
	Tubes		SS 304					
	Baffle plates, tie rods and nuts		SS 304					
31.0	Generator Oil Cooler							
	Tubes Plate		IS 2062 Gr. B					
	Water box		IS 2062 Gr. B					
	End Cover		IS 2062 Gr. B					
	Water box flange		IS 2062 Gr. B					
	Stud & Nut		SA 193 B7 / 194-2H					
	Tubes		SS 304					
SECTION - 4, MEDIUM PRESSURE (MP) PROCESS STEAM SYSTEM								
1.0	Flow	TPH	Normal: 75 Peak: 90					
2.0	Pressure at Terminal Point	bar(a)	Min-12, Max-14					
3.0	Temperature at Terminal Point	°C	Min-190, Max-220					
SECTION - 5, LOW PRESSURE (LP) PROCESS STEAM SYSTEM								
1.0	Flow	TPH	Normal: 115 Peak: 140					
2.0	Pressure at Terminal Point	bar(a)	Min-4.3, Max-6.5					
3.0	Temperature at Terminal Point	°C	Min-160, Max-190					
SECTION - 6, SURFACE CONDENSER								
1.0	Type of Condenser		Single shell with divided water box					
2.0	No of condenser		One (1) for each unit					
	Orientation		Perpendicular to turbine rotor axis					
	Equipment Design Code		HEI for Surface Condenser (Latest Edition)					
3.0	Number of passes		2					
4.0	Design condenser back pressure	bar (a)	By Bidder					
5.0	Exhaust temperature	°C	By Bidder					
6.0	Design Heat Load of Condenser	kW	Condenser shall be designed to take care of condensing load of about 10 MW generation with zero process steam requirement.					
7.0	Cooling water flow	m3/h	By Bidder					
8.0	Cleanliness factor	%	90					
9.0	C.W. Velocity in tubes	m/sec.	2.5 (max)					
10.0	Tube size	OD (mm) x BWG	By Bidder					
11.0	Shell side design pressure	kg/cm ² (g)	Turbine pressure relief self closing type disc release pressure & full vacuum					
12.0	Shell side design temperature	°C	Turbine exhaust hood temperature high trip setting.					
13.0	Tube side design pressure	kg/cm ² (g)	Shall be equal to the circulating water pump shut-off head, rounded off to next higher 0.5 kg/cm plus an allowance for water hammer surge, etc.					
14.0	Tube side design temperature	°C	60					
15.0	Water box design pressure	kg/cm ² (g)	Shall be equal to the circulating water pump shut-off head, rounded off to next higher 0.5 kg/cm plus an allowance for water hammer surge, etc.					
16.0	Water box test pressure	kg/cm ² (g)	1.5 times the design pressure					
17.0	Cooling water design parameters							
	-Inlet temperature	°C	34.6					
	-Outlet temperature	°C	39.6					
18.0	Pressure drop across the tubes	mic	Max 5					
19.0	Hot-well storage capacity from normal level to low-low level	m ³	Five (5) minutes retention					
20.0	Material of construction							
	- Condenser neck, condenser shell & hotwell		ASTM A516-70					
	- Water box		ASTM A516 Gr 70					
	- Tube sheets		SA516Gr70 + SS clad					
	- Condenser tubes		SS (SA 213 TP304, seamless)					
	- Tube support plates		SA516Gr70					
	- Nozzle (on shell / waterbox)		SA106GrB / SA516Gr70					
	- Flange		SA105 / SA516Gr70					
	- Bolts		SA 193 Gr B7					
	- Nuts		SA 194 Gr 2H					
21.0	Construction Features							
	- Connection between turbine exhaust and condenser		By Bidder					
22.0	Weights							
	- When equipment completely filled with water	kg	By Bidder					
	- Empty	kg	By Bidder					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
23.0	Codes and standards		ASME / HEI					
SECTION - 7, CONDENSER AIR EVACUATION SYSTEM								
1.0	Type of Vacuum system		Steam Jet air ejector (SJAE)					
2.0	Number required		Two(2) x 100% holding ejectors and One(1)x100% Hogging Ejector , for each unit					
3.0	Motive steam parameters to SJAE							
	a) Pressure	bar (g)	By Bidder					
	b) Temperature	°C	By Bidder					
	c) Flow	t/h	By Bidder					
4.0	Capacity							
	Capacity of holding SJAE		Shall be not less than 120 percent of the capacity obtained from HEI standards					
	Capacity of hogging SJAE		Shall be able to achieve vacuum upto 0.34 kg/sq.cm (a) within 30 minutes, from atmospheric pressure					
5.0	Fouling Factor	h.m ² /C/Kcal	By Bidder					
6.0	Material of construction							
	- Diffusers		CS					
	- Nozzle		SS 304					
	- Inter & after cooler shell		SA 516 Gr. 70					
	- Inter and after cooler tubes		SA 213 Gr. TP 304. Also all baffle plates, tie rods and nuts shall be of SS304 constuction					
SECTION - 8, CONDENSER TUBE CLEANING SYSTEM								
1.0	Ball Collector qty	Nos	2 x 50% ,each unit					
2.0	Recirculation pump							
	- Quantity	Nos	2 x 50% ,each unit					
	- Type		By Bidder					
	- Motor rating	kW	By Bidder					
3.0	Ball strainer qty		2 x 50% ,each unit					
SECTION - 9, DEBRIS FILTER								
1.0	Quantity		2 x 50% ,each unit					
2.0	Type		By Bidder					
3.0	Filter element		By Bidder					
SECTION - 10, CONDENSER WATER BOX PRIMING SYSTEM								
1.0	Vacuum Control tank qty	Nos	1x 100% ,each unit					
2.0	Seperator qty	Nos	2 100% ,each unit					
3.0	Plate heat exchanger		2x100% ,each unit					
4.0	Vacuum pump							
	- Quantity	Nos	By Bidder					
	- Capacity	m ³ /h	By Bidder					
	- Motor rating	kW	By Bidder					
SECTION - 11, GLAND STEAM CONDENSER								
1.0	Number of gland steam condensers		One (1) ,each unit					
2.0	Type		Shell and tube type with 2x 100% ,exhauster					
3.0	Number of tube passes		By Bidder					
4.0	Power consumption of vapour exhauster fan	kW	By Bidder					
5.0	Material of construction							
	Shell		SA106 Gr. B					
	Tubes		SA 213 TP 304					
	Tubes Sheet		SS 304					
	Baffles		SS 304					
	End Cover and flange		SA 516 Gr. 70					
	Rest all parts		CS					
6.0	Fouling / Cleanliness factor		By Bidder					
SECTION - 12, CONDENSATE EXTRACTION PUMP								
1.0	Type of the pump		Vertical Cannister					
2.0	Redundancy		3 x 100% ,each Unit					
3.0	Design capacity per pump	m ³ /h	CEP design flow shall correspond to the maximum condensate flow as specified plus 10 % margin for pump wear.					

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SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
4.0	Total dynamic head (TDH) at design		While establishing the design TDH the following shall be considered : Discharge Pressure: a) Make up water storage tank operating pressure. b) Static discharge head from the condensate pump discharge nozzle centerline to the centerline of Make up water storage tank inlet nozzle. c) Pressure loss across the gland steam condenser (GSC) & ejector condenser d) Pressure loss through the piping system Suction Pressure: The total suction pressure is equal to the sum of the condenser pressure and the static head, minus the pressure drop in the piping system from the condenser outlet to the centerline of suction nozzle of pump including entrance loss at the condenser hotwell outlet. The condenser pressure is considered as per the heat and mass balance diagram. The static suction head is the difference between the Low-Low Level in the hotwell and the centerline of suction nozzle of CEP, at the design condensate pump suction temperature. An additional 10% margin over the calculated friction loss shall be considered for friction loss calculation.					
5.0	Minimum flow per pump	m3/h	Not less than twenty five (25) percent					
6.0	Best efficiency point of pump	%	Shall be at 100% TG MCR (Guaranty case)					
7.0	Shut-off pressure	bar	Between 115% and 130% of pump design total dynamic head of pump.					
8.0	NPSH available (min.)	m	Shall be based on condenser hotwell lowest level and total head loss in the suction line considering the condenser operating pressure and vapour pressure of the fluid					
9.0	NPSH required at 3% head break	m	Shall not be greater than 80% of NPSH available over the entire range of operation from minimum flow to pump runout and it should be min 1 m lesser than the NPSH available.					
10.0	Pump efficieny at design point	%	By Bidder					
11.0	Motor rating	kW	By Bidder					
12.0	Acceptable noise level at all operating conditions		Not greater than 85 dBA at 1.0m from the outline of equipment					
	Suction specific speed	US units	not greater than 11,000					
	Maximum allowable vibration level at all operating conditions (Peak)	mm/sec	As per API 610 (10th Edition)					
	Maximum speed	rpm	1500					
	Pressure drop across strainer @ 50% clogged condition	bar	0.15					
	Material of construction							
13.0	Mounting flange		CS					
14.0	Discharge elbow, Column pipe		CS					
15.0	Suction bell, Bowl or casing, Discharge casing		CS					
16.0	Diffuser & guide vanes, cannister		12% CHR					
17.0	Wearing rings		12% CHR Handened					
18.0	Shaft sleeves		12% CHR Handened					
19.0	Pump & Drive shaft		AISI 4140					
20.0	Impeller		12% CHR					
SECTION - 13, DEAERATOR								
	General							
1.0	Manufacturer		By Bidder					
2.0	Type of deaerating feed water heater		Spray cum trav type					
3.0	Type of spraying arrangement		Spray valves (variable flow area)					
4.0	Operation		Constant pressure operation					
5.0	Number required		One					
	Design Data							
6.0	Design conditions		Deaerator design shall match steam generator requirement with steam supply from LP Process Steam Header / Turbine bleed					
7.0	Design pressure of deaerator and feed water storage tank	kg/cm ² (g)	By Bidder 125% of maximum deaerating steam pressure rounded off to next higher 0.5 kg/cm² and full vacuum					

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PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
8.0	Design temperature of deaerator	°C	By Bidder Shall be compatible with heating source temperature of steam or 205°C whichever is higher, rounded off to next higher 5°C					
9.0	Design temperature of feed water storage tank	°C	By Bidder 5°C higher than saturation temperature corresponding to the design pressure or 205°C whichever is higher, rounded off to next higher 5°C					
10.0	Net feed water storage tank capacity at 2/3 rd level (normal) between normal level and top of boiler feed pump suction in deaerator exclusive of volume of any internal piping, baffles & excluding volume of dished ends	m ³	10 minutes storage capacity at BMCR for both the steam generators between normal level & low-low level					
11.0	Corrosion allowance over and above design code requirements	mm	3.2					
12.0	Pressure drop across spray valve assembly at maximum condensate flow	kg/cm ²	0.5					
13.0	Deaerator Vent Condenser		Required					
	Material of construction							
14.0	Deaerator shell & heads		SA 516 Gr 70 or equivalent					
15.0	Feed water storage tank shell & heads		SA 516 Gr 70 or equivalent					
16.0	Trays		Stainless steel to SS 304					
17.0	Tray enclosure		Stainless steel to SS 304					
18.0	Spray valves / sprayer assembly		Stainless steel to SS 304					
19.0	Steam distribution pipe (Internal/Nozzles/ Condensate pipes)		SA 106 Gr. B or equivalent					
20.0	Splash plates, baffle plates		Stainless steel to SS 304					
21.0	Bolts		SA-193 B7 or equivalent					
22.0	Nuts		SA-194 2H or equivalent					
23.0	Gaskets		CAF 40					
24.0	Internal bolting, if any		Stainless steel to SS 304					
25.0	Vent orifice		Stainless steel to SS 304					
26.0	Deaerator vent condenser shell		SA 516 Gr 70 or equivalent					
27.0	Deaerator vent condenser tubes		Stainless steel to SS 304					
	Accessories							
28.0	Vortex breaker for feed water outlet nozzle		Yes					
29.0	Vent orifice plate		Yes					
30.0	Safety relief valve		Yes					
31.0	Internal startup steam heating pipes		Yes					
32.0	Saddle supports (fixed and roller mounted) as required/specified.		Yes					
33.0	Manhole covers for deaerator and feedwater storage tank		Yes					
34.0	Tray access door in deaerator		Yes					
35.0	Maintenance platforms and walkway around equipment.		Yes					
36.0	Stand pipes for mounting of level instruments along with root valves		Yes					
37.0	Insulation clips		Yes					
38.0	Lifting lugs		Yes					
39.0	Name plates		Yes					
40.0	Vacuum breaker valve.		Yes					
41.0	Vent valves with orifices		Yes					
42.0	Companion flanges with nuts, bolts, and gaskets for all flanged terminal connections.		Yes					
43.0	One non – return valve along with locked open type isolating gate valve required as vacuum breaker.		Yes					
44.0	Pressure equalizing line for extraction steam inlet line with non return valve (for spray type deaerator)		Yes					
SECTION - 14, BOILER FEED PUMP								
1.0	Manufacturer		By Bidder					
2.0	No. of Pumps		2 × 100 % (1W + 1 SB) per boiler, Total 4 nos					
3.0	Type of pump		Centrifugal multistage barrel type main pump with variable speed hydraulic coupling connected to an electric motor. However, the coupling between hydraulic coupling and pump/motor shall be flexible spacer type coupling.					
4.0	Type of drive		AC Electric Motor					
5.0	Flow water flow	m ³ /h	110% of BMCR requirement with 3% Blowdown including spray water requirement for process PRDS and auxiliary PRDS.					
6.0	Maximum design temperature	°C	200					
7.0	Feed Water Temperature	°C	By Bidder					
8.0	Total dynamic head	mlc	By Bidder					
9.0	Minimum flow through the pump at design speed	kg/hr	By Bidder					

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PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
10.0	Maximum combined shutoff head at maximum speed	m/c	By Bidder					
11.0	NPSH required							
12.0	(a) At design flow	m/c	By Bidder					
13.0	(b) At power consumption guarantee point	m/c	By Bidder					
14.0	Margin required between NPSH available and NPSH required							
15.0	(a) At design flow	m/c	By Bidder					
16.0	(b) At power consumption guarantee point	m/c	By Bidder					
17.0	Efficiency							
	(a) At power consumption guarantee point	%	By Bidder					
	(b) At design point	%	By Bidder					
18.0	Motor Power input (main pump and accessories)							
	(a) At rated flow and head	kW	By Bidder					
	(b) At power consumption guarantee point	kW	By Bidder					
19.0	Drive motor rating	kW	By Bidder					
20.0	Rated Speed	rpm	By Bidder					
21.0	Maximum design speed	rpm	2980					
22.0	Maximum suction specific speed	rpm	< 9 5 00					
23.0	Pump shut-off head	m/c	120-130% of TDH at design point ,no negative tolerance					
24.0	Minimum capacity of low flow recirculation control valve at pump rated speed kg./hr.		Not less than 25% of rated capacity tolerance					
25.0	Max noise level over entire range of operation at 1.0 m from pump outline	dB(A)	85					
26.0	Reverse speed for which pump and driver is designed	rpm	By Bidder					
27.0	Insulation cladding metal surface temperature	°C	50					
28.0	Type of external casing		Barrel					
29.0	Type of sealing arrangement		Mechanical Seal (API Plan 23)					
30.0	Coupling		Flexible					
31.0	Balancing leak-off connection		By Bidder					
32.0	Material of construction							
	Outer casing		Forged carbon steel					
	Inner casing		12 % CHR					
	Impeller		12 % CHR					
	Wearing rings		12 % CHR Hardened					
	Stuffing box bushing		12 % CHR Hardened					
	Stuffing box		13% Cr steel to A743-CA15 or equivalent					
	Shaft		AISI 4140					
	Shaft sleeve		12 % CHR Hardened					
	Diffuser/Volute		12 % CHR					
	Strainer		Stainless steel mesh					
33.0	Cooling Water requirement per Pump							
34.0	Total Cooling water required	m ³ /hr	By Bidder					
35.0	Lubricating Oil System for BFP							
36.0	Lubrication system (if required)							
37.0	Design capacity	m ³ /hr.	By Bidder					
38.0	Reservoir capacity	m ³	By Bidder					
39.0	Reservoir material		By Bidder					
40.0	Type of pump (s)		By Bidder					
41.0	Number of pump(s)		By Bidder					
42.0	Pump speed	rpm	By Bidder					
43.0	Shaft power	kW	By Bidder					
44.0	Motor Rating	kW	By Bidder					
45.0	Total weight of assembled unit	kg.	By Bidder					
SECTION - 15, MAKE UP WATER STORAGE TANK								
1.0	Number	m3	2 x 50%					
2.0	Capacity	m3	By Bidder					
3.0	Storage time	min	By Bidder					
4.0	Type		Fixed cone roof type					
5.0	Material of construction							
	Storage tank shell & heads		SA 516 Gr 70 or equivalent					
	Steam distribution pipe (Internal/Nozzles/ Condensate pipes		SA 106 Gr. B or equivalent					
	Splash plates, baffle plates (if any)		Stainless steel to SS 304					
	Bolts		SA-193 B7 or equivalent					
	Nuts		SA-194 2H or equivalent					
	Gaskets		CAF 40					
	Internal bolting, if any		Stainless steel to SS 304					
SECTION - 16, CONDENSATE MAKE UP PUMP								
1.0	Type		Horizontal Centrifugal Pump					
2.0	Configuration		2 x 100%					
3.0	Capacity	m3/h	By Bidder					
4.0	Total dynamic head	m	By Bidder					
5.0	NPSH required	m	By Bidder					
6.0	Efficiency	%	By Bidder					
7.0	Motor rating	kW	By Bidder					
8.0	Material of construction		By Bidder					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
	Outer casing		Forged carbon steel					
	Inner casing		12 % CHR					
	Impeller		12 % CHR					
	Wearing rings		12 % CHR Hardened					
	Stuffing box bushing		12 % CHR Hardened					
	Stuffing box		13% Cr steel to A743-CA15 or equivalent					
	Shaft		AISI 4140					
	Shaft sleeve		12 % CHR Hardened					
	Diffuser/Volute		12 % CHR					
	Strainer		Stainless steel mesh					
SECTION - 17, PRESSURE REDUCING & DE-SUPERHEATING STATIONS								
9.0	Location		HP PRDS- From main steam header to MP process steam header LP PRDS- From MP process steam header to LP process steam header Other PRDS as per Bidder's system requirement					
10.0	Configuration		HP PRDS- 1 EA LP PRDS- 1 EA Other PRDS as per Bidder's system requirement					
11.0	Size	NB	By Bidder					
SECTION - 18, AIR CONDITIONING AND VENTILATION SYSTEM								
VAPOUR ABSORPTION CHILLERS								
1	GENERAL							
1.1	DESIGNATION		VAPOUR ABSORPTION CHILLER					
1.2	NUMBERS OFFERED	Nos.	BY BIDDER					
1.3	TAG NUMBERS		BY BIDDER					
1.4	MAKE, MODEL NUMBER AND PLACE OF MANUFACTURE		BY BIDDER					
1.5	CAPACITY OF EACH CHILLING PACKAGE		BY BIDDER					
1.6	AT SPECIFIED DESIGN CONDITIONS	TR	BY BIDDER					
1.7	AT AHRI STANDARD RATING CONDITIONS	TR	BY BIDDER					
1.8	CAPACITY CONTROL		10 TO 100% AUTOMATIC					
1.9	REFRIGERANT / ABSORBENT PIPING REQUIRED		YES					
1.10	OVERALL SIZE(L X W X H)	mm	BY BIDDER					
1.11	MINIMUM OVERHEAD CLEARANCE REQUIRED FOR INSTALLATION AND SERVICE	mm	BY BIDDER					
1.12	MINIMUM TUBE REMOVAL / CLEANING SPACE REQUIRED ON EITHER END OF CONDENSER	mm	BY BIDDER					
1.13	MINIMUM SERVICE SPACE REQUIRED ON EITHER SIDE	mm	BY BIDDER					
1.14	OPERATING WEIGHT	kg	BY BIDDER					
1.15	TYPE OF VIBRATION ISOLATORS		NEOPRENE RUBBER PADS WITH SOLE PLATES FOR LEVELLING.					
1.16	AUTOMATIC PURGE UNIT		YES					
1.17	CORROSION INHIBITOR		YES					

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SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
1.18	NOISE LEVEL AT 1.5 M DISTANCE	dB(A)	BY BIDDER					
1.19	AHRI CERTIFICATION		YES					
1.20	COMPANION FLANGES AS PER ANSI B 16.5 # WITH NUT BOLT AND GASKETS		YES					
2	GENERATOR							
2.1	TYPE		STEAM FIRED DOUBLE EFFECT					
2.2	STEAM FIRED		BY BIDDER					
2.3	PRESSURE AT CONTROL VALVE INLET	kg/cm ² (g)	BY BIDDER					
	SUPERHEAT AT CONTROL VALVE INLET	°C	BY BIDDER					
2.4	FLOW RATE FOR EACH CHILLER	kg/hr	BY BIDDER					
2.5	CONDENSATE PRESSURE AVAILABLE AT THE OUTLET OF UNIT INSULATION	kg/cm ² (g)	BY BIDDER					
			BY BIDDER					
2.6	MATERIAL AND THICKNESS	mm	BY BIDDER					
2.7	DENSITY	kg/m ³	BY BIDDER					
	THERMAL CONDUCTIVITY	kCal/m hr °C	BY BIDDER					
2.8	INSULATION FINISH		BY BIDDER					
3	CHILLER							
3.1	MAKE AND MODEL NUMBER		BY BIDDER					
3.2	CAPACITY AT DESIGN CONDITIONS	TR	BY BIDDER					
3.3	TOTAL HEAT TRANSFER AREA		BY BIDDER					
3.4	REFRIGERANT SIDE	m ²	BY BIDDER					
3.5	WATER SIDE	m ²	BY BIDDER					
3.6	FOULING FACTOR	m ² hr °C / kCal	0.0001					
3.7	WATER FLOW RATE	m ³ /hr	BY BIDDER					
3.8	WATER INLET/OUTLET TEMPERATURE	°C	BY BIDDER					
3.9	MAXIMUM WATER SIDE PRESSURE DROP	MLC	7					
3.10	REFRIGERANT SIDE DESIGN PRESSURE	kg/cm ² (g)	BY BIDDER					
3.11	WATER SIDE DESIGN PRESSURE	kg/cm ² (g)	BY BIDDER					
3.12	REFRIGERANT EVAPORATING TEMPERATURE	°C	BY BIDDER					
3.13	TYPE OF MOTORIZED VALVE		YES					
3.14	INSULATION		BY BIDDER					
3.15	MATERIAL		BY BIDDER					
3.16	THICKNESS	mm	BY BIDDER					
3.17	DENSITY	kg/m ³	BY BIDDER					
3.18	THERMAL CONDUCTIVITY	kCal/m hr °C	BY BIDDER					
3.19	INSULATION FINISH		BY BIDDER					
4	CONDENSER / ABSORBER							
4.1	MAKE AND MODEL NUMBER		BY BIDDER					
4.2	TYPE		WATER COOLED					
4.3	HEAT REJECTION CAPACITY AT DESIGN CONDITION	KCal/Hr	BY BIDDER					
4.4	TOTAL HEAT TRANSFER AREA		BY BIDDER					
4.5	REFRIGERANT SIDE	m ²	BY BIDDER					
4.6	WATER SIDE	m ²	BY BIDDER					
4.7	FOULING FACTOR	m ² hr °C / kCal	0.0002					
4.8	WATER FLOW RATE	m ³ /hr	BY BIDDER					
4.10	WATER INLET/OUTLET TEMPERATURE	°C	BY BIDDER					
4.11	MAXIMUM WATER SIDE PRESSURE DROP	MLC	7					
4.12	REFRIGERANT SIDE DESIGN PRESSURE	kg/cm ² (g)	BY BIDDER					
4.13	WATER SIDE DESIGN PRESSURE	kg/cm ² (g)	BY BIDDER					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
4.14	TYPE OF MOTORIZED VALVE		ON -OFF TYPE					
4.15	MATERIALS OF CONSTRUCTION		BY BIDDER					
4.16	LOWER AND UPPER SHELL		SA 515 GR 70					
4.17	HIGH TEMPERATURE GENERATOR SHELL		SA 106 GR.B, SA 515 GR 70					
4.18	TUBES FOR LOW TEMPERATURE GENERATOR, CHILLER, CONDENSER AND ABSORBER		SEAMLESS COPPER					
4.19	TUBES FOR HIGH TEMPERATURE GENERATOR		SEAMLESS CUPRO NICKEL/STAINLESS STEEL					
4.20	REFRIGERANT PIPING		SA 106 GR B					
4.21	ABSORBENT PIPING		SA 106 GR B					
4.22	REFRIGERANT / ABSORBENT PUMPS		BY BIDDER					
4.23	IMPELLER		STAINLESS STEEL					
4.24	CASING		CARBON STEEL					
4.25	SHAFT		STAINLESS STEEL					
5	ELECTRICAL							
5.1	MOTOR		YES					
5.2	STARTER		YES					
5.3	TYPE OF STARTER		DOL/STAR DELTA					
6	CONTROL PANEL							
6.1	TYPE		MICRO- PROCESSOR/ MICRO COMPUTER CONTROL PANEL					
6.2	CONTROL PANEL TO BE INTERFACED WITH BMS		YES					
6.3	PLANT MANAGER		YES					
7	ESSENTIAL SPARES							
7.1	GASKETS	SETS	BY BIDDER					
7.2	FASTENERS	SETS	BY BIDDER					
7.3	SEALS	SETS	BY BIDDER					
8	PERFORMANCE GUARANTEES							
8.1	CAPACITY OF CHILLING PACKAGE	TR	BY BIDDER					
8.2	POWER CONSUMPTION OF EACH CHILLING PACKAGE	KW	BY BIDDER					
8.3	CHILLED WATER FLOW RATE		BY BIDDER					
8.4	CHILLED WATER INLET TEMPERATURE	°C	BY BIDDER					
8.5	CHILLED WATER OUTLET TEMPERATURE	°C	BY BIDDER					
8.6	CHILLED WATER PRESSURE DROP	MLC	BY BIDDER					
8.7	COOLING WATER FLOW RATE	m ³ /hr	BY BIDDER					
8.8	COOLING WATER OUTLET TEMPERATURE	°C	BY BIDDER					
8.9	COOLING WATER PRESSURE DROP	MLC	BY BIDDER					
8.10	STEAM FLOW RATE	kg/hr	BY BIDDER					
8.11	HOT WATER FLOW RATE	m ³ /hr	BY BIDDER					
8.12	FUEL CONSUMPTION	kg/hr	BY BIDDER					
9	MISCELLANEOUS		BY BIDDER					
9.1	COMPLETE DETAILS OF CONTROL PANEL		ENCLOSED / NOT ENCLOSED					
9.2	SPARE PARTS LIST		ENCLOSED / NOT ENCLOSED					
9.3	PERFORMANCE CURVE/RATING CHARTS WITH OPERATING POINTS MARKED		ENCLOSED / NOT ENCLOSED					
9.4	DETAILS OF PURGE UNIT SEPARATOR		ENCLOSED / NOT ENCLOSED					
9.5	DESCRIPTION OF OPERATION INDICATING ANTI-CRYSTALLISATION MEASURES BUILT INTO THE SYSTEM		ENCLOSED / NOT ENCLOSED					
10	ESSENTIAL SPARES							
10.1	GASKETS	SETS						
10.2	FASTENERS	SETS						
10.3	SEALS	SETS						
LIQUID SCREW CHILLING UNITS								
1	GENERAL							

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
1.1	DESIGNATION		SCREW CHILLER					
1.2	NUMBERS OFFERED	Nos.	1					
1.3	TAG NUMBERS		BY BIDDER					
1.4	LOCATION		INDOOR					
1.5	DUTY		CONTINUOUS					
1.6	MAKE, MODEL NUMBER & PLACE OF MANUFACTURE		BY BIDDER					
1.7	CAPACITY OF EACH CHILLING PACKAGE		CAPACITY OF SCREW CHILLER SHALL BE SAME AS VAM.					
1.7.1	AT SPECIFIED CONDITIONS	TR	BY BIDDER					
1.7.2	AT AHRI STANDARD RATING CONDITIONS	TR	BY BIDDER					
1.8	REFRIGERANT		R134a					
1.9	AUTOMATIC PURGE UNIT IN CASE OF R123 REQUIRED		YES					
1.1	REFRIGERANT LEAK DETECTION AND ALARM IN CASE OF R123 CHILLERS REQUIRED		YES					
1.11	OVERALL SIZE (L X W X H)	mm	BY BIDDER					
1.12	MINIMUM OVERHEAD CLEARANCE FOR INSTALLATION AND SERVICE RE	mm	BY BIDDER					
1.13	MINIMUM TUBE REMOVAL / CLEANING SPACE REQUIRED ON EITHER EN	mm	BY BIDDER					
1.14	MINIMUM SERVICE SPACE REQUIRED ON ALL SIDES	mm	BY BIDDER					
1.15	OPERATING WEIGHT	kg	BY BIDDER					
1.16	TYPE OF VIBRATION ISOLATORS		SPRING ISOLATORS					
1.17	SEISMIC SNUBBERS		PROVIDED / NOT PROVIDED					
1.18	NOISE LEVEL AT 1.5 M DISTANCE	dB(A)	BY BIDDER					
1.19	AHRI CERTIFICATION		YES					
1.2	PAINTING		AS PER MRFs STD					
2	COMPRESSOR							
2.1	TYPE		SEMI-HERMETIC TWIN SCREW					
2.2	MAKE AND MODEL NUMBER		BY BIDDER					
2.3	DRIVE		DIRECT/GEAR					
2.4	DRIVE GUARD		YES					
2.5	LUBRICATION		FORCED FEED WITH AN OIL PUMP					
2.6	STATIC AND DYNAMIC BALANCING OF IMPELLER		AS PER ISO 1940					
2.7	MAGNETIC BEARINGS		REQUIRED / NOT REQUIRED					
2.8	NO OF STAGES OF COMPRESSION		BY BIDDER					
2.9	SUCTION TEMPERATURE	°C	BY BIDDER					
2.1	SUCTION PRESSURE	kg/cm ² (g)	BY BIDDER					
2.11	CONDENSING TEMPERATURE	°C	BY BIDDER					
2.12	CONDENSING PRESSURE	kg/cm ² (g)	BY BIDDER					
2.13	OPERATING SPEED	RPM	BY BIDDER					
2.14	CAPACITY AT OPERATING CONDITIONS	TR	BY BIDDER					
2.15	TOTAL POWER CONSUMED AT OPERATING CONDITIONS	kW	BY BIDDER					
2.16	MOTOR RATING	kW	BY BIDDER					
2.17	POWER CONSUMPTION AT PART LOADS AT SPECIFIED DESIGN CONDITIO	IKW/TR	BY BIDDER					
2.17.1	1		BY BIDDER					
2.17.2	0.75		BY BIDDER					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
2.17.3	0.5		BY BIDDER					
2.17.4	0.25		BY BIDDER					
2.18	INTEGRATED PART LOAD VALUE (IPLV) AND APPLICATION PART LOAD VALUE (APLV) AS PER AHRI STANDARD		IPLV/APLV					
2.19	CAPACITY CONTROL		AUTOMETIC 10-100%					
2.19.1	INLET GUIDE VANE CONTROL		PROVIDED / NOT PROVIDED					
2.19.2	VARIABLE SPEED		PROVIDED / NOT PROVIDED					
2.19.3	MAGNETIC BEARING		PROVIDED / NOT PROVIDED					
3.0	CHILLER							
3.1	TYPE		SHELL AND TUBE					
3.2	MAKE AND MODEL NUMBER		BY BIDDER					
3.3	LIQUID TO BE COOLED		WATER					
3.4	CAPACITY AT DESIGN CONDITIONS	TR	BY BIDDER					
3.6	FOULING FACTOR	m ² Hr °C/ kCal	0.0001					
	MATERIAL OF CONSTRUCTION							
3.7.1	SHELL, END COVERS & TUBE SHEETS		CARBON STEEL					
3.7.2	TUBES		INNER GROOVED SEAMLESS COPPER					
3.8	WATER / BRINE FLOW RATE	m ³ /hr	BY BIDDER					
3.9	WATER INLET/OUTLET TEMPERATURE	°C	BY BIDDER					
3.1	WATER VELOCITY IN TUBES	m/s	2.5					
3.11	WATER SIDE PRESSURE DROP	MLC	BY BIDDER					
3.12	REFRIGERANT SIDE DESIGN PRESSURE	kg/cm ² (g)	BY BIDDER					
3.13	WATER SIDE DESIGN PRESSURE	kg/cm ² (g)	16					
3.14	REFRIGERANT SIDE TEST PRESSURE	kg/cm ² (g)	BY BIDDER					
3.15	WATER SIDE TEST PRESSURE	kg/cm ² (g)	24					
3.16	SYSTEM REFRIGERANT CHARGE	kg	BY BIDDER					
3.17	REFRIGERANT EVAPORATING TEMPERATURE	°C	BY BIDDER					
3.18	INSULATION							
3.18.1	MATERIAL		Nitrile rubber					
3.18.2	THICKNESS	mm	25					
3.18.3	DENSITY	kg/m3	BY BIDDER					
3.18.4	THERMAL CONDUCTIVITY	kCal/mhr deg C	BY BIDDER					
3.18.5	INSULATION FINISH		BY BIDDER					
3.19	TYPE OF MOTORISED VALVE AT OUTLET PIPING		ON-OFF TYPE					
3.20	DETAILS OF MOTORISED VALVE		ENCLOSED / NOT ENCLOSED					
3.21	COMPANION FLANGES		PROVIDED / NOT PROVIDED					
3.22	TYPE OF COMPANION FLANGES OFFERED		ANSI / VICTUALIC COUPLING					
3.23	FASTENERS / GASKETS		PROVIDED / NOT PROVIDED					
4.0	CONDENSER							
4.1	WATER COOLED CONDENSERS		SHELL AND TUBE					
4.2	CONDENSER COOLING WATER QUALITY		BY BIDDER					
4.3	MAKE AND MODEL NUMBER		BY BIDDER					
4.4	HEAT REJECTION CAPACITY AT DESIGN CONDITIONS	kCal/Hr	BY BIDDER					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
4.5	TOTAL HEAT TRANSFER AREA		BY BIDDER					
4.5.1	REFRIGERANT SIDE	m2	BY BIDDER					
4.5.2	WATER SIDE	m2	BY BIDDER					
4.6	FOULING FACTOR	FPS	0.00025					
4.7	WATER FLOW RATE	m³/hr	BY BIDDER					
4.8	WATER INLET/OUTLET TEMPERATURE	°C	33/38					
4.9	WATER SIDE PRESSURE DROP	MLC	NOT EXCEEDING 7					
4.1	REFRIGERANT SIDE DESIGN PRESSURE	kg/cm²(g)	BY BIDDER					
4.11	WATER SIDE DESIGN PRESSURE	kg/cm²(g)	16					
4.12	REFRIGERANT SIDE TEST PRESSURE	kg/cm²(g)	BY BIDDER					
4.13	WATER SIDE TEST PRESSURE	kg/cm²(g)	24					
4.16	MATERIAL OF CONSTRUCTION							
4.16.1	SHELL, END COVERS & TUBE SHEETS		CARBON STEEL					
4.16.2	TUBES		INNER GROOVED SEAMLESS COPPER					
4.17	COMPANION FLANGES		PROVIDED / NOT PROVIDED					
4.18	TYPE OF COMPANION FLANGES		ANSI / VICTUALIC COUPLING					
4.19	FASTENERS & GASKETS		PROVIDED / NOT PROVIDED					
5.0	<u>OIL COOLER</u>							
5.1	TYPE		SHELL & TUBE HEAT EXCHANGER					
5.2	MATERIAL OF CONSTRUCTION							
5.2.1	SHELL		SS304 / A516 GR 60 / A-285 GR C					
5.2.2	TUBE SHEETS		SS304 / A516 GR 60 / A-285 GR C					
5.2.3	TUBE		SS304 /SA 179					
6.0	<u>ELECTRICAL</u>							
6.1	STARTER		BY CONTRACTOR					
6.2	TYPE OF STARTER		SOFT STARTER					
7.0	<u>CONTROL PANEL</u>							
7.1	COMPLETE DETAILS OF ELECTRICAL PANEL		ENCLOSED / NOT ENCLOSED					
7.2	COMPLETE DETAILS OF MICROPROCESSOR/ MICRO-COMPUTER PANEL		ENCLOSED / NOT ENCLOSED					
7.3	COMPLETE DETAILS OF PLANT MANAGER		ENCLOSED / NOT ENCLOSED					
7.4	CONTROL PANEL TO BE INTERFACED WITH BMS (TCP/IP)		YES					
8.0	<u>MISCELLANEOUS</u>							
8.1	SPARE PARTS LIST		YES / NO					
8.2	PERFORMANCE CURVE/RATING CHARTS WITH OPERATING POINTS MARKED		ENCLOSED / NOT ENCLOSED					
8.3	DETAILS OF SEPARATOR		YES / NO					
8.4	DETAILS OF OIL COOLER		YES / NO					
8.5	DETAILS OF ECONOMISER		YES / NO					
9.0	<u>PERFORMANCE GUARANTEES</u>							
9.1	CAPACITY OF EACH CHILLING PACKAGE	TR	BY BIDDER					
9.2	POWER CONSUMPTION FOR EACH CHILLING PACKAGE	kW	BY BIDDER					
9.3	CHILLED WATER / BRINE FLOW RATE	m³/hr	BY BIDDER					
9.4	CHILLED WATER / BRINE OUTLET TEMP. AT DESIGN INLET TEMPERATURE	°C	BY BIDDER					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
9.5	CHILLED WATER / BRINE PRESSURE DROP	MLC	BY BIDDER					
9.6	COOLING WATER FLOW RATE	m ³ /hr	BY BIDDER					
9.7	COOLING WATER OUTLET TEMPERATURE	°C	BY BIDDER					
9.8	COOLING WATER PRESSURE DROP	MLC	BY BIDDER					
10	ESSENTIAL SPARES							
10.1	GASKETS	SETS						
10.2	FASTENERS	SETS						
10.3	SEALS	SETS						
AIR HANDLING UNIT								
1	GENERAL							
1.1	DESIGNATION		BY BIDDER					
1.2	NUMBERS REQUIRED	Nos.	N (Working)+1 Standby					
1.3	TAG NUMBERS		BY BIDDER					
1.4	LOCATION		INDOOR					
1.5	DUTY		CONTINUOUS					
1.6	TYPE		DRAW THROUGH					
1.7	INSTALLATION		FLOOR MOUNTED					
1.8	POSITIONING		HORIZONTAL					
1.9	CASING		DOUBLE SKIN					
1.9.1	INNER/OUTER SKIN		POWDER COATED					
1.9.2	PROFILE TYPE		THERMOBREAK					
1.9.3	THICKNESS OF FRAME WORK	Mm	75 / 100 / 125 / 150 / 200					
1.9.4	MATERIAL AND GAUGE OF CASING		OUTER CASING 1.2 MM GSS PRE POWDER COATED INNER SKIN 1.2 MM PLAIN SS 304 L					
1.1	NOISE LEVEL AT 1.5 M DISTANCE	Db (a)	<70					
1.11	MARINE LIGHTS		YES					
1.12	PAINTING OF FAN & MS STRUCTURAL FRAME WORK		MANUFACTURER'S STD.					
1.13	LIMIT SWITCH		YES					
1.14	MAKE AND MODEL NUMBER		BY BIDDER					
1.15	OVERALL SIZE (L) X (W) X (H)	mm	BY BIDDER					
1.16	MINIMUM SERVICE SPACE REQUIRED ON ALL SIDES FOR MAINTENANCE	mm	BY BIDDER					
1.17	OPERATING WEIGHT	Kg	BY BIDDER					
1.18	PAINTING OF FAN AND MS STRUCTURAL FRAME WORK		BY BIDDER					
2	FILTERS		BY BIDDER					
2.1	PRE-FILTER REQUIRED		YES					
2.1.1	MAKE AND MODEL NUMBER		BY BIDDER					
2.1.2	NUMBER OF FILTERS		BY BIDDER					
2.1.3	SIZE OF EACH FILTER (L) X (W) X (H)	mm	BY BIDDER					
2.1.4	RATED CAPACITY OF EACH FILTER	M ³ /hr	BY BIDDER					
2.1.5	MAXIMUM FACE VELOCITY	M/s	2.5					
2.1.6	FILTER MEDIA		BY BIDDER					
2.1.7	MOC OF PRE FILTER FRAME		AL					
2.1.8	WASHABLE TYPE		YES					
2.1.9	EFFICIENCY	%	90 DOWN TO 10 MICRONS					
2.1.10	MAXIMUM PRESSURE DROP AT RATED CAPACITY							
A)	CLEAN CONDITION	MMWC	6					
B)	CLOGGED CONDITION	MMWC	12					
2.1.11	PRESSURE GAUGE ACROSS PRE-FILTER		YES					
2.2	FINE-FILTER REQUIRED		YES					
2.2.1	MAKE AND MODEL NUMBER		BY BIDDER					
2.2.2	NUMBER OF FILTERS		BY BIDDER					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
2.2.3	SIZE OF EACH FILTER (L) X (W) X (H)	mm	BY BIDDER					
2.2.4	RATED CAPACITY OF EACH FILTER	M ³ /hr	BY BIDDER					
2.2.5	MAXIMUM FACE VELOCITY	M/s	2.5					
2.2.6	FILTER MEDIA		BY BIDDER					
2.2.7	MOC OF FINE FILTER FRAME		AL					
2.2.8	WASHABLE TYPE		YES					
2.2.9	EFFICIENCY	%	99% DOWN TO 5 MICRONS					
2.2.10	MAXIMUM PRESSURE DROP AT RATED CAPACITY							
A)	CLEAN CONDITION	MMWC	6					
B)	CLOGGED CONDITION	MMWC	18					
2.2.11	PRESSURE GAUGE ACROSS FINE-FILTER		YES					
3	COOLING COIL							
3.1	TYPE OF COIL		CHILLED WATER COIL					
3.2	COOLING CAPACITY	TR	BY BIDDER					
3.3	APPARATUS DEW POINT TEMPERATURE	°C	BY BIDDER					
3.4	ENTERING AIR DBT	°C	BY BIDDER					
3.5	ENTERING AIR WBT	°C	BY BIDDER					
3.6	LEAVING AIR DBT	°C	BY BIDDER					
3.7	LEAVING AIR WBT	°C	BY BIDDER					
3.8	NUMBER OF ROWS DEEP	Nos.	MINIMUM 4					
3.9	REFRIGERANT TEMPERATURE FOR DX COIL	°C						
3.12	MOC OF COOLING COIL TUBE		CU					
3.13	MOC OF COOLING COIL FINS		AL					
3.14	COOLING COIL HEADER		CU					
3.15	COOLING HYDROPHILIC COATING		YES					
3.16	AIR FACE VELOCITY	M/sec	<2.5					
3.17	FINNED COIL FACE AREA	M ²	BY BIDDER					
3.18	TUBE OUTSIDE DIAMETER AND THICKNESS	mm	BY BIDDER					
3.19	AIR SIDE PRESSURE DROP	mmWC	BY BIDDER					
4	ELECTRIC STRIP HEATER		YES					
4.1	NO. OF STEPS	NOS.	BY BIDDER					
4.2	RATING OF EACH STEP	KW	BY BIDDER					
5	HUMIDIFIER							
5.1	TYPE		PAN					
5.2	CAPACITY	Kw	BY BIDDER					
5.3	MINIMUM NUMBER OF STEPS	Nos.	BY BIDDER					
6	FAN							
6.1	TYPE		BACKWARD CURVED					
6.2	MAKE & MODEL NO.		BY BIDDER					
6.3	CAPACITY	CFM	BY BIDDER					
6.4	STATIC PRESSURE	MMWC	BY BIDDER					
6.5	FAN TYPE		CENTRIFUGAL					
6.6	AIR INLET TYPE TO FAN		DIDW					
6.7	DRIVE TYPE		BELT DRIVEN					
6.8	BELT GUARD		YES					
6.9	ACCESS DOOR GUARD IN FAN SECTION		YES					
6.10	DISCHARGE DIRECTION		TO MATCH WITH DUCTING LAYOUT					
6.11	CLASS OF CONSTRUCTION		I / II / III					
6.12	FLAME PROOF REQUIREMENT		NO					
6.13	MOC OF CASING		GSS					
6.14	MOC OF IMPELLER		GSS					
6.15	MOTOR & BLOWER BASE FRAME		AL					
6.16	VIBRATION ISOLATORS		YES					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
6.16.1	TYPE OF VIBRATION ISOLATORS		BY BIDDER					
6.17	IMPELLER SPEED	Rpm	BY BIDDER					
6.18	FAN OUTLET AIR VELOCITY	M/sec	BY BIDDER					
6.19	MOTOR		BY BIDDER					
6.20	BRAKE POWER / LIMIT LOAD	Kw	BY BIDDER					
6.21	MOTOR RATING / SYNCHRONOUS SPEED	Kw / rpm	BY BIDDER					
6.22	POWER INPUT TO MOTOR AT DUTY POINT	Kw	BY BIDDER					
6.23	VIBRATION ISOLATORS		BY BIDDER					
6.23.1	MAKE AND MODEL NUMBER		BY BIDDER					
6.23.2	VIBRATION DAMPENING EFFICIENCY	%	BY BIDDER					
6.24	STARTER		BY BIDDER					
6.25	MOTOR PROVIDED WITH VFD		NO					
7	MIXING BOX AND DAMPER		NOT REQUIRED					
8	PERFORMANCE GUARANTEES		BY BIDDER					
8.1	DEHUMIDIFIED AIR QUANTITY		BY BIDDER					
8.2	STATIC PRESSURE		BY BIDDER					
8.3	ENTERING DRY BULB TEMPERATURE		BY BIDDER					
8.4	ENTERING WET BULB TEMPERATURE		BY BIDDER					
8.5	LEAVING DRY BULB TEMPERATURE		BY BIDDER					
8.6	LEAVING WET BULB TEMPERATURE		BY BIDDER					
8.7	NOISE LEVEL AT ADISTANCE OF 1.5 M	Db (a)	<70					
AIR WASHER								
1	GENERAL							
1.1	DESIGNATION		AIR WASHER FOR TG BUILDING					
1.2	NUMBER OFFERED	Nos.	BY BIDDER					
1.3	MAKE AND MODEL NUMBER		BY BIDDER					
1.4	OVERALL SIZE (LXBXH)	mm	BY BIDDER					
1.5	EPOXY PAINTING OF CS MATERIALS		YES					
2	DESIGN DATA							
2.1	TYPE OF AIR WASHER		SPRAY TYPE WITH DOUBLE BANK					
2.2	AIR HANDLING CAPACITY	M ³ /Hr	BY BIDDER					
2.3	SATURATION EFFICIENCY	%	90					
2.4	MAXIMUM FACE VELOCITY (AIR) ON MEDIA	m/sec	2.54					
2.5	AIR SIDE PRESSURE DROP	mmWC	BY BIDDER					
2.6	SPRAY TYPE		DOUBLE BANKS WITH OPPOSED TYPES					
2.6.1	NUMBER OF SPRAY BANKS		DOUBLE BANKS					
2.6.2	NUMBER OF NOZZLES PER BANK		BY BIDDER					
2.6.3	NUMBER OF FLOODING NOZZLES		BY BIDDER					
2.6.4	CAPACITY OF EACH SPRAY NOZZLE/EACH FLOODING NOZZLE	M ³ /Hr	BY BIDDER					
2.6.5	MAXIMUM PRESSURE DROP THROUGH SPRAY NOZZLES	Kg/cm ²	2.4					
2.6.6	PRESSURE REQUIRED AT INLET OF SPRAY HEADER	Kg/cm ²	BY BIDDER					
2.6.7	PRESSURE REQUIRED AT INLET OF FLOODING NOZZLE HEADER	Kg/cm ²	BY BIDDER					
2.7	PREFILTER TYPE		BY BIDDER					
2.7.1	FACE VELOCITY	m/s	2.5					
2.7.2	PRESSURE DROP	mmWC	6 - CLEAN CONDITION / 12 - CLOGGED CONDITION					
2.8	DRIP ELEMINATOR PRESSURE DROP		BY BIDDER					
2.9	INLET AIR TEMPERATURE							

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
2.9.1	DRY BULB	°C	40					
2.9.2	WET BULB	°C	28					
2.10	TOTAL STATIC PRESSURE OF FAN	mmWC	BY BIDDER					
2.11	NO. OF BLOWER FOR MEETING TOTAL AIR FLOW							
2.12	TYPE OF BLOWER		CENTRIGUGAL DIDW BACKWARD					
2.13	FLOW OF EACH BLOWER	M ³ /Hr	BY BIDDER					
2.14	TOTAL EFFIENCY OF BLOWER	%	BY BIDDER					
2.15	BLOWER BREAK POWER (EACH)	kW	BY BIDDER					
2.16	BLOWER MOTOR RATING (EACH)	kW	BY BIDDER					
2.17	RECIRCULATION WATER PUMP		BY BIDDER					
2.17.1	WATER RECIRCULATION FLOW	M ³ /Hr	BY BIDDER					
2.17.2	PUMP TOTAL HEAD	mWC	BY BIDDER					
2.17.3	MAX. PRESSURE DROP THROUGH THE WATER SPRAY NOZZLES	mWC	BY BIDDER					
2.17.4	PUMP BRAKE POWER	kW	BY BIDDER					
2.17.5	PUMP MOTOR RATING	kW	BY BIDDER					
2.17.6	QUANTITY OF PUMP FOR EACH AIR WASHER	Nos.	1 WORKING +1 STANDBY					
2.18	UTILITY REQUIREMENTS							
2.18.1	MAKE UP WATER REQUIREMENT	M ³ /Hr	BY BIDDER					
2.18.2	BLEED OFF WATER DISCHARGED	M ³ /Hr	BY BIDDER					
3	MATERIAL OF CONSTRUCTION							
3.1	TANK		MS TANK					
3.2	CATWALK		HDG CS					
3.3	AIR DISTRIBUTION PLATES		18G GSS					
3.4	SPRAY NOZZLES		BRASS					
3.5	FLOODING NOZZLES		BRASS					
3.6	INSPECTION DOOR		CS WITH SIGHT GLASS					
3.7	ELIMINATOR PLATES		PVC WITH MS FRAME					
3.8	SUCTION SCREEN		24 G BRASS					
3.9	PIPE HEADERS AND PIPING		HDG CS					
3.10	PREFILTER		BY BIDDER					
3.11	FINE FILTER		BY BIDDER					
3.12	PAD FOR RIGID MEDIA TYPE		BY BIDDER					
3.13	INTERNAL PIPING		BY BIDDER					
3.14	CASING		DOUBLE SKIN SS CASING WITH PUF INSULATION					
4	ACCESSORIES TO BE INCLUDED							
4.1	MAKE-UP WITH FLOT VALVE AND QUICK-FILL CONNECTIONS WITH ISOLATING VALVE, ETC.		YES					
4.2	DRAIN WITH ISOLATING VALVE AND OVERFLOW CONNECTION, ETC.		YES					
4.3	MARINE LIGHTS		YES					
4.4	INSPECTION DOOR		YES					
4.5	SUPPORTING FRAME WORK FOR ENTIRE CASING		YES					
4.6	WATER LEVEL SWITCH WITH ALARM AND INTERLOCKING WITH PUMP		YES					
4.7	ACCESS LADDERS WITH HANRAILS AND MONKEY LADDERS		YES					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
4.8	SUCTION SUMP COVER		YES					
4.9	DIFFERENTIAL PRESSURE SWITCH ON FILTERS		NO					
4.10	SUPPLY AIR OUTLET DAMPER(S)		YES					
4.11	BACK DRAFT DAMPER(S)		NO					
4.12	SATURATION EFFICIENCY TEST		YES					
5	SPARES AND MAINTENANCE TOOLS AND TACKLES		BY BIDDER					
5.1	SPRAY NOZZLES		BY BIDDER					
5.2	DRIVE BELTS FOR BLOWER		BY BIDDER					
5.3	FAN BEARINGS		BY BIDDER					
5.4	MOTOR BEARING	No.	BY BIDDER					
SPLIT AIR CONDITIONERS								
1	GENERAL							
1.1	DESIGNATION		SPLIT AIR-CONDITIONERS (SAC)					
1.2	NUMBERS OFFERED	Nos	BY BIDDER					
1.3	TAG NUMBERS		BY BIDDER					
1.4	MAKE & MODEL NUMBER		BY BIDDER					
1.5	PLACE OF MANUFACTURE		BY BIDDER					
1.6	NOMINAL CAPACITY OF EACH SAC	TR	BY BIDDER					
1.7	CAPACITY OF EACH SAC AT DESIGN CONDITIONS	TR	BY BIDDER					
1.8	HEAT PUMP MODEL		NO					
1.9	HEATING CAPACITY	Kw	NA					
1.10	OVERALL SIZE		BY BIDDER					
1.11	INDOOR UNIT	mm x mm xmm mm x	BY BIDDER					
1.12	OUTDOOR UNIT	mm x mm xmm	BY BIDDER					
1.13	CLEARANCE REQUIRED ON ALL SIDES OF INDOOR / OUTDOOR UNITS	Mm	BY BIDDER					
1.14	REFRIGERANT		R410A / NON CFC, NON HCFC					
1.15	WEIGHT – INDOOR / OUTDOOR UNIT	Kg	BY BIDDER					
1.16	NUMBER OF REFRIGERATION CIRCUITS / SAC		BY BIDDER					
1.17	TOTAL INPUT POWER AT DESIGN CONDITIONS TO EACH SAC	kW	BY BIDDER					
1.18	BEE STAR RATING		3 / 4 / 5					
1.19	DESIGN CONDITIONS		BY BIDDER					
1.2	OUTSIDE							
1.21	DRY BULB TEMPERATURE	°C	BY BIDDER					
1.22	WET BULB TEMPERATURE	°C	BY BIDDER					
1.23	INSIDE							
1.3	DRY BULB TEMPERATURE	°C	BY BIDDER					
1.31	RELATIVE HUMIDITY	%	BY BIDDER					
1.32	INDOOR UNIT (IDU)							
1.4	TYPE		HI-WALL					
1.5	NO. OF IDUs PER SPLIT AC UNIT (SAC)		ONE / TWO					
1.6	FAN		BY BIDDER					
1.61	CAPACITY OF FAN	CFM	BY BIDDER					
1.62	FAN SPEED		SINGLE / MULTISPEED					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
1.63	IF MULTISPEED, STEPS OF SPEED		3 / 4 / 5					
1.64	BRAKE POWER OF FAN	kW	BY BIDDER					
1.65	POWER INPUT TO MOTOR AT DUTY POINT	kW	BY BIDDER					
1.66	MOTOR RATING OF FAN	kW	BY BIDDER					
1.67	FAN MOTOR TYPE		STD					
1.68	MOTOR MAKE		BY BIDDER					
1.7	DX COOLING COIL							
1.71	NUMBER OF ROWS	Nos.	BY BIDDER					
1.72	COOLING CAPACIY OF COIL AT DESIGN CONDITIONS		BY BIDDER					
1.73	SENSIBLE COOLING CAPACITY OF COIL	Kcal/Hr	BY BIDDER					
1.74	LATENT COOLING CAPACITY OF COIL	Kcal/Hr	BY BIDDER					
1.75	NUMBER OF FINS PER CENTIMETRE		BY BIDDER					
1.76	AIR FACE VELOCITY	m/sec	BY BIDDER					
1.77	ANTI CORROSIVE COATING ON COIL		YES					
1.8	FILTERS							
1.81	ANTIDUST FILTER (PRE FILTER)		YES					
1.82	FILTER MATERIAL							
1.83	DEODORISATION FILTER		YES					
1.84	FILTER MATERIAL							
1.85	ANTI-BACTERIA FILTER		YES					
1.86	FILTER MATERIAL							
1.87	OVERALL SIZE OF EACH FILTER L x B							
1.88	ULTRAVIOLET SCREEN		YES					
1.9	OUTDOOR UNIT							
1.91	NOISE LEVEL AT 1.0 FROM SOURCE	dBA	BY BIDDER					
1.92	COMPRESSOR							
1.92.1	TYPE		HERMETIC SCROLL / ROTARY					
1.92.3	NUMBER OF COMPRESSORS PER OUTDOOR UNIT	Nos.	BY BIDDER					
1.92.4	MAKE AND MODEL NUMBER		BY BIDDER					
1.92.5	PLACE OF MANUFACTURE		BY BIDDER					
1.92.6	SATURATED SUCTION / CONDENSING TEMPERATURE	°C	BY BIDDER					
1.92.7	INPUT POWER AT DESIGN CONDITION PER COMPRESSOR	kW	BY BIDDER					
1.92.8	MOTOR RATING PER COMPRESSOR		BY BIDDER					
1.92.9	CAPACITY CONTROL AVAILABLE		BY BIDDER					
1.93	CONDENSERS		BY BIDDER					
1.93.1	HEAT REJECTION CAPACITY OF EACH CONDENSER	KCal/Hr	BY BIDDER					
1.93.2	CONDENSER FANS		BY BIDDER					
1.93.3	NUMBERS IN EACH CONDENSING UNIT	Nos.	BY BIDDER					
1.93.4	CAPACITY OF EACH FAN	m3/hr	BY BIDDER					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
1.93.5	BRAKE POWER OF EACH FAN	kW	BY BIDDER					
1.93.6	INPUT POWER OF EACH FAN	kW	BY BIDDER					
1.93.7	MOTOR RATING OF EACH FAN	kW	BY BIDDER					
1.93.8	FAN TYPE		AXIAL, PROPELLER					
1.93.9	ANTI-CORROSIVE COATING ON BODY		YES					
1.93.10	ANTI-CORROSIVE COATING ON COIL		YES					
1.93.11	NOISE LEVEL AT 1.0M FROM SOURCE	dBA	BY BIDDER					
1.94	ACCESSORIES							
1.94.1	CORDLESS REMOTE CONTROL		YES					
1.94.2	OCCUPANCY SENSOR IN IDU		NO					
1.94.3	ON-OFF TIMER		YES					
1.94.4	SEQUENTIAL CONTROLLER		NO					
1.94.5	MOUNTING FRAME WITH ALL THE NECESSARY ACCESSORIES FOR IDU AND ODU		YES					
1.94.6	EPOXY PAINTING OF MOUNTING FRAMES		YES					
1.94.7	MINIMUM CABLE LENGTH WITH PLUG		YES					
1.94.8	AUTO-RESTART		YES					
1.94.9	FILTER CLEANING INDICATOR		YES					
1.95	MAKES		BY BIDDER					
1.95.1	THERMOSTATIC EXPANSION VALVE		BY BIDDER					
1.95.2	HIGH AND LOW PRESSURE CUT OUTS		BY BIDDER					
1.95.3	THERMOSTAT		BY BIDDER					
1.96	PERFORMANCE GUARANTEES		BY BIDDER					
1.96.1	CAPACITY OF EACH UNIT AT DESIGN CONDITIONS	TR	BY BIDDER					
1.96.2	TOTAL POWER INPUT AT DESIGN CONDITIONS FOR EACH UNIT	KW	BY BIDDER					
1.96.3	AIR HANDLING FAN	CFM						
a	DEHUMIDIFIED AIR FLOW CAPACITY		MINIMUM 330 CFM/TR					
1.96.4	NOISE LEVEL AT 1.0 M FROM							
a	INDOOR UNIT	dBA	MAXIMUM 45					
b	OUTDOOR / CONDENSING UNIT	dBA	MAXIMUM 65					
1.96	CONFIRM THAT UNITS CAN BE INSTALLED OPERATED AND SERVICED IN AVAILABLE SPACE		YES / NO					
1.97	CONFIRM THAT UNITS ARE SUITABLE FOR SPECIFIED VOLTAGE AND FREQUENCY		YES / NO					
COOLING TOWER								
1	GENERAL		COOLING TOWER FOR HVAC SYSTEM					
1.1	DESIGNATION		COOLING TOWER					
1.2	NUMBER REQUIRED		N WORKING+1 STANDBY					
1.3	TAG NUMBERS		BY BIDDER					
1.4	MAKE AND MODEL NUMBER		BY BIDDER					
1.5	PLACE OF MANUFACTURE		BY BIDDER					
1.6	OPERATION		CONTINUOUS / 24 Hrs/Day					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
1.7	TYPE OF COOLING TOWER		INDUSED DRAFT COOLING TOWER					
1.8	TYPE OF FILL ARRANGEMENT		BY BIDDER					
1.9	TYPE OF DRIFT ELIMINATOR		BY BIDDER					
2	DESIGN DATA		BY BIDDER					
2.1	COOLING TOWER CAPACITY		BY BIDDER					
2.2	DESIGN HOT WATER INLET TEMPERATURE	°C	BY BIDDER					
2.3	DESIGN COLD WATER OUTLET TEMPERATURE (MAX)	°C	BY BIDDER					
2.4	DESIGN AMBIENT WET BULB TEMPERATURE (SUMMER)	°C	BY BIDDER					
2.5	WIND VELOCITY FOR DESIGN OF STRUCTURE		AS PER IS875					
2.6	MAKE UP WATER SOURCE		BY BIDDER					
2.7	MAKE UP WTER ANALYSIS		BY BIDDER					
2.8	FLOW VELOCITY IN HOT WATER PIPING (MAX)	M/Sec	2					
2.9	AVAILABLE PRESSURE IN HOT WATER HEADER AT BATTERY LIMIT	Kg/cm ² g	BY BIDDER					
2.1	DRIFT LOSS PER TOWER	M ³ /Hr	BY BIDDER					
2.11	NO. OF FAN PER TOWER	No.	BY BIDDER					
2.12	No. OF BLADE PER FAN	No.	BY BIDDER					
2.13	FAN SPEED	RPM	BY BIDDER					
2.14	FAN DIA	MM	BY BIDDER					
2.15	FAN STATIC PRESSURE	MWC	BY BIDDER					
2.16	FAN BKW	KW	BY BIDDER					
2.17	FAN DRIVE		BY BIDDER					
2.18	TYPE OF COUPLING		BY BIDDER					
2.19	POWER INPUT TO FAN MOTOR	KW	BY BIDDER					
2.2	TOTAL WEIGHT OF TOWER	KG	BY BIDDER					
2.2	OVERALL SIZE OF TOWER (LXBXH)	MM	BY BIDDER					
3	MATERIAL OF CONSTRUCTION		BY BIDDER					
3.1	CASING		FRP					
3.2	AIR INLET LOUVERS		FRP					
3.3	FILL		PVC					
3.4	FILL SUPPORT		SS					
3.5	INTERNAL SUPPORTING STRUCTURE		SS					
3.6	DRIFT ELIMINATOR		PVC					
3.7	FAN DECK		FRP					
3.8	FAN GUARD		SS					
3.9	FAN BLADE		FRP/CAST ALUMINIUM					
3.1	DRIVE SHAFT		HOLLOW SS					
3.11	LADDER		SS					
3.12	FOUNDATION BOLT		HDGS					
3.13	COLD WATER BASIN		FRP					
4	ACCESSORIES ,AUXILIARIES AND SERVICES							
4.1	COLD WATER OUTLET, OVERFLOW ,DRAIN AND MAKE UP WATER PIPE AND VALVES		YES					
4.2	COLD WATER BASIN		YES					
4.3	HOT WATER PIPING		YES					
4.4	FAN GUARDS		YES					
4.5	LADDER		YES					
4.6	MOTTOR		YES					
4.7	MOTOR STARTER		YES					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
4.8	LOCAL PUSH BUTTON		YES					
4.9	EARTHING PROTECTION		YES					
4.1	TEMPERATURE GAUGE ON HOT WATER INLET		YES					
4.11	TEMPERATURE GAUGE ON COLD WATER BASIN		YES					
4.12	VIBRATION LIMIT SWITCH TO STOP THE FAN EXCESSIVE VIBRATION		YES					
4.13	INSTRUMENTS REQUIRED DURING PERFORMANE TESTING		YES					
4.14	ERECTION		YES					
4.15	ERECTION SUPERVISION		YES					
5	PERFORMANCE GUARANTEES							
5.1	COOLING TOWER CAPACITY	M ³ /Hr	BY BIDDER					
5.2	COOLING RANGE	°C	BY BIDDER					
5.3	DESIGN AMBIET WET BULB TEMPERATURE (SUMMER)	°C	BY BIDDER					
5.4	COLD WATER TEMPERATURE	°C	BY BIDDER					
5.5	TOTAL POWER CONSUMPTION	KW	BY BIDDER					
5.6	COMMISSIONING		YES					
5.7	PERFORMANCE TESTING		YES					
PUMP								
1	DESIGNATION		CENTRIFUGAL PUMP (END SUCTION TOP DISCHARGE) FOR HVAC SYSTEM					
2	NUMBER OFFERED	Nos.	N WORKING +1 STANDBY					
3	TAG NUMBERS		BY BIDDER					
4	PUMP MAKE AND MODEL NUMBER		BY BIDDER					
5	DESIGN CAPACITY	M ³ /Hr	BY BIDDER					
6	DIFFERENTIAL HEAD	MLC	BY BIDDER					
7	SHUT-OFF HEAD	MLC	BY BIDDER					
8	HYDROSTATIC TEST PRESSURE	Kg/cm ² (g)	BY BIDDER					
9	NUMBER OF STAGES		1					
10	PUMP EFFICIENCY AT DUTY POINT	%	BY BIDDER					
11	PUMP SPEED	RPM	BY BIDDER					
12	PUMP BKW	KW	BY BIDDER					
13	MAXIMUM PUMP POWER REQUIREMENT	KW	BY BIDDER					
14	POWER INPUT TO DRIVER AT DUTY POINT	KW	BY BIDDER					
15	METHOD OF LUBRICATION		BY BIDDER					
16	MINIMUM CONTINOUS FLOW	M ³ /Hr	BY BIDDER					
17	NPSH REQUIRED	MLC	BY BIDDER					
18	TYPE OF CONSTRUCTION		BY BIDDER					
19	DRIVE TRANSMISSION DETAILS		BY BIDDER					
20	DRIVER RATING	KW	BY BIDDER					
21	DRIVER SPEED	RPM	BY BIDDER					
22	DRIVER EFFICIENCY	%	BY BIDDER					
23	DIRECTION OF ROTATION FROM THE DRIVER END		BY BIDDER					
24	MOMENT OF INERTIA OF PUMP ROTOR	Kg-m2	BY BIDDER					
25	SUCTION NOZZLE		BY BIDDER					
25.1	ORIENTATION		BY BIDDER					
25.2	SIZE	mm NB	BY BIDDER					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
26	DISCHARGE NOZZLE		BY BIDDER					
26.1	ORIENTATION		BY BIDDER					
26.1	SIZE	mm NB	BY BIDDER					
27	TYPE AND MAKE OF MECHANICAL SEAL		BY BIDDER					
28	TYPE OF COUPLING		BY BIDDER					
29	MAXIMUM ALLOWABLE SIZE OF SOLIDS	mm	BY BIDDER					
30	WEIGHT OF BARE PUMP	Kg	BY BIDDER					
31	WEIGHT OF DRIVER	Kg	BY BIDDER					
32	WEIGHT OF COMMON BASE PLATE	Kg	BY BIDDER					
33	NOISE LEVEL AT 1.0M	dB	BY BIDDER					
34	MAXIMUM TORQUE(100%) SPEED		BY BIDDER					
35	VIBRATION LEVEL		BY BIDDER					
36	ACCESSORIES AS PER DATA SHEET A TO BE INCLUDED		YES/NO					
38	OUTLINE DIMENSIONAL DRAWING TO BE ENCLOSED		YES/NO					
39	FOUNDATION DRAWING WITH STATIC AND DYNAMIC LOADS TO BE ENCLOSED		YES/NO					
40	CROSS-SECTION DRAWING OF PUMP WITH PART LIST AND MATERIALS OF CONSTRUCTION AND RELEVANT STANDARDS TO BE ENCLOSED		YES/NO					
41	PERFORMANCE CURVES FLOW RATE Vs HEAD, BKW, EFFICIENCY, NPSHR AND TORQUE-SPEED CURVE TO BE ENCLOSED		YES/NO					
42	MATERIAL OF CONSTRUCTION							
42.1	CASING		SS					
42.2	IMPELLER		SS					
42.3	SHAFT		SS					
42.4	SHAFT SLEEVE		BRONZE					
42.5	CASING RING		BRONZE					
42.6	IMPELLOR RING		BRONZE					
42.7	BASE PLATE		CS					
43	PERFORMANCE GUARANTEE		BY BIDDER					
43.1	CAPACITY	M ³ /Hr	BY BIDDER					
43.2	DIFFERENTIAL HEAD	MLC	BY BIDDER					
43.3	POWER CONSUMPTION	KW	BY BIDDER					
44	SPARES AND MAINTENANCE TOOLS AND TACKLES							
44.1	CASING RING	SETS	2					
44.2	IMPELLOR RING	SETS	2					
44.3	SHAFT SLEEVE	SETS	1					
44.4	GLAND PACKING /SEAL	SETS	1					
44.5	PUMP BEARING	SETS	4					
44.6	MOTOR BEARING	SETS	4					
AIR DISTRUBUTION SYSTEM								
1	GENERAL		BY BIDDER					
1.1	DESIGNATION		AIR DISTRIBUTION SYSTEM FOR HVAC SYSTEM					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
1.2	DUCTING		BY BIDDER					
1.3	TYPE		RECTANGULAR					
1.4	MATERIAL		GSS, 275 GSM ZINC COATING					
2	DIFFUSER		BY BIDDER					
2.1	DIFFUSERS WITH VOLUME CONTROL DAMPERS FOR SUPPLY AIR		YES					
2.2	TYPE		TO MATCH WITH FALSE CEILING					
2.3	PATTERN		TO MATCH WITH FALSE CEILING					
2.4	MATERIAL		AL WITH POWDER COATING					
2.5	DIFFUSERS WITHOUT DAMPERS FOR RETURN AIR		YES					
2.6	TYPE		TO MATCH WITH FALSE CEILING					
2.7	PATTERN		TO MATCH WITH FALSE CEILING					
2.8	MATERIAL		AL WITH POWDER COATING					
3	GRILLES		BY BIDDER					
3.1	GRILLES WITH VOLUME CONTROL DAMPERS FOR SUPPLY AIR		YES					
3.2	TYPE		DOUBLE ACTING					
3.3	MATERIAL		AL WITH POWDER COATING					
3.4	GRILLES WITHOUT DAMPERS FOR RETURN / EXHAUST AIR		YES					
3.5	TYPE		DOUBLE ACTING					
3.6	MATERIAL		AL WITH POWDER COATING					
4	DAMPERS		BY BIDDER					
4.1	VOLUME CONTROL DAMPER FOR RECTANGULAR DUCTING		YES					
4.2	TYPE		OPPOSED BLADE TYPE					
4.3	FIRE DAMPERS		YES					
4.4	TYPE OF FIRE DAMPER ACTIVATION		MOTORIZED					
4.5	FIRE RATING	Minutes	120					
5	INSULATION		BY BIDDER					
5.1	THERMAL INSULATION		YES					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
5.2	MATERIAL		Closed cell Nitrile rubber with Aluminium foil					
5.3	DENSITY	Kg/m ³	32					
5.4	THICKNESS	mm	19 MM					
5.5	THERMAL CONDUCTIVITY	Kcal/hr-m-°C	BY BIDDER					
5.6	ACOUSTIC INSULATION		YES					
5.7	MATERIAL		Open cell Nitrile rubber					
5.8	DENSITY	Kg/m ³	140					
5.9	THICKNESS	mm	25					
6	MISCELLANEOUS		BY BIDDER					
6.1	PLENUM		BY BIDDER					
6.2	ACCESS DOORS		YES					
6.3	FLEXIBLE JOINTS AT LOCATIONS OTHER THAN EQUIPMENTS		BY BIDDER					
6.4	FRAME WORKS FOR DIFFUSERS AND GRILLES AND WALL MOUNTED DAMPERS		YES					
6.5	MATERIAL		CS					
6.6	SEALANTS FOR SEAMS		NO					
6.7	RETURN AIR BOXING		NO					
6.8	PAINTING		BY BIDDER					
6.9	DUCTING		UNPAINTED					
6.10	REINFORCEMENTS		RED OXIDE PRIMER EPOXY					
6.11	SUPPORTS		RED OXIDE PRIMER EPOXY					
7.0	LOUVERS		BY BIDDER					
7.1	GENERAL		BY BIDDER					
7.2	DESIGNATION		BY BIDDER					
7.3	TYPE		FIXED					
7.4	AIR FLOW RATE	M ³ /Hr	BY BIDDER					
7.5	QUANTITY	m ²	BY BIDDER					
7.6	SIZE(EACH) AND NUMBER		BY BIDDER					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
7.7	DESIGN FACE VELOCITY	m/Sec	2.5					
7.8	DESIGN WIND PRESSURE	Kg/m ²	BY BIDDER					
7.90	PRESSURE DROP ACROSS THE LOUVERS	mmWC	BY BIDDER					
7.10	ANGLE OF BLADES	deg (°)	35					
7.11	PERCENTAGE OF FREE AREA	%	35 TO 37%					
7.12	MATERIALS OF CONSTRUCTION		BY BIDDER					
7.13	FRAME		14G AL (MIN)					
7.14	BLADE		18G AL (MIN)					
7.15	BEARING		NYLON					
7.16	BLADE LINKAGE ROD		8 MM Ø, CRS					
7.17	BIRD SCREEN		16G GS WIRE					
7.18	MISCELLANEOUS		BY BIDDER					
7.19	GROUTING OF LOUVER FRAME		BY BIDDER					
7.20	PAINTING		POWDER COATING					
7.21	COMMON FRAMEWORK WITH DAMPER / FILTER / DAMPER AND FILTER		REQUIRED					
8.0	FILTERS (PRE-FILTER)		BY BIDDER					
8.1	GENERAL		BY BIDDER					
8.2	DESIGNATION		HVAC SYSTEM					
8.3	APPLICATION		PRE-FILTER					
8.4	TYPE		CASSETTE / FLANGE					
8.5	MANUFACTURER		BY BIDDER					
8.6	MODEL NUMBER		BY BIDDER					
8.7	WHETHER CLEANABLE		YES					
8.8	CLEANING METHOD		BY BIDDER					
8.9	REMOVAL AND CLEANING IN REMOTE PLACE BY AIR JET / WATER		BY BIDDER					
8.10	AIR / WATER PRESSURE REQUIRED	Kg/cm ² g	BY BIDDER					
8.11	MECHANICAL CLEANING IN SITE (WITHOUT REMOVING FILTERS) BY REVERSE COMPRESSED AIR JET		BY BIDDER					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
8.12	AIR PRESSURE REQUIRED	Kg/cm ² g	BY BIDDER					
8.13	FILTER MEDIA		BY BIDDER					
8.14	LIFE OF FILTER MEDIA FOR THROW AWAY TYPE	Hrs	BY BIDDER					
8.15	DUST LOADING CAPACITY	gms	BY BIDDER					
8.16	DESIGN DATA		BY BIDDER					
8.17	TOTAL FACE AREA OF FILTERS	m ²	BY BIDDER					
8.18	NUMBER OF FILTERS		BY BIDDER					
8.19	SIZE OF EACH FILTER L X B X THK	mm	610 MM X 610 MM X 50 MM THK					
8.20	DESIGN AIR FLOW RATE PER FILTER	M ³ /Hr	BY BIDDER					
8.21	WEIGHT OF EACH FILTER	Kg	BY BIDDER					
8.22	PRESSURE DROP AT DESIGN FLOW RATE		BY BIDDER					
8.23	CLEAN CONDITION	mmWc	6 MMWC					
8.24	CLOGGED CONDITION	mmWC	12 MMWC					
8.25	EFFICIENCY	%	90% DOWN TO 10 MICRONS (MERV 8)					
8.26	TYPE OF CONTAMINATION		CORROSIVE					
8.27	MAXIMUM FILTER FACE VELOCITY		2.5 M/SEC					
8.28	MATERIALS OF CONSTRUCTION		BY BIDDER					
8.29	FILTER PANEL FRAME		BY BIDDER					
8.30	MOUNTING FRAME / SUPPORTING FRAMEWORKFOR FILTER ASSEMBLY		GSS HOT DIP GALVANISED AUXILIARY STEEL CHANNELS OR ANGLES					
8.31	GASKETS FOR FILTER ASSEMBLY		NEOPRENE RUBBER					
8.32	FASTENERS		GS / SS					
8.33	MISCELLANEOUS		BY BIDDER					
8.34	TYPE AND METHOD OF TESTS AS SPECIFIED ARE ACCEPTABLE		BY BIDDER					
8.35	WHETHER FILTER IS COMPATIBLE WITH THE TYPE OF CONTAMINATION		BY BIDDER					
8.36	SELECTION CHARTS WITH DUTY POINT MARKED FOR CLEAN AND CLOGGED FILTER CONDITION TO BE ENCLOSED		BY BIDDER					
9.0	FILTERS (FINE-FILTER)		BY BIDDER					
9.1	GENERAL		BY BIDDER					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
9.2	DESIGNATION		HVAC SYSTEM					
9.3	APPLICATION		FINE FILTER					
9.4	TYPE		CASSETTE / FLANGE					
9.5	MANUFACTURER		BY BIDDER					
9.6	MODEL NUMBER		BY BIDDER					
9.7	WHETHER CLEANABLE		BY BIDDER					
9.8	CLEANING METHOD		CLEANABLE					
9.9	REMOVAL AND CLEANING IN REMOTE PLACE BY AIR JET / WATER		BY BIDDER					
9.10	AIR / WATER PRESSURE REQUIRED	Kg/cm ² g	BY BIDDER					
9.11	MECHANICAL CLEANING IN SITE (WITHOUT REMOVING FILTERS) BY REVERSE COMPRESSED AIR JET		BY BIDDER					
9.12	AIR PRESSURE REQUIRED	Kg/cm ² g	BY BIDDER					
9.13	FILTER MEDIA		BY BIDDER					
9.14	LIFE OF FILTER MEDIA FOR THROW AWAY TYPE	Hrs	BY BIDDER					
9.15	DUST LOADING CAPACITY	gms	BY BIDDER					
9.16	DESIGN DATA		BY BIDDER					
9.17	TOTAL FACE AREA OF FILTERS	m ²	BY BIDDER					
9.18	NUMBER OF FILTERS		BY BIDDER					
9.19	SIZE OF EACH FILTER L X B X THK	mm	610 MM X 610 MM X 300 MM THK					
9.20	DESIGN AIR FLOW RATE PER FILTER	M ³ /Hr	BY BIDDER					
9.21	WEIGHT OF EACH FILTER	Kg	BY BIDDER					
9.22	PRESSURE DROP AT DESIGN FLOW RATE		BY BIDDER					
9.23	CLEAN CONDITION	mmWc	6 MMWC					
9.24	CLOGGED CONDITION	mmWC	12 MMWC					
9.25	EFFICIENCY	%	99% DOWN TO 5 MICRONS (MERV 13)					
9.26	TYPE OF CONTAMINATION		RADIO ACTIVE / CORROSIVE					
9.27	MAXIMUM FILTER FACE VELOCITY	m/sec	1.8					
9.28	MATERIALS OF CONSTRUCTION		BY BIDDER					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
9.29	FILTER PANEL FRAME		BY BIDDER					
9.30	MOUNTING FRAME / SUPPORTING FRAMEWORKFOR FILTER ASSEMBLY		GSS HOT DIP GALVANISED AUXILIARY STEEL CHANNELS OR ANGLES					
9.31	GASKETS FOR FILTER ASSEMBLY		NEOPRENE RUBBER					
9.32	FASTENERS		GS / SS					
9.33	MISCELLANEOUS		BY BIDDER					
9.34	TYPE AND METHOD OF TESTS AS SPECIFIED ARE ACCEPTABLE		BY BIDDER					
9.35	WHETHER FILTER IS COMPATIBLE WITH THE TYPE OF CONTAMINATION		BY BIDDER					
9.36	SELECTION CHARTS WITH DUTY POINT MARKED FOR CLEAN AND CLOGGED FILTER CONDITION TO BE ENCLOSED		BY BIDDER					
AXIAL FAN								
1	GENERAL		AXIAL FAN FOR HVAC SYSTEM					
1.1	DESIGNATION : AXIAL FANS FOR		BY BIDDER					
1.2	FOR NORMAL VENTILATION	Yes / No	YES					
1.3	FOR VENTILATION UNDER FIRE	Yes / No	NO					
1.4	NUMBER REQUIRED: (W+S)		BY BIDDER					
1.5	TAG NUMBERS		BY BIDDER					
1.6	LOCATION:		INDOOR					
1.7	DUTY:	Hrs/Day	CONTINUOUS 24 HRS/DAY					
1.8	LOCATION IN HAZARDOUS AREA:		BY BIDDER					
1.9	HAZARDOUS AREA CLASSIFICATION		AS PER IS 5572 ZONE 0 / 1 / 2					
2	DESIGN DATA		BY BIDDER					
2.1	CAPACITY AT SUCTION CONDITIONS		BY BIDDER					
2.1.1	NORMAL	M ³ /Hr	BY BIDDER					
2.1.2	MINIMUM	M ³ /Hr	BY BIDDER					
2.1.3	MAXIMUM	M ³ /Hr	BY BIDDER					
2.2	FLUID HANDLED:		AIR					
2.3	FLUID CONDITION AT SUCTION		BY BIDDER					
2.3.1	TEMPERATURE	°C	AMBIENT					
2.3.2	RELATIVE HUMIDITY	%	AMBIENT					
2.3.3	DENSITY	Kg/M ³	AMBIENT					
2.4	STATIC PRESSURE	mmWC	BY BIDDER					
2.5	MAXIMUM FAN SPEED		BY BIDDER					
2.5.1	FOR IMPELLER DIAMETER 450 MM AND LESS:	RPM	< 1500					
2.5.2	FOR IMPELLER DIAMETER ABOVE 450 MM:	RPM	< 1000					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
2.6	DESIGN AMBIENT TEMPERATURE	°C	50					
2.7	ELEVATION ABOVE MEAN SEA LEVEL	M	BY BIDDER					
2.8	FAN POSITION:		BY BIDDER					
2.9	FIRE RATING (ONLY FOR FIRE APPLICATION)		BY BIDDER					
2.9.1	TEMPERATURE (MAX): 250 0C FOR 2 HRS		BY BIDDER					
2.10	TYPE: VANE AXIAL / TUBE AXIAL / PROPELLER		TUBE AXIAL					
2.11	SPARK RESISTANT CONSTRUCTION AS PER AMCA:		BY BIDDER					
2.12	DRIVE: DIRECT / BELT		DIRECT					
2.13	ADJUSTABLE PITCH BLADES REQUIRED:		NO					
2.14	TYPE OF MOUNTING:		WALL					
2.15	PAINTING		BY BIDDER					
2.16	FIRE RESISTANT PAINT	Yes / No	BY BIDDER					
2.17	FAN MOTOR ASSEMBLY - STATICALLY / DYNAMICALLY BALANCED AS PER AMCA-204	Yes / No	YES					
3	MATERIALS OF CONSTRUCTION		BY BIDDER					
3.1	CASING:		CS					
3.2	IMPELLER:		CAST AL					
3.3	SHAFT:		EN 8					
3.4	FLEXIBLE CONNECTION AT FAN INLET / OUTLET:		YES					
3.5	VOLUME CONTROL DAMPERS AT FAN INLET / OUTLET: YES / NO		YES					
3.6	INLET GUARD: YES / NO		YES					
3.7	LOUVERED SHUTTERS: YES / NO		YES					
3.8	WALL COWL WITH BIRD SCREEN: YES / NO		YES					
3.9	NEOPRENE RUBBER PADS: YES / NO		YES					
3.10	FOUNDATION BOLTS: YES / NO		YES					
3.11	VIBRATION ISOLATORS: YES / NO		YES					
3.12	RIBBED NEOPRENE RUBBER PADS BETWEEN FOUNDATION BLOCK AND FLOOR FOR FLOOR MOUNTED FANS: YES / NO		NO					
3.13	FOR DESIGN, TESTING AND INSPECTION		IS 2312, IS 3588 AMCA 203, AMCA 210, AMCA					
4	SERVICES		BY BIDDER					
4.1	ERECTION: YES / NO		YES					
4.2	ERECTION SUPERVISION: YES / NO		YES					
4.3	TESTING AND COMMISSIONING: YES / NO		YES					
5	ELECTRICAL		BY BIDDER					
5.1	MOTORS:		BY BIDDER					
5.2	STARTERS:		BY BIDDER					
6	PERFORMANCE GUARANTEES		BY BIDDER					
6.1	CAPACITY AT SUCTION CONDITIONS	M ³ /Hr	BY BIDDER					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
6.2	STATIC PRESSURE	mmWC	BY BIDDER					
6.3	POWER CONSUMPTION	kW	BY BIDDER					
7.0	SPARES AND MAINTENANCE TOOLS AND TACKLES(ESSENTIAL SPARES)							
7.1	BEARING	SETS	2					
7.2	BELT	SETS	2					
7.3	FLEXIBLE CONNECTIONS	NOS.	1 EACH FOR INLET AND OUTLET					
7.4	NEOPRENE RUBBER PADS:	SETS	2					
CENTRIFUGAL FAN								
1	GENERAL							
1.1	DESIGNATION		CENTRIFUGAL FANS FOR HVAC SYSTEM					
1.2	NUMBER REQUIRED		BY BIDDER					
1.3	TAG NUMBERS		BY BIDDER					
1.4	LOCATION		INDOOR					
1.5	DUTY :		CONTINUOUS					
1.6	LOCATION IN HAZARDOUS AREA		NO					
1.7	MAKE AND MODEL NUMBER		BY BIDDER					
1.8	PLACE OF MANUFACTURE		BY BIDDER					
2	DESIGN DATA		BY BIDDER					
2.1	CAPACITY AT SUCTION CONDITIONS		BY BIDDER					
2.1.1	NORMAL :	M ³ /Hr	BY BIDDER					
2.1.2	MINIMUM	M ³ /Hr	BY BIDDER					
2.1.3	MAXIMUM	M ³ /Hr	BY BIDDER					
2.2	GAS HANDLED		AIR					
2.3	GAS CONDITION AT SUCTION		BY BIDDER					
2.3.1	TEMPERATURE	°C	AMBIENT					
2.3.2	RELATIVE HUMIDITY	%	BY BIDDER					
2.3.3	DENSITY :	Kg/M ³	AMBIENT					
2.4	STATIC PRESSURE :	mmWC	BY BIDDER					
2.5	TOTAL PRESSURE	mmWC	BY BIDDER					
2.6	MAXIMUM OUTLET VELOCITY	M/Sec	12					
2.7	DESIGN AMBIENT TEMPERATURE	°C	50					
2.8	ELEVATION ABOVE MEAN SEA LEVEL	M	BY BIDDER					
2.9	MAXIMUM FAN SPEED	RPM	< 1000					
2.10	FAN SUITABLE FOR VARIABLE SPEED DRIVE	YES / NO	YES					
2.11	EFFICIENCY		BY BIDDER					
2.11.1	STATIC		BY BIDDER					
2.11.2	TOTAL		BY BIDDER					
2.12	SEAL SYSTEM		LABYRINTH / RESTRICTIVE RING / MECHANICAL SEAL					
2.13	WEIGHT		BY BIDDER					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
2.13.1	FAN	Kg	BY BIDDER					
2.13.2	MOTOR	Kg	BY BIDDER					
2.13.3	FAN MOTOR ASSEMBLY INCLUDING BASE FRAME AND V-BELT DRIVE	Kg	BY BIDDER					
2.14	TOTAL DYNAMIC LOAD	Kg	BY BIDDER					
2.15	NOISE LEVEL AT 1.5 M DISTANCE FROM FAN	dBA	75					
2.16	MINIMUM FAN SPEED FOR STABLE OPERATION	RPM	BY BIDDER					
2.17	MOTOR RATING REQUIREMENT AT MAXIMUM SPEED	KW	BY BIDDER					
2.18	DOCUMENTS TO BE ENCLOSED		BY BIDDER					
2.18.1	GENERAL ARRANGEMENT DRAWING WITH MAJOR DIMENSIONS		YES					
2.18.2	PARTS LIST WITH CODES AND MATERIALS OF CONSTRUCTION		YES					
2.18.3	RATING CHARTS OR TABLES WITH SELECTION MARKED		YES					
2.18.4	PERFORMANCE CURVE WITH DUTY POINT MARKED		YES					
3	CONSTRUCTION FEATRURES		BY BIDDER					
3.1	TYPE		DOUBLE WIDTH DOUBLE INLET (DWDI)					
3.2	BLADE TYPE		BACKWARD CURVED					
3.3	ARRANGEMENT NUMBER AS PER AMCA		REFER AMCA STANDARD 99-2404-78 IN AMCA STANDARDS HANDBOOK					
3.4	DRIVE		BELT					
3.5	SPLIT CASING REQUIRED		YES					
3.6	PAINTING		MANUFACTURER'S STANDARD					
3.7	MECHANICAL SEAL		YES					
3.8	FAN SUITABLE FOR VARIABLE SPEED DRIVE		YES					
4	MATERIALS OF CONSTRUCTION		BY BIDDER					
4.1	CASING		CS					
4.2	IMPELLER		CS					
4.3	SHAFT		EN 8					
4.4	SHAFT SLEEVE		SS 410					
4.5	OUTLET DAMPER		GSS					
4.6	INLET GUIDE VANE		NA					
4.7	INLET GUARD		GS WIRE					
4.8	IMPELLER		BY BIDDER					
4.8.1	DIAMETER	mm	BY BIDDER					
4.8.2	MOMENT OF INERTIA	Kg M ²	BY BIDDER					
5	ACCESSORIES		BY BIDDER					
5.1	FLEXIBLE CONNECTION AT FAN OUTLET AND AT PLENUM CONECTION		YES					
5.2	INLET GUARD		YES					
5.3	INLET VANE		NO					
5.4	OUTLET VCD & NRD		YES					
5.5	COMMON BASE FRAME		YES					
5.6	FOUNDATION BOLTS		YES					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
5.7	VIBRATION ISOLATORS		YES					
5.7.1	TYPE		SPRING					
5.7.2	MINIMUM VIBRATION ISOLATION EFFICIENCY	%	80					
5.8	RIBBED NEOPRENE RUBBER PADS BETWEEN FOUNDATION BLOCK AND FLOOR		YES					
5.9	OUTLET DAMPER		YES					
5.10	FLEXIBLE COUPLING AND COUPLING GUARD		NO					
5.11	DRAIN VALVE		YES					
6	SERVICES		BY BIDDER					
6.1	ERECTION		YES					
6.2	ERECTION SUPERVISION		YES					
6.3	TESTING AND COMMISSIONING		YES					
7	ELECTRICAL		BY BIDDER					
7.1	MOTORS		BY BIDDER					
7.2	STARTERS		BY BIDDER					
8	SPARES AND MAINTENANCE TOOLS AND TACKLES		BY BIDDER					
8.1	RECOMMENDED SPARE PARTS LIST FOR 2 YEARS NORMAL OPERATION		BY BIDDER					
9	CODES AND STANDARDS		BY BIDDER					
9.1	FOR DESIGN, TESTING AND INSPECTION		IS 4894, AMCA 203, AMCA 210, AMCA 300					
10	PERFORMANCE GUARANTEES		BY BIDDER					
10.1	CAPACITY AT SUCTION CONDITIONS :	M ³ /Hr	BY BIDDER					
10.2	STATIC PRESSURE :	mmWC	BY BIDDER					
10.3	POWER CONSUMPTION :		BY BIDDER					
10.3.1	POWER INPUT TO FAN AT DUTY POINT (BKW)	KW	BY BIDDER					
10.3.2	MAXIMUM POWER REQUIREMENT AT SELECTED SPEED	KW	BY BIDDER					
10.4	MOTOR RATING	KW	BY BIDDER					
10.5	POWER INPUT TO MOTOR AT DUTY POINT	KW	BY BIDDER					
11.0	SPARES AND MAINTENANCE TOOLS AND TACKLES (SPARES FOR TWO YEARS OPERATION)							
11.1	BEARING (MOTOR)	SETS	2					
11.2	BEARING (FAN)	SETS	2					
11.3	PILLY BELT DRIVE	SETS	1					
11.4	BELT	SETS	2					
PROPELLER FANS								
1	GENERAL		PROPELLER FANS FOR TOILET AREA					
1.1	DESIGNATION :		BY BIDDER					
1.2	FOR NORMAL VENTILATION	Yes / No	YES					
1.3	FOR VENTILATION UNDER FIRE	Yes / No	NO					
1.4	NUMBER REQUIRED: (W+S)		BY BIDDER					
1.5	TAG NUMBERS		BY BIDDER					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
1.6	LOCATION:		INDOOR					
1.7	DUTY:	Hrs/Day	CONTINUOUS					
1.8	LOCATION IN HAZARDOUS AREA:		NO					
1.9	HAZARDOUS AREA CLASSIFICATION		AS PER IS 5572 ZONE 0 / 1 / 2					
2	DESIGN DATA		BY BIDDER					
2.1	CAPACITY AT SUCTION CONDITIONS		BY BIDDER					
2.1.1	NORMAL	M ³ /Hr	BY BIDDER					
2.1.2	MINIMUM	M ³ /Hr	BY BIDDER					
2.1.3	MAXIMUM	M ³ /Hr	BY BIDDER					
2.2	FLUID HANDLED:		AIR					
2.3	FLUID CONDITION AT SUCTION		BY BIDDER					
2.3.1	TEMPERATURE	°C	AMBIENT					
2.3.2	RELATIVE HUMIDITY	%	AMBIENT					
2.3.3	DENSITY	Kg/M ³	AMBIENT					
2.4	STATIC PRESSURE	mmWC	BY BIDDER					
2.5	MAXIMUM FAN SPEED		BY BIDDER					
2.5.1	FOR IMPELLER DIAMETER 450 MM AND LESS:	RPM	1500					
2.5.2	FOR IMPELLER DIAMETER ABOVE 450 MM:	RPM	1000					
2.6	DESIGN AMBIENT TEMPERATURE	°C	50					
2.7	ELEVATION ABOVE MEAN SEA LEVEL	M	BY BIDDER					
2.8	FAN POSITION:		BY BIDDER					
2.9	FIRE RATING (ONLY FOR FIRE APPLICATION)		BY BIDDER					
2.9.1	TEMPERATURE (MAX): 250 0C FOR 2 HRS		BY BIDDER					
2.10	TYPE: VANE AXIAL / TUBE AXIAL / PROPELLER		PROPELLER					
2.11	SPARK RESISTANT CONSTRUCTION AS PER AMCA:		NA					
2.12	DRIVE: DIRECT / BELT		DIRECT					
2.13	ADJUSTABLE PITCH BLADES REQUIRED:		NO					
2.14	TYPE OF MOUNTING:		WALL					
2.15	PAINTING		BY BIDDER					
2.16	FIRE RESISTANT PAINT	Yes / No	BY BIDDER					
2.17	FAN MOTOR ASSEMBLY - STATICALLY / DYNAMICALLY BALANCED AS PER AMCA-204	Yes / No	YES					
3	MATERIALS OF CONSTRUCTION		BY BIDDER					
3.1	CASING:		CS					
3.2	IMPELLER:		CAST AL					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
3.3	SHAFT:		EN 8					
3.6	INLET GUARD: YES / NO		YES					
3.7	LOUVERED SHUTTERS: YES / NO		YES					
3.8	WALL COWL WITH BIRD SCREEN: YES / NO		YES					
3.9	NEOPRENE RUBBER PADS: YES / NO		NO					
3.10	FOUNDATION BOLTS: YES / NO		YES					
3.12	RIBBED NEOPRENE RUBBER PADS BETWEEN FOUNDATION BLOCK AND FLOOR FOR FLOOR MOUNTED FANS: YES / NO		NO					
4	SERVICES		BY BIDDER					
4.1	ERECTION: YES / NO		YES					
4.2	ERECTION SUPERVISION: YES / NO		YES					
4.3	TESTING AND COMMISSIONING: YES / NO		YES					
5	ELECTRICAL		BY BIDDER					
5.1	MOTORS:		BY BIDDER					
5.2	STARTERS:		BY BIDDER					
6	PERFORMANCE GUARANTEES		BY BIDDER					
6.1	CAPACITY AT SUCTION CONDITIONS	M ³ /Hr	BY BIDDER					
6.2	STATIC PRESSURE	mmWC	BY BIDDER					
6.3	POWER CONSUMPTION	kW	BY BIDDER					
7.0	SPARES AND MAINTENANCE TOOLS AND TACKLES							
7.1	MOTOR BEARINGS	SETS	2					
7.2	SHAFT KEY	No.	1					
ROOF EXTRACTORS								
1	GENERAL		ROOF EXTRACTOR FOR TG BUILDING					
1.1	DESIGNATION		BY BIDDER					
1.2	NUMBER OFFERED	Nos	BY BIDDER					
1.3	TAG NUMBERS		BY BIDDER					
1.4	MAKE AND MODEL NUMBER		BY BIDDER					
1.5	OPERATION		CONTINUOUS					
2	LOCATION		OUTDOOR					
2.1	PLACE OF MANUFACTURE		BY BIDDER					
3	DESIGN DATA		BY BIDDER					
3.1	IMPELLER TYPE		AXIAL					
3.2	NORMAL CAPACITY AT SUCTION CONDITIONS	M ³ /Hr	BY BIDDER					
3.3	STATIC PRESSURE	mmWC	BY BIDDER					
3.4	STATIC EFFICIENCY	%	BY BIDDER					
3.5	IMPELLER DIAMETER	mm	BY BIDDER					
3.6	IMPELLER SPEED	RPM	BY BIDDER					
3.7	BALANCING GRADE		BY BIDDER					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
3.8	OPENING SIZE REQUIRED L X B		BY BIDDER					
3.9	SPARK RESISTENT CONSTRUCTION TYPE AS PER AMCA		BY BIDDER					
3.10	TOTAL OPERATOING WEIGHT OF ROOF EXTRACTOR INCLUDING HOOD	Kg	BY BIDDER					
3.11	NOISE LEVEL AT 1.5 M DISTANCE FROM FAN	dB(A)	BY BIDDER					
3.12	MATERIAL OF CONSTRUCTION		BY BIDDER					
3.13	CASING		CS					
3.14	IMPELLER		CAST ALUMINIUM					
3.15	SHAFT		EN-8					
4	POWER REQUIREMENT		BY BIDDER					
4.1	POWER INPUT TO FAN AT DUTY POINT (BKW)	kW	BY BIDDER					
4.2	MOTOR RATING	kW	BY BIDDER					
4.3	POWER INPUT TO MOTOR AT DUTY POINT	kW	BY BIDDER					
5	DOCUMENTS TO BE ENCLOSED		BY BIDDER					
5.1	GENERAL ARRANGEMENT DRAWINGS WITH MAJOR DIMENSIONS		BY BIDDER					
5.2	PARTS LIST CODES AND MATERIALS OF CONSTRUCTION		BY BIDDER					
5.3	RATING CHARTS OR TABLES WITH SELECTION MARKED		BY BIDDER					
5.4	PERFORMANCE CURVES WITH DUTY POINT MARKED		BY BIDDER					
5.5	MOUNTING DETAILS WITH WALL OPENING REQUIREMENTS		BY BIDDER					
5.6	RECOMMENDED SPARE PARTS LIST FOR 2 YEARS NORMAL OPERATION		BY BIDDER					
6.0	PERFORMANCE GUARANTEES		BY BIDDER					
6.1	CAPACITY AT SUCTION CONDITIONS	M ³ /Hr	BY BIDDER					
6.2	STATIC PRESSURE	mmWC	BY BIDDER					
6.3	POWER CONSUMPTION	kW	BY BIDDER					
6.4	PERFORMANCE TEST AT SITE REQUIRED		YES					
6.5	SPARES AND MAINTENANCE TOOLS AND TACKLES							
6.6	IMPELLOR	SETS	1					
6.7	MOUNTING BOLT	SETS	1					
6.8	BEARING	SETS	2					
6.9	GASKET	SETS	4					
6.10	ROOF CLOSING SHEET	SETS	1					
SECTION - 20. CRANES AND HOISTS								
A	Cranes							
1	Location		STG building					
2	Type		Double Girder EOT					
3	Number required		One (1)					
4	Capacity (MH/AH)	Ton	75 / 10					
5	Crane span	Mtr	By Bidder					
6	Lift	Mtr	By Bidder					
7	Runway length	Mtr	Shall be selected based onTG Building					
8	Operating floor elevation		Shall be selected based onTG Building					
9	Location		Indoor					
10	Crane Classification		As per IS 13834					
11	Operation		Remote and Cabin					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
12	Power consumption	kW	By Bidder					
13	Crane duty and classification		By Bidder					
14	Crane Speed (Main Hoist / Aux. Hoist / Cross travel / Long Travel)	M/minute	By Bidder					
15	Creep speed of crane (Main Hoist / Aux. Hoist / Cross travel / Long Travel)	M/minute	By Bidder					
16	Vertical deflection of crane girder	mm	By Bidder					
17	Wire rope factor of safety , type and construction		By Bidder					
18	Brake type and Factor of safety for all motions		By Bidder					
19	Long travel walkway required	mm	750 mm clear walkway(both side)					
20	All advance safety features like Danger Focus light, load display, Drag chain, camera etc.		By Bidder					
21	MATERIALS AND CODES OF CONSTRUCTION			Bidder to note Cast iron parts is not permitted for any item				
a	Bridge girder		IS 2062 GR.B					
b	Rope drums and sheaves		IS 3177 (As per IS 2062 Gr.B & stress relived or of seamless steel pipe as per ASTM A- 106 Grade A or B)					
c	Wire rope		IS 2266					
d	Bearings		Ball or roller type bearing life shall be minimum 10,000 working hours					
e	Shafts and axles		Carbon steel					
f	Lifting hooks		Forged and heat treated alloy steel / carbon steel as per IS 15560					
g	Long and cross travel wheels		Rim toughened, heat treated cast steel or wrought steel MTL: C55MN-75 as per IS 1570					
h	Crane rails		IS 3443					
i	Lubrication		Centralized grease lubrication with hand operated grease pump					
j	Brake (MH,AH)		Electro hydraulic thruster – 1 no. Electromagnetic – 1 no.					
k	Brake (LT,CT)		Electro hydraulic thruster 1 no. with each motor					
21	Electrical							
a	Motors		By Bidder					
b	Starters		By Bidder					
c	Control panel mounting		Mounted on Crane Bridge					
d	Runway conductors		Shrouded type Copper conductor touch proof					
e	Cross travel conductors		Flexible trailing cable					
f	Power conductors		Minimum 4 mm ² aluminum					
g	Control cable		Minimum 2.5 mm ² stranded copper					
h	Lighting cables		Minimum 2.5 mm ² stranded copper					
22	TESTS AND INSPECTION							
a	Over load test		Yes					
b	For hoisting		Yes					
c	For crane motions		By Bidder					
d	Test loads		Maximum 1 / 900 of span					
e	Deflection of main girders with load at the centre		Yes					
f	Speed check for all motions		Yes					
g	Insulation test for all electrical equipment							
23	PERFORMANCE GUARANTEES							
a	Capacity	ton						
b	Lift	m						
c	Speeds for all motions	mpm	+/-10%					
B	Electric Hoist							
1	Capacity		Handling equipments weighing above 1000kg or with a lift >10mtr					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	TCE SPEC. ↓ BIDDER >>	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
2	Location		Indoor / Outdoor					
3	Power consumption	kW	By Bidder					
4	Hoist duty		By Bidder					
5	Speed (Hoist / Crab travel)	M/minute	By Bidder					
6	Wire rope factor of safety , type and construction		By Bidder					
7	Brake type and Factor of safety for all motions		By Bidder					
8	Applicable standard		IS 3938					
9	Monorail by		By Bidder					
10	Type of hoist gears		Spur /Helical					
11	Type of trolley		Motor driven					
12	Hoisting speed : single speed/dual speed/variable speed	m/min.	4.0					
13	Trolley travel speed	m/min.	10.0					
14	Creep speed required for		10 % of Hoist speed					
15	Hoist		Yes					
16	Trolley		Yes					
17	Type of down shop lead		Flexible trailing cable / PVC shrouded bus bar					
18	Method of operation		Pendant push button station					
19	Inching and plugging controls							
20	Inching control required for		Hoisting and / or travel					
21	Plugging control required for		Hoisting and / or travel					
22	MATERIALS AND CODES OF CONSTRUCTION							
a	Trolley wheels		Rim toughened, heat treated cast or forged or rolled steel / graded cast iron					
b	Rope drum and sheaves		IS 3938					
c	Wire rope		IS 2266- steel core					
d	Chain drum or chain wheel		Heavy duty malleable casting / pressed sheet steel					
e	Link chain		Alloy steel IS 3109 / IS 6216/IS 3077					
f	Gears and pinions		Spur/ helical as per IS 4460/ BS436/ BS 721/ AGMA standards					
g	Bearings		Ball or roller type anti-friction bearings as per IS 5669/ IS 5692/ IS 5932/ IS 5935					
h	Shafts and axles		Carbon steel/ alloy steel					
i	Brakes (fail-safe)		Electromagnetic / Electro thrustors					
j	Lifting hook (type and m.o.c)		C Shank, Swiveling type with locking arrangement Forged and heat treated alloy steel / carbon steel as per IS 2758 / IS 2759 / IS 3822 / IS 4164 / IS 15560					
k	Lubrication (bearings):		Life-lubricated/centralised grease lubrication					
l	Lubrication(gear box):		Centralised grease lubrication with hand operated grease pump/ oil splash lubricated/life-time grease lubricated					
m	Safety latch for hook:-		Yes					
23	TESTS AND INSPECTION							
a	Overload test with 125 % of Specified load		Yes					
b	Test loads		By Bidder					
c	Speed check for all motions:		Yes					
d	Insulation test for all Electrical equipment		Yes					
C	Manual Hoist							
1	Location		Handling equipments weighing < 1000 kg or with a lift <10mtr.					
2	Effort for operation		By Bidder					
3	Hoist duty		By Bidder					
4	Wire rope factor of safety , type and construction		By Bidder					
5	Brake type for all motions		By Bidder					
6	MATERIALS OF CONSTRUCTION							

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
a	Trolley wheels		Rim Toughened, Heat Treated Cast or Forged or Rolled Steel/Graded Cast Iron					
b	Load chain		Alloy Steel IS 3109/ IS 6216					
c	Load chain wheel, main arm holding upper hook and block holding bottom hook		Heavy Duty Malleable Casting/ Pressed Sheet Steel					
d	Hand chain		IS 2429/ BS 6405					
e	Hand chain wheel		Pressed Sheet Steel					
f	Gears and pinions		Spur/Helical As Per IS 4460/ BS 436/ BS 721/AGMA Standards					
g	Bearings		Ball Or Roller Type Anti-Friction Bearings As Per IS 5669/IS5692/IS 5932/IS 5935					
h	Shafts and axles		Carbon Steel					
i	Brake		Screw And Friction Disc Type Self-Actuating Load Pressure Brake/Any Other Standard Design					
j	Lifting hook		Forged And Heat Treated Alloy Steel/Carbon Steel As Per IS 2758 / IS 2759 / IS 3822 / IS 4164 / IS 15560					
k	Lubrication		Manually By Hand Operated Grease Pumps Through Respective Grease Nipples					
7	TESTS AND INSPECTION		As per the technical specification					
a	Overload test with 150 % of specified load		Yes					
b	Test loads		By Bidder					
c	Performance test at site by vendor		Yes					
SECTION - 21, Sump Pumps								
	TG Building Sump Pumps							
1.0	Type of Sump Pumps		Submersible					
	Design Conditions							
1.0	No. of Pumps		2 x100%					
2.0	Capacity	m3/hr	5					
3.0	Total Head	mwc	Later					
4.0	Material of Construction		Suitable to waste water quality					
5.0	Feed to - Oily water collection sump		By Bidder					
	Boiler Area Sump Pumps							
1.0	Type of Sump Pumps		Submersible					
	Design Conditions							
1.0	No. of Pumps		2 x100%					
2.0	Capacity	m3/hr	5					
3.0	Total Head	mwc	Later					
4.0	Material of Construction		Suitable to waste water quality					
5.0	Feed to - Oily water collection sump		By Bidder					
	Transformer Area Sump Pumps							
1.0	Type of Sump Pumps		Submersible					
	Design Conditions							
1.0	No. of Pumps		2 x100%					
2.0	Capacity	m3/hr	5					
3.0	Total Head	mwc	Later					
4.0	Material of Construction		Suitable to waste water quality					
5.0	Feed to - Oily water collection sump		By Bidder					
	Fuel Oil Area Sump Pumps							
1.0	Type of Sump Pumps		Submersible					
	Design Conditions							
1.0	No. of Pumps		2 x100%					
2.0	Capacity	m3/hr	5					
3.0	Total Head	mwc	Later					
4.0	Material of Construction		Suitable to waste water quality					
5.0	Feed to - Oily water collection sump		By Bidder					
	Ash Silo Area Sump Pumps							
1.0	Type of Sump Pumps		Submersible					
	Design Conditions							
1.0	No. of Pumps		2 x100%					
2.0	Capacity	m3/hr	5					
3.0	Total Head	mwc	Later					
4.0	Material of Construction		Suitable to waste water quality					
	Feed to - Existing coal run off pond		By Bidder					
	Boiler & ESP Area Sump Pumps-Wash Water							
1.0	Type of Sump Pumps		Submersible					

TECHNICAL DATASHEET (MECHANICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13258B	
SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
	Design Conditions							
1.0	No. of Pumps		2 x100%					
2.0	Capacity	m3/hr	5					
3.0	Total Head	mwc	Later					
4.0	Material of Construction		Suitable to waste water quality					
	Feed to - Existing coal run off pond		By Bidder					
	NOTE: 1.							
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	PPD. BY	RKS	RKS					
	CHD. BY	AM	AM					
	APD. BY	PSG	PSG					
	DATE	17-09-2024	25-09-2024					

TECHNICAL DATASHEET (ELECTRICAL SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	EPC Package			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13833A	SHEET OF
SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
SECTION - 1, SYNCHRONOUS GENERATOR AND GEN. AUXILIARIES								
1.0	Prime Mover for Generator	-	Steam Turbine					
2.0	Location	-	STG Building					
3.0	Indoor or Outdoor	-	Indoor					
4.0	Quantity	Nos.	2					
5.0	Design Ambient temp.	°C	40					
6.0	Rated MVA	(MVA)	By BIDDER					
7.0	Rated MW at pf	(MW)	30					
8.0	Rated Lagging Power Factor	-	0.8					
9.0	Rated Frequency	(Hz)	50					
10.0	Rated Speed	(RPM)	3000 rpm		1500 rpm			
11.0	Rated Voltage	(kV)	11					
12.0	Number of Phases		3					
13.0	Stator Winding Connection	-	STAR					
14.0	Type of cooling		Closed circuit air cooled with air to water integral heat exchanger					
			(IC9A1W7)					
	a) Stator Winding		By BIDDER					
	b) If water cooled No of exchanges		By BIDDER					
	c) Rotor Winding and Stator Core		By BIDDER					
15.0	Class of Insulation							
	a) Stator Winding		Class "F" insulation and Temperature Rise limited to class "B"					
	b) Rotor Winding		-- do --					
16.0	Power Frequency withstand voltage	(kV)	by bidder as per IEC-34-15					
17.0	Basic Impulse Level of Stator Winding	(kVp)	by bidder as per IEC-34-15					
18.0	Short Circuit Ratio	(Pu)	> 0.5					
19.0	Minimum Direct Axis Saturated Sub-transient Reactance	(Pu)	By BIDDER					
20.0	Maximum Direct Axis Unsaturated Transient Reactance	(Pu)	By BIDDER					
21.0	Nominal response of Excitation system		Minimum 2.0					
SECTION - 2, GENERATOR AUXILIARY CUBICAL								
1.0	GENERAL							
1.1	Application/Designation		GENERATOR AUXILIARY CUBICAL (GAC)					
1.2	Quantity		2					
1.3	Installation	Indoor / Outdoor	Indoor					
1.4	Type		Phase segregated bus arrangement, self-cooled.					
1.5	Enclosure		IP-55					
1.6	Rated Continuous Current Mian Run & Neutral		By Bidder					
1.7	Material							
1.7.1	Bus Conductor		Electrolytic grade copper					
1.7.2	GAC Enclosure		3 mm Thick CRCA Sheet					
1.8	Voltage Transformer and Surge Protection Cubical							
1.8.1	Voltage Transformer							
a)	Quantity		By Bidder					
b)	Rated Voltage							
i) Primary		kV	11 / v 3					
ii) Secondary S1		V	110 / v 3					
iii) Secondary S2		V	110 / v 3					
c)	Rated Burden of each secondary	VA	By Bidder					

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SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
d)	Accuracy class		Measurement - Class 0.2A for tariff Metering and 0.2 for Measurement, Protection- Class 3P					
1.8.2	Lightning Arrester							
a)	Quantity		By Bidder					
b)	Type		Metal-Oxide Surge Arrester Molded with silicone Polymer.					
c)	Rated volatge (Hermitically sealed)	kV (rms)	12					
d)	Maximum Continuous operating voltage	kV (rms)	11					
e)	Rated Frequency	Hz	50					
f)	Nominal discharge current (8/20 micro-sec wave)	kA	10					
g)	Power Frequency withstand Voltage	kV (rms)	28					
1.8.3	Surge Capacitor							
a)	Quantity		By Bidder					
b)	Type		Surge Protection					
c)	Rated Voltage		18					
d)	Rated Frequency		50					
e)	Rated Capacitance		0.25 Microfarads ±10%					
f)	Power Frequency withstand Voltage		38					
g)	Basic Insulation Level		95					
1.9	Generator Neutral Grounding Cubical							
1.9.1	Neutral Groundig Transformer							
1.9.2	Type		Epoxy Cast Resin, Dry Type					
1.9.3	No. of phases and frequency		1					
1.9.4	Rated Primary Cvoltage		11					
1.9.5	Rater Secondary Voltage		240					
1.9.6	Inmpedance		15.8					
1.9.7	Winding insulatin class		F					
1.9.8	Ratio		11000/240					
1.9.9	Rated output of transformer		63					
1.9.10	Max. permissible temperature Rise		80 Deg. C					
1.9.11	Type of cooling		Air Cooled					
1.10	Neutral Grounding Resistor							
1.11	Continuous rated / short time rated		20A / 200A for 5 min					
1.12	Rated Voltage		240					
1.13	Frequency		50					
1.14	Material		ASTM-A240-304 Punched Stainless Steel					
1.15	Voltage Level Insulation		3k					
1.16	Service condition		Indooe					
1.17	Cooling		Air Cooled					
1.18	Current Carrying capacity		200A for 5 Min					
1.19	Ohmic value		1.07 +/- 10% Ohm					
1.20	CTs Secondary side of NGT for 100% Stator Earth Falut		By Bidder					
SECTION - 3, SEGREGATED PHASE BUS DUCT								
A.	General							
1.0	Make & country of the manufacturer	-						
2.0	Rated frequency	-	50 Hz (+5% to -5%)					
3.0	Type	-	Segregated phase busduct					

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SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
4.0	Enclosure	-	Aluminium alloy (99.5%)					
5.0	Conductor	-	Aluminum alloy (99.5%)					
6.0	Degree of protection	-	Dust tight weather proof Min. IP 55					
7.0	Applicable Standard	-	Bidder to specify					
B.	11kV Isolated Phase busduct							
1.0	Make & country of the manufacturer	-	Bidder to specify					
2.0	Reference standard	-	Bidder to specify					
3.0	Type of cooling	-	Natural Air cooled					
4.0	Rated Voltage	kV	11 kV					
5.0	Rated Lightning impulse withstand voltage (peak)	kV peak	75 kV					
6.0	Rated one minute power frequency withstand voltage (rms)	kV (rms)	28 kV					
7.0	Continuous current rating for GT SPBD	A	Bidder to specify					
8.0	Temperature (absolute) of conductor/enclosure considering ambient temperature of 40°C at full load operation	°C						
	a) Plain bolted joint	°C	70 °C					
	b) Silver plated bolted joint	°C	105 °C					
	c) Busduct enclosure	°C	80 °C					
9.0	Short time current rating for one (1) sec. for Main run	kA (rms)	40 kA					
10.0	Momentary short circuit current for Main run	kA peak	108 kA					
11.0	Short time current rating for one (1) sec. for tap off connection to UAT	kA (rms)	70 kA					
12.0	Momentary short circuit current for tap off connection to UAT	kA peak	189 kA					
13.0	Bus Conductor for SPBD Main Run							
	a) Material & grade		Bidder to specify					
	b) A.C. resistance at 90 deg C	Ohm/m/ph	Bidder to specify					
	c) 50 Hz reactance	Ohm/m/ph	Bidder to specify					
	d) Loss in busbar at 100% load	kW/3phase/m	Bidder to specify					
	e) Loss in busbar enclosure at 100% load	kW/3phase/m	Bidder to specify					
	f) Short circuit forces	kg/m	Bidder to specify					
	g) Support spacing	mm	Bidder to specify					
SECTION - 4, CONTROL AND PROTECTION PANEL								
a)	Generator Measuring and Control Panel		Required					
b)	Generator Protection Panel		Required					
SECTION - 5, SERVICE TRANSFORMER								
1.0	Manufacturer & Place		Bidder to specify					
2.0	Service		Bidder to specify					
3.0	Type		Bidder to specify					
4.0	Reference standards		Bidder to specify					
5.0	Quantity		As per Specification					
6.0	Type of cooling		ONAN					
7.0	Rating		As per Specification					
8.0	Rated kVA	kVA	Bidder to specify					
9.0	Rated voltage HV/LV	kV	6.6 / 0.433					
10.0	Number of phases		3					
11.0	Rated Frequency	HZ	50Hz, +5% to -5%					
12.0	Rated current for HV & LV side	Amps						
13.0	HV no load current at rated voltage	Amps						
14.0	No load current as a percentage of Rated Full load current							
15.0	Maximum guaranteed Temperature rise above 40°C ambient							
	a) in oil by thermometer (NA)	° C	40					
	b) in winding by resistance	° C	55					

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SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
16.0	Connections (HV & LV windings)		Delta Star					
17.0	Vector group		Dyn11					
18.0	Winding material		Bidder to specify					
19.0	Winding insulation category		Bidder to specify					
20.0	Hot spot temperature in winding	°C	98					
21.0	Tap Changer Details							
a)	Type of Tap changer		Off Circuit Tap Changer (OCTC)					
b)	Variation		+5 to -5 in steps of 2.5%					
22.0	Losses							
a)	Guaranteed losses		Bidder to specify					
b)	No-load loss at rated voltage & frequency (Max.)	kW	Bidder to specify					
c)	Load loss at rated current at 75°C (Max.)	kW	Bidder to specify					
23.0	Impedance	%	Bidder to specify					
24.0	Resistance at 75°C	Ohms	Bidder to specify					
25.0	Guaranteed Efficiency at 75°C winding temperature and at 0.8 p.f. lag							
a)	At full load	%	Bidder to specify					
b)	At 3/4load	%	Bidder to specify					
c)	At 1/2load	%	Bidder to specify					
26.0	Maximum short time current rating of transformer	Amps	Bidder to specify					
27.0	Regulation at full load and at 75°C at upf & 0.8 pf lag	%	Bidder to specify					
28.0	Maximum flux density							
a)	At rated voltage	Wb / m2	Bidder to specify					
b)	At 110% rated voltage	Wb / m2	Bidder to specify					
29.0	Type of oil preservation system(NA)		Bidder to specify					
30.0	Type of Pressure relief device (NA)		Bidder to specify					
31.0	Termination arrangement HV side / LV side / LV neutral side		Bidder to specify					
32.0	Details of bushings (HV, LV & LV neutral)							
a)	Type		Bidder to specify					
b)	Voltage class	kV	Bidder to specify					
c)	Power frequency withstand voltage (wet & dry)	kV	Bidder to specify					
d)	Impulse withstand voltage	kV	Bidder to specify					
e)	Creepage distance	mm	Bidder to specify					
33.0	HV Cable box							
a)	Degree of protection		Bidder to specify					
b)	Phase to Phase Clearances	mm	Bidder to specify					
c)	Phase to earth Clearances	mm	Bidder to specify					
35.0	LV Neutral Bushing Current transformers							
a)	Type		Bidder to specify					
b)	Current ratio		Bidder to specify					
c)	Burden and accuracy class		Bidder to specify					
36.0	Short time withstand current and duration	kA & sec	Bidder to specify					
37.0	Radiator							
a)	Type & material		Bidder to specify					
b)	No. of radiators / bank		Bidder to specify					
c)	Thickness of steel	mm	Bidder to specify					
d)	Pressure withstand capacity	kg / m ²	Bidder to specify					
38.0	Vacuum withstand capacity of main tank, radiators & accessories.	mm of Hg	Bidder to specify					
39.0	Tank details							
a)	Thickness of side plate	mm	Bidder to specify					
b)	Thickness of top plate	mm	Bidder to specify					

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SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
	c) Thickness of bottom plate	mm	Bidder to specify					
	d) Pressure withstand capacity	kg /m ²	Bidder to specify					
	e) Vacuum withstand capacity	mm of Hg	Bidder to specify					
40.0	Minimum clearance height for lifting core and winding from tank	mm	Bidder to specify					
41.0	Dimension/ Weight of transformer							
	a) Overall dimension L x W x H	mxmxm	Bidder to specify					
	b) Total weights	kg	Bidder to specify					
42.0	Oil quantity (NA)	Litre	Bidder to specify					
43.0	Marshalling box Degree of protection							
	b) Accuracy class	-	Bidder to specify					
44.0	Ground Bus							
	a) Material	-	Copper					
	b) Size	mmxmm	50x6					
45.0	Earthing trucks for earthing the busbar		One of each type to be provided					
46.0	Earthing trucks for earthing outgoing cables		Two of each type to be provided.					
SECTION -6 , MV SWITCHGEAR								
1.0	Switchgear Assembly							
	a) Make & country of manufacturer	-	Totally enclosed, metal clad, drawout type					
	b) Type	-	Bidder to specify					
	c) Reference Standard	-	Bidder to specify					
	d) Voltage	kV	6.6 kV					
	e) Phase, Frequency	No, Hz	3 ph, 50 Hz ±5%					
	f) Short Circuit Rating	-						
	Peak withstand	kA peak	Bidder to specify					
	Short-time withstand for 3s	kA rms	40					
	Momentary withstand capacity of the entire switchgear	kA	Bidder to specify					
	g) Insulation level							
	Impulse voltage withstand	kV peak	Bidder to specify					
	One minute power frequency withstand voltage	kV	Bidder to specify					
	h) Degree of protection	-	IP 4X					
2.0	Bus bar							
	a) Material & Grade	-	Electrolytic Copper					
	b) Cross sectional Area/Size	mm ² /mm	Bidder to specify					
	c) Continuous Current (at site condition, 40°C ambient and within cubicle)	A	Bidder to specify					
	d) Maximum temperature (absolute) for an ambient of 40°C	°C	Bidder to specify					
3.0	Bus support insulator							
	a) Type/Material		Bidder to specify					
	b) Voltage Class	kV	6.6					
4.0	Circuit Breaker							
	a) Make		Bidder to specify					
	b) Type		VCB					
	c) Rated voltage	kV	6.6					
	d) Max. continuous voltage	kV	7.2					
	e) Short-time current for 3s	kA rms	40					
	f) Max. temperature (absolute) for an ambient of 50°C	°C	Bidder to specify					
	g) Rated operating duty	-	O-0.3 min - CO-3 min-CO					
5.0	Interrupting capacity at rated voltage and operating duty							
	a) Symmetrical	kA rms	Bidder to specify					
	b) Asymmetrical KA peak	kA	Bidder to specify					
	c) Maximum DC component	%	Bidder to specify					
6.0	Type & Material of contacts							

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	a) Main	-	Bidder to specify					
	b) Arcing	-	Bidder to specify					
	c) Whether contacts silver plated	-	Bidder to specify					
7.0	Minimum clearance in air							
	a) Type of arc control device provided	-	Bidder to specify					
	b) Type	-	Bidder to specify					
	c) Operating Mechanism	-	Bidder to specify					
	d) No. of breaker operations stored	-	Bidder to specify					
	e) Spring reserve for one C-O-C-O operation available	Yes/No	Bidder to specify					
	f) Method of closing during power supply failure	-	Bidder to specify					
8.0	Spring charging motor							
	a) Class of Insulation	-	Bidder to specify					
	b) Time required to charge the spring from fully discharged condition	s	Bidder to specify					
9.0	Number of operations before interrupter maintenance required							
	a) At rated short circuit current	-	Bidder to specify					
	b) At full load current	-	Bidder to specify					
10.0	Current Transformer							
	a) Type	-						
	b) Rated secondary current	-	1 A					
	c) Short-time current for 1s	kA rms	Bidder to specify					
	d) Class of insulation	-						
	e) Accuracy class							
	f) Core balance CT provided for							
	g) Incomers / Tie feeders	Yes / No	Bidder to specify					
	h) Transformer feeders	Yes / No	Bidder to specify					
	i) Motor feeders	Yes / No	Bidder to specify					
11.0	Voltage Transformer							
	a) Type	-	Bidder to specify					
	b) Burden	VA	Bidder to specify					
	c) Over voltage factor		Bidder to specify					
	Continuous	-	1.2					
	30 seconds	-	1.5					
	d) Class of insulation	-	Bidder to specify					
12.0	Relays (details to be provided for each relay)							
	a) Provided with built-in test facilities	(Yes/No)	Bidder to specify					
	b) Type of mounting	-	Bidder to specify					
	c) Make	-	Bidder to specify					
	d) Type	-	Bidder to specify					
	e) Setting range	%	Bidder to specify					
	f) No. of contacts	-	Bidder to specify					
	g) Burden	VA	Bidder to specify					
13.0	Meters (Furnish details for each type of meter separately)							
	a) Type	-	Bidder to specify					
	b) Accuracy class	-	Bidder to specify					
14.0	Ground Bus							
	a) Material	-	Copper					
	b) Size	mmxmm	50x6					
15.0	Earthing trucks for earthing the busbar		One of each type to be provided					
16.0	Earthing trucks for earthing outgoing cables		Two of each type to be provided.					
SECTION -7 , LV SWITCHGEAR								
1.0	PCC / MCC / DB							

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	a) Make	-	Bidder to specify					
	b) Type	-	Bidder to specify					
	c) Reference Standard	-	Bidder to specify					
	d) Voltage (Nom./Max)	V	415					
	e) Phase/Frequency	No/Hz	3Ph / 50 Hz					
	f) Short Circuit Rating							
	Interrupting Symmetrical	kA rms						
	Short-time for 1 Sec	kA rms	Refer Scope of Supply sheet - LV Switchgear					
	g) Insulation level	kV						
	h) Degree of Protection	-	IP 54					
	i) Dimensions of vertical section in mm (L x D x H)	mmxmmxmm	Bidder to specify					
	j) Equipment working height limits from floor level	mm	Bidder to specify					
2.0	Bus conductor							
	a) Material & Grade	-	Electrolytic Copper					
	b) Busbar size	mm ²	Bidder to specify					
	c) Current density	A/mm ²	Bidder to specify					
	d) Support spacing	m	Bidder to specify					
	e) Type of insulating sleeve for busbars	-	Bidder to specify					
	f) One second withstand capability	kA (rms)	40					
	g) Temperature rise over 40°C ambient for rated current	°C	Bidder to specify					
	for short circuit current	°C	Bidder to specify					
	h) Minimum clearance of busbars and connections							
	Phase to phase	mm	Bidder to specify					
	Phase to ground	mm	Bidder to specify					
	i) Bus support insulator		Bidder to specify					
	Material	-	Bidder to specify					
	Min. total creepage distance	mm	Bidder to specify					
3.0	Air Circuit Breaker							
	a) Make	-	Bidder to specify					
	b) Type	-	Bidder to specify					
	c) Standards applicable	-	Bidder to specify					
	d) Rated voltage	V	400					
	e) Continuous current rating							
	As per manufacturer's standard	A	Bidder to specify					
	Under site conditions after derating for ambient and within cubicle	A	Bidder to specify					
	f) Symmetrical and asymmetrical interrupting current	kA rms	Bidder to specify					
	g) Making current (peak)	kA	Bidder to specify					
	h) Total opening time (measured from trip coil energisation)	ms	Bidder to specify					
	i) Closing time	ms	Bidder to specify					
4.0	Contactors (Please furnish datas separately for AC & DC contactors)							
	a) Type	-	Bidder to specify					
	b) Rated making capacity	kA	Bidder to specify					
	c) Rated breaking capacity	kA	Bidder to specify					
	d) Duty category	-	Bidder to specify					
	e) Class of Protection for Motor feeders	-	Bidder to specify					
5.0	Isolating Switches							
	a) Make	-	Bidder to specify					
	b) Type	-	Bidder to specify					
	c) Rated voltage	V	Bidder to specify					

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	d) Rated Current	A	Bidder to specify					
	e) Utilisation Category	kA	Bidder to specify					
6.0	Current Transformers							
	a) Type	-	Bidder to specify					
	b) Type of insulation	-	Bidder to specify					
	c) CT secondary current	A	Bidder to specify					
	d) Accuracy Class	-	Bidder to specify					
7.0	Voltage Transformer							
	a) Type	-	Bidder to specify					
	b) Type of insulation	-	Bidder to specify					
	c) Accuracy Class	-	Bidder to specify					
8.0	Relays							
	a) Make & type	-	Bidder to specify					
	b) Relays details (Type reference for each application is to be furnished)	-	Bidder to specify					
9.0	Instruments and Meters							
	a) Type	-	Bidder to specify					
	b) Size	mm x mm	Bidder to specify					
	c) Accuracy Class	-	Bidder to specify					
10.0	Local Pushbuttons / Control stations							
	a) Type	-	Bidder to specify					
	b) Enclosure material	-	Bidder to specify					
	c) Degree of Protection	-	Bidder to specify					
11.0	Control Transformers							
	a) Type of Insulation	-	Bidder to specify					
	b) Voltage ratio	V/V	Bidder to specify					
12.0	Control switch / Selector Switch							
	a) Type	-	Bidder to specify					
	b) Contact rating	A	Bidder to specify					
SECTION -8, BLACK START DIESEL GENERATOR (BSDG)								
1.0	BLACK START DG							
a)	Make	-	Bidder to specify					
b)	Type	-	Bidder to specify					
c)	Reference Standard	-	Bidder to specify					
d)	Voltage (Nom./Max)	V	6600					
e)	Phase/Frequency	No/Hz	3Ph / 50 Hz					
f)	Spped	rpm	Bidder to specify					
g)	Short circuit withstand capacity	%	Bidder to specify					
h)	Overload Capacity	%	Bidder to specify					
i)	Design Ambient	Deg. C	Bidder to specify					
j)	Insulation	-	Bidder to specify					
k)	Enclosure	-	Bidder to specify					
l)	Terminals	-	Bidder to specify					
SECTION -9, EMERGENCY DIESEL GENERATOR (EDG)								
1.0	EMERGENCY DG							
a)	Make	-	Bidder to specify					
b)	Type	-	Bidder to specify					
c)	Reference Standard	-	Bidder to specify					
d)	Voltage (Nom./Max)	V	415					
e)	Phase/Frequency	No/Hz	3Ph / 50 Hz					
f)	Spped	rpm	Bidder to specify					

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SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
g)	Short circuit withstand capacity	%	Bidder to specify					
h)	Overload Capacity	%	Bidder to specify					
i)	Design Ambient	Deg. C	Bidder to specify					
j)	Insulation	-	Bidder to specify					
k)	Enclosure	-	Bidder to specify					
l)	Terminals	-	Bidder to specify					
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REVISIONS	REV. NO.	P0	R0			TATA CONSULTING ENGINEERS LIMITED		
	PPD. BY	RKS	RKS					
	CHD. BY	AM	AM					
	APD. BY	PSG	PSG					
	DATE	17-09-2024	25-09-2024					

TECHNICAL DATASHEET (C&I SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	EPC Package			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT, KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13833A	SHEET OF
SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
Instrumentation & Control system								
1.0	System Configuration	-	As per DCS system architecture drawing (TCE.13833A-IC-SK-001)					
2.0	System Power Supply	-	230 VAC UPS redundant feeder					
3.0	Card Replacement under Power On Condition (Hot swappable)	-	Required for all cards					
4.0	Global distributed real-time data-base available to all clients	-	Required for client server architecture					
5.0	Surge protectors for all cables entering from outdoor area	-	Required					
6.0	Modular architecture and expandable in future	-	Required. Bidder to furnish Expandability for Server level, Controller level, I/O Level, Workstation Level.					
7.0	Redundancy requirement	-						
7.1	Controller (Processor) modules	-	Required					
7.2	Power supply module redundancy (controller racks)	-	Required					
7.3	Power supply module redundancy (I/O racks)	-	Required					
7.4	I/O modules for closed loop	-	Required					
7.5	I/O modules for trip parameters	-						
7.6	Bulk Power Supply Units (SMPS)	-	Required for controller, IO cards, Racks etc.					
7.7	Media and modules for network communication	-	Required					
7.8	Ethernet TCP/IP network for communication between DCS operator station, engineering station, I/Os, servers & printers	-	Required / Other options bidder to indicate					
7.9	Communication between controllers	-	Required					
7.10	Redundant communication modules required for communication between	-	Required					
a)	Controllers & Servers	-	Required					
b)	Controllers & I/O modules	-	Required					
c)	Controllers & Remote I/Os (Redundant communication modules at both ends)	-	Required					
7.11	Foundation Fieldbus H1 interface module	-	Required					
7.12	Foundation Fieldbus segment power conditioner	-	Required					
7.13	Historian	-	Required					
8.0	System capable of Interconnectivity of multiple systems from different suppliers	-	Required					
9.0	All the software loaded on the system. Soft copy of the same in the form of CD/DVD with software & hardware keys shall be supplied	-	Required					
10.0	No. of process and logic tags supported	-	*					
11.0	Field proven system and in use in International market for at least 2 (Two) Years for the model offered and in similar type of project.	-	Required					
12.0	Interface With MCC	-	Required					
13.0	G3 Conformal Coating according to ANSI/ISA S 71.04 / equivalent to achieve high corrosion resistance for all modules	-	Required					
14.0	The conformal coating shall be done where the cards are manufactured. Local coating is not acceptable.	-	Required					
15.0	The report data shall be stored on the Operator Station and then transferred to CD/DVD for storage	-	Required					
16.0	License for tag nos. shall be provided such that 60% spare tag nos. available after commissioning of the system	-	Required					
17.0	To protect the electronic equipment, the control room floors shall have an antistatic surface at least two meters around all panels and consoles	-	Required					
18.0	It shall not be necessary to remove field wiring to replace input / output module.	-	Required					
19.0	All the signals displayed on the UPS panel shall be repeated on the DCS HMI screen through communication link	-	Required					
20.0	Configurable multi loop controller	-	Required, DCS shall be capable of running multiple loops of different scan times with assigned priority.					

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Instrumentation & Control system								
21.0	Void	-						
22.0	Scan time	-	Selectable. Allocate different scan times to any I/O points.					
a)	For open loops	-	100 milli second or better.					
c)	For normal closed loops	-	250 milli second or better					
d)	For Sequence Of Events points	-	1 milli second					
23.0	Main and redundant controller	-	Active at all time					
24.0	Logic changes in main processor download to redundant processor automatically	-	Required without manual intervention. The status should be displayed on the MMIs.					
25.0	Application Program	-	Programmable from engineering station. All programme to be provided in RW DVDs					
26.0	Status monitoring of power supply modules of CPU & I/O modules	-	On modules and operator station					
27.0	Noise isolation: Common mode & Normal mode noise reduction	-	Required					
28.0	Codes And Standards	-	The DCS system supplied shall conform to the latest version of codes and standard mentioned below					
a)	EMI & RFI Immunity	-	Latest version of IEC STD 801 Part 3 or equivalent National / International Standard					
b)	Electromagnetic Compatibility	-	Latest version of IEC 61000-4-2 & 3 or equivalent National / International Standard					
c)	Electromagnetic Emissions	-	Latest version of VDE 0871, Class-B or equivalent National / International Standard					
d)	Functional safety on electrical / electronic / programmable electronic safety - related systems	-	Latest version of IEC 61508-1-7 or equivalent National / International Standard					
e)	Electrostatic Discharge	-	Latest version of IEC-801.2 or equivalent National / International Standard					
f)	Programming Languages	-	Latest version of IEC 61131-3 or equivalent National / International Standard					
g)	Surge withstand capability	-	Latest version of IEEE STD.472, IEEE C37.90.1, IEC-255.4 or equivalent National / International Standard					
h)	Software Quality Assurance Plans	-	Latest version of IEEE 730.1-89 or equivalent National / International Standard					
i)	Software Configuration	-	Latest version of IEEE 828 / 1042 or equivalent National / International Standard					
j)	Environmental conditions	-	Latest version of ISA S 71.01 & 71.04 or equivalent National / International Standard					
k)	Electronic Cards, Subassemblies & Components for Vibration, Drop, Shock etc.	-	Latest version of IEC-68.2.6, 27, 31 and NSTA or equivalent National / International Standard					
l)	Types of Enclosures	-	Latest version of NEMA Standard ICS-6-110.15 to 110.22 or equivalent National / International Standard					
m)	Racks, Panels and Associated Equipment	-	Latest version of EIA : RS-310-B, ANSI C83.9 - 1972 or equivalent National / International Standard					
PROCESSOR								
29.0	Changeover time from main to standby processor (in case of main processor failure)	-	Change over shall be bump-less. The processor shall be uninterrupted during the changeover. Bidder to indicate the change over time (Minimum 10 ms).					
30.0	Logic changes possible through MMI	-	Yes, With necessary security. Both on-line & offline modification shall be possible.					
31.0	Debugging/ simulation software	-	Should be preloaded in engineering station unit as a system feature					
32.0	Self-diagnostics software	-	Required, In the processor. Diagnostic shall be upto card level					
33.0	Online configuration	-	Required					
34.0	Output status on loss of power	-	Outputs shall go to fail safe position which shall be user defined					
35.0	Sequence control functions	-	Required					
36.0	Control modes	-	Manual, Auto, Semi Auto (Step by step mode)					
37.0	Battery type	-	Rechargeable Ni-Cd with min. 2 years lifetime					
38.0	Battery drain alarm/ indication	-	Required, on MMI					

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Instrumentation & Control system								
39.0	Providing "Flash RAM" instead of battery back-up for data protection	-	Preferable, Bidder to elaborate the system availability					
40.0	Estimated CPU load with furnished configuration	-	CPU loading shall not exceed 50% (including wired and future spare I/Os). Also including final logic programming. The same shall be demonstrated at site during Site Acceptance Tests.					
41.0	Synchronisation of real time clock	-	Required for DCS and all peripherals and interfaced devices Time synchronization through GPS					
42.0	Interfaces and communication ports for each controller	-						
a)	Interface to servers	-	Required of 100 Mbps, Redundant Communication Processors					
b)	Communication ports	-	25% spare communication ports after fully networked					
c)	Interface with Utility systems	-						
43.0	Date & Time	-	System date & time shall be adjustable online, auto synchronisation between all peripherals and interfaced ~~addresses~~					
44.0	Memory loading maximum 50%	-	Required					
	ALGORITHMS REQD. AS A MINIMUM	-	By Bidder					
45.0	Control algorithms	-						
a)	Proportional control	-	Required					
b)	PI, PID, PD and adaptive gain	-	Required					
c)	External feedback / set point facility	-	Required					
d)	Sample & hold PID, PID with batch switch	-	Required					
e)	Ratio control	-	Required					
f)	PID with dead band	-	Required					
g)	Cascade control	-	Required					
h)	On-off control	-	Required					
i)	Feed forward control	-	Required					
46.0	Selector	-	Low, High , Mean value, Median, Override					
	SELF DIAGNOSTIC TESTS							
47.0	Input diagnostics	-	Required					
48.0	Configuration diagnostics	-	Required					
49.0	Memory diagnostics	-	Required					
50.0	System hardware check	-	Required					
51.0	Output diagnostic	-	Required					
52.0	External hardware check	-	Required					
53.0	Power system Diagnostics	-	Required					
54.0	Alarm indication in MMI when any self-diagnostic test fails	-	Required					
55.0	Communication healthiness	-	Required					
	COMMUNICATION SYSTEM FOR CONTROLLER	-						
56.0	Type of protocol for communication between server & controller, server & MMI	-	Fully deterministic, TCP/IP, IEEE 802.3u. The Ethernet Switches shall be fault tolerant and redundant					
57.0	Speed for above communications	-	100 Mbps					
58.0	Type & speed of communication between I/Os and controller	-	*					

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Instrumentation & Control system								
59.0	Type of communication bus/comm. Topology	-	Industrial twisted pair / Co-axial / Bus structured					
60.0	Connecting or disconnecting the required sub-system from the network	-	Required on line					
61.0	Bus loading allowed	-	Shall not exceed 50%. The same shall be demonstrated at site during Site Acceptance Tests.					
	MAN MACHINE INTERFACE (MMI) / MIS INTERFACE PC	-						
62.0	Quantity	-	Refer configuration drawing					
63.0	Operating system	-	Windows XP or latest available at the time of supply					
64.0	Interchangeability between the MMIs	-	Required					
65.0	Online configuration changes possibility	-	Required					
66.0	Ethernet card	-	Required					
67.0	VOID							
68.0	VOID							
69.0	VOID							
70.0	Processor	-	Core 2 duo					
71.0	Ports (Other than those required for connecting monitor, keyboard, mouse)	-	Ethernet ports as required by the system configuration, 2 nos. USB port in front and 2 USB ports on rear / side, one RS-232 serial port, one parallel port and 1 multimedia speaker interface port					
72.0	Power Supply	-	240 V AC, inbuilt SMPS required					
73.0	Screen	-						
a)	Size	-	32" Flat LED, High definition					
b)	Pixel resolution	-	1280 x 1024 pixels					
c)	Colour Monitor	-	Required					
d)	Display update time	-	Must be < 1 sec.					
e)	Single screen for each operator station	-						
74.0	Keyboard	-	Standard Qwerty full-stroke type					
75.0	Optical mouse- scroll type	-	Required					
76.0	Software to be loaded on each MMI	-	OS Client					
	FEATURES OF DATA ACQUISITION & CONTROL SYSTEM SOFTWARE	-						
77.0	Trending function	-						
77.1	Real time	-	Required					
a)	Trend assign parameters as minimum	-	SP, PV, MV, DEV etc.					
b)	Historical trending	-	Required					
c)	Trend points for sampling time of 1 sec to 10 sec	-	Required					
78.0	Logging functions	-						
a)	Log formats	-	User definable					
b)	Event logging	-	Required					
c)	Hourly logs	-	Required					
d)	Shift logs	-	Required					

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Instrumentation & Control system								
e)	Daily logs	-	Required					
f)	Weekly logs	-	Required					
g)	Maintenance logs	-	Required					
h)	Logging frequency	-	User selectable					
79.0	Alarm display function	-						
a)	Last alarm always to Appear on top of screen	-	Regardless which page is being seen					
d)	Differentiation between Process & system alarms	-	Required					
e)	Group display function	-	Required					
h)	Facility to acknowledge and bypass groups of alarms together	-	Required					
i)	Alarm list shall give an overview of the status of the alarms	-	Required					
j)	Varied alarm sound for different priority levels	-	Required					
k)	Unit wise or otherwise (as defined by Consultant / Client) segregation of Alarms related to DCS / Third party systems	-	Required					
l)	Unit wise or otherwise (as defined by Consultant / Client) report building / configuration & printing	-	Required					
m)	Alarms / events shall be separated in various fields like tag name, Alarm / event type, alarm status, source of alarm, area, value, limit priority, etc.	-	Required					
n)	Present only logical alarm information to the plant operator in case of unit start up and upset condition	-	Required					
o)	Logical processing of events to aid operator to quickly access the normal or emergency situation and take corrective action	-	Required					
p)	Alert all concerned plant personnel and officials in case of any problem as per plant operating philosophy	-	Required					
80.0	Information display group	-	8 faceplates per window with following details					
a)	Input	-	Required					
b)	Output	-	Required					
c)	Set point	-	Required					
d)	Tag nos.	-	Required					
e)	Set point status	-	Required					
f)	Mode status	-	Required					
g)	Service description	-	Required					
81.0	Print message history required	-	Yes					
82.0	Alarm handling while continuous alarm condition	-	Required					
83.0	Alarm priorities and levels	-	Min. 5 levels					
84.0	Faceplate details should be user selectable	-	Required					
85.0	Faceplate indication colors selection	-	Easy, Menu driven required					
86.0	Tag security for individual tags	-	Required					
87.0	MMI database should be selectable	-	Possible by assigning MMI name/PC no.					
88.0	Control drawing & logics for engineering & use	-	SAMA /Ladder/Function blocks					
89.0	Change in Engg. Unit of any tag made to be reflected in the graphics also	-	Required					
90.0	Change of operation mode : auto, manual, cascade	-	System should ask reasons & should be historised for future reference					
91.0	Operation mark on the tag: Faceplates & Graph	-	Required – e.g. - service, repair, calibration, maintenance, no operation etc.					

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Instrumentation & Control system								
92.0	Safe operation range indicators on tag's faceplate	-	Required for safe operating range : low & high					
93.0	Alarm & trip mark indicators on tag's faceplate	-	Required for : low-low, low, high & high-high level					
94.0	Clamp input facility	-	Required to be clamped if goes beyond certain range/value					
95.0	Repeat alarm after preset time for critical poll	-	Required, even if it is acknowledge by operator but still in alarm stage					
96.0	Pass, fail, stuckup status for every sequence	-	Required, to know where the process sequence has stuckup					
97.0	Scan time setting for individual sequence table	-	Required					
98.0	Timers counting capacity	-	Upto 9999 seconds and/or 9999 minutes					
99.0	Generate flags from timer status	-	Required from : on, stop, deviation, pause					
100.0	Pause facility in the timer	-	Required					
101.0	Counter counting capacity	-	Upto 9999 (0 to 9999 or 9999 to 0)					
102.0	Functional blocks	-	Readymade library for ease of engineering					
103.0	Faceplate to appear on trend display on call	-	Required					
104.0	Scrolling facility in the stored trend	-	Required					
105.0	Trend pause, compress/ expand 'x' & y axis	-	Required					
106.0	History storage sub system	-						
a)	History storage	-	Required for all parameters, all process/ system alarms, operator action, upsets, changes etc. at minimum sampling rate (1 user-selectable) for a period of					
b)	Historical data shall reside on each operator station	-	Required					
c)	Archiving of any of the tags listed in the database either externally generated or internally generated	-	Required					
d)	Search feature on alarm, history, operator action etc.	-	Required					
e)	Allow selection of any point in the system to be added and configured for archiving	-	Required					
f)	Standard Windows tree / list view presentation techniques to facilitate display and editing of archive timers, graphical data displays and tabular data displays	-	Required					
g)	Facility to define archive timers in increments of milliseconds, seconds, minutes, hours or days	-	Required					
h)	Visualization of historical data in both tabular and graphical form	-	Required					
i)	Capability to archive values per analog point including a) Actual value, b) Maximum, c) Minimum, d) Sum, e) Mean	-	Required					
j)	Capability to archive digital values on either a rising or falling edge.	-	Required					
k)	Historical trend shall be possible with a minimum sample time of 1 sec and shall be available for 1 month at any moment of time	-	Required					
l)	Each operator station shall have licenses for minimum 2000 analog tags.	-	Required					
m)	Data Retrieval feature for selected data points	-	Required					
107.0	Fault Handling	-						
107.1	For process inputs and outputs	-	Generate Invalid value status					
107.2	A value shall be declared invalid if any of the following conditions are true	-	Required					
a)	If a value is out of range	-						
b)	If a value cannot be measured or calculated	-						
c)	If source element is found faulty	-						
d)	If a value is declared invalid by the source element	-						
107.3	Invalid value status	-	To be used as a logical input to initiate control algorithm changes.					

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Instrumentation & Control system								
107.4	For control algorithm's input declared invalid	-	Configure and use its substitute value					
107.5	In case of communication subsystem failure	-	Regulatory control algorithms continue operating with the last valid information.					
108.0	In case of failure of the power and after resumption of the power	-	No drive/heater shall start automatically.					
109.0	Double check and re-authentication feature in each of the operator stations	-	Required					
110.0	Monitor & control the complete plant from any of the operator stations	-	Required					
111.0	The communication network shall utilise automatic network self-addressing technology (plug and play). Automatically assign unique new controller addressing when a new device is connected to the control network.	-	Required					
112.0	Maintenance override switch for all trip interlocks for maintenance purpose on operator stations	-	Required					
113.0	Software design shall be such that future revisions or updates of the system operating software will not affect the successful operation of the system	-	Required					
114.0	Multiple level of password protection with access for writing on line in to the instrument, adding/deleting/rename instruments in the database, calibration management settings, etc along with system warning	-	Required					
115.0	All interlocks shall be executed in DCS. For interlock, soft set-points shall be generated for trip signals. Analog signal shall be wired to DCS for generating the trip signals	-	Required					
116.0	Close loop both AI & AO to be wired to the same controller	-	Required					
117.0	I/Os for trip, cause & effect of each interlock to be in same controller	-	Required					
118.0	Running hour display shall be provided for all the pumps / equipments	-	Required					
119.0	Integration of all flow-rate measurements (for computation/display of quantitative flow)	-	Required					
INKJET PRINTER		-						
120.0	Quantity	-	Refer configuration drawing/"					
121.0	Resolution	-	1200 dpi minimum					
122.0	On demand printing	-	Required					
123.0	Table for printer	-	Required					
124.0	Type	-	INKJET Colour printer					
125.0	Type	-	Laser jet printer (black & white)					
126.0	On demand printing	-	Required					
127.0	Table for printer	-	Required					
INPUT/OUTPUT SYSTEM		-						
128.0	Signal isolation for all I/Os	-	Optical or galvanic					
129.0	Individual fuse for digital inputs & outputs	-	Required, Fused Terminals shall be provided.					
130.0	Module failure indication in module and DCS	-	Required					
131.0	Indication and alarm in DCS for module failure	-	Required					
132.0	In case of failure of controllers or communication between controller and remote I/O or power failure the Input/Output shall attain fail safe position	-	Required. Fail safe position shall be user defined & software configurable					
133.0	Max. I/O density per Remote I/O Panel	-	Bidder to state,					
Analog input module		-						
a)	No. of points/module	-	8					
b)	Type of inputs	-	RTD, T/C, 4-20 mA, either 2 wire or 4 wire system with loop power for 2 wire transmitter.					
c)	Resolution	-	12 bit including sign					
d)	Support HART Protocol to carry out all diagnosis & calibration of the transmitters from operator stations	-	Required					

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Instrumentation & Control system								
e)	Intrinsic safe barrier for instruments located in Hazardous area	-	Required					
f)	Type of isolation	-	Galvanic					
135.0	Analog output module	-						
a)	No. of points per module	-	8					
b)	Type of outputs	-						
c)	Resolution	-	12 bit including sign					
d)	Type of isolation	-	Galvanic					
e)	Intrinsic safe barrier for instruments located in Hazardous area	-	Required					
f)	Support HART Protocol to carry out all diagnosis & calibration of the transmitters from operator stations	-	Required					
136.0	Digital input module	-						
a)	No. of inputs / module	-	32					
b)	Type of input	-	Potential free contacts					
c)	Type of isolation	-	Optical					
d)	LED status indication for each input	-	Required					
e)	Interrogation voltage (generation by system)	-	24V DC					
f)	Filtering at input stage	-	Required					
137.0	Digital output module	-						
a)	No. of outputs per module	-	32					
b)	Type of outputs	-	Interposing relays for each output, with 1 no. changeover contact, rating:2A, 24 VDC					
c)	Relay contact rating and no. of contacts	-						
d)	Discrete relays/relay boards	-	Relays mounted on relay boards to be provided.					
e)	Type of isolation	-	Optical					
f)	LED status indication for each output	-	Required					
g)	Output Status	-	Outputs shall change to fail-safe position in case of main processor failure					
ENGINEERING STATION								
139.0	Quantity	-	Refer configuration drawing					
140.0	Central Processing Unit (CPU)	-	quad core processor or better					
141.0	CPU speed	-	1.73 G Hz or higher.					
142.0	DDR RAM	-	1 GB					
143.0	Hard disk	-	300 GB					
144.0	Combo drive	-	DVD & CD read & write drive					
145.0	Video Display Unit (VDU)	-	32" Flat LED, High definition					
146.0	Integrated	-	10/100 Mbps Ethernet LAN interface card IEEE 802.3 u					
147.0	Communication ports	-	One serial, one parallel, min. four USB ports, blue tooth & WIFI enabled, minimum one Ethernet port, internal modem required, 2 USB ports at front and 1 No.					
148.0	Mouse	-	Optical mouse & Touch pad					
149.0	Speakers	-	Required					

TECHNICAL DATASHEET (C&I SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	EPC Package			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT , KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13833A	SHEET OF
SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
Instrumentation & Control system								
150.0	Cables & accessories required for connecting to DCS	-	Required					
151.0	Software to be loaded	-						
a)	1 No. licensed copy of engineering software	-	Required					
b)	MS office 2007, Latest version of Adobe Acrobat read/write software. Latest version of anti-virus kit shall be provided with license for 3 year up gradation.	-	Required					
SERVERS								
152.0	Processor	-						
153.0	Operating system	-	Windows 8.0 or latest version available at the time of supply					
154.0	Function as OPC server	-	Required					
155.0	Online configuration changes possibility	-	Required					
156.0	Ethernet card	-	Required for 10/100/1000 Mbps, TCP/IP, all interface cards shall be PCI based and Quantity shall be as per system requirements					
157.0	Hard Disk	-	4x160 GB SCSI HDD, 15 K rpm, RAID level 5					
158.0	Combo drive	-	DVD/CDRW Combo drive					
159.0	Additional communication Ports	-	One RS- 232 serial ports , one parallel port, two USB ports, Ethernet ports as required by the system configuration.					
160.0	Screen Size	-	32" Flat LED, High definition					
161.0	Software to be loaded	-						
a)	Licensed copy (VCL or licenses equal to no. of MMIs) of Data Acquisition & Control System (DACS) Software for DCS (including for drives) and Operating system software for redundant servers, MS Office 2007, Latest version of Adobe Acrobat read/write software, Latest version of Anti-virus kit (Antivirus kit support shall be provided with license for 3	-	Required					
b)	1 No. license of Engineering software for the DCS. At a time, it shall be possible to use any one of the MMIs as Engineering Station.	-	Required					
c)	OS-Server	-	Required					
d)	HART management software	-	Required					
e)	Recovery/ Backup CD/DVDs	-	Required for all the specified software & drivers for servers, MMIs & engineering station					
162.0	TRAINING							
162.1	Comprehensive training programs for the system, including the controller, networks and Operator stations	-	Required					
162.2	Training of PURCHASER personnel (Engineers, Technicians and Plant Operators) in tuning, modification, operation and maintenance of DCS	-	Required					
162.3	Duration of training at site	-	Required					
162.4	Controller hardware training courses shall include as minimum	-						
a)	CPU, power supply, communication cards, backplane, local I/O racks	-	Required					
b)	I/O cards	-	Required					
c)	Ethernet communication	-	Required					
d)	Fault tolerant architecture and fail-safe architecture	-	Required					
162.5	OS hardware training courses contents shall include as minimum	-						
a)	OS system Overview	-	Required					
b)	System architecture, including networking and redundancy	-	Required					
c)	The display hierarchy, and the graphical, trending, alarm and reporting displays	-	Required					
162.6	Controller engineering training courses content shall include as minimum	-						
a)	Configuration of the I/O hardware devices	-	Required					
b)	Configuration of the communication networks	-	Required					

TECHNICAL DATASHEET (C&I SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	EPC Package			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT , KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13833A	SHEET OF
SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
Instrumentation & Control system								
c)	Configuration of continuous and sequential control operations	-	Required					
d)	Design of operating and monitoring strategies	-	Required					
162.7	OS/ES engineering training courses content shall include as minimum	-						
a)	Introduction to Windows	-	Required					
b)	Creation of an OS system application	-	Required					
c)	Creation, administration and management of OS system database	-	Required					

TECHNICAL DATASHEET (C&I SYSTEM)								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	EPC Package			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT , KANSARIGUDA, RAYAGADA, ODISHA, INDIA			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13833A	SHEET OF
SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
Instrumentation & Control system								
d)	Creation, administration and management of graphics display	-	Required					
e)	Creation, administration and management of system alarming	-	Required					
f)	Creation, administration and management of the historical subsystem	-	Required					
g)	Creation, administration and management of the reporting subsystem	-	Required					
h)	OS application programming	-	Required					
i)	Connection to third party device	-	Required					
j)	Usage of OPC tools	-	Required					
k)	Sample programming	-	Required					
l)	All functions of Engineering Station software	-	Required					
m)	Training manuals	-	6 sets (hard copy) and soft copy shall be furnished					
162.8	Training at Manufacturers Units	-						
a)	Training for PURCHASER's representatives	-	Required					
b)	Duration of training	-	2 weeks					
c)	Training for proficiency in operating the Equipment, technology, operation and maintenance	-						
163.0	SPARES	-						
a)	Input and output modules wired upto marshalling panels	-	20 % of used I/Os of each type					
b)	Wired slots for mounting the spare modules	-	20% of used slots					
c)	Interposing relays wired in cabinet for all wired spare digital outputs	-	Required					
d)	Terminals mounted in each panel	-	20% of used terminals					
e)	MCBs mounted in each panel	-	20% of used MCBs					
f)	Spare space in the cabinets to install additional relays in future	-	20% of used relays					
g)	Unused node addresses in communication network	-	0.1					
	Spares to be kept in store	-						
h)	Modules	-	10% of used modules of each type or 1 no. of each type- whichever is higher					
i)	Interposing relays	-	10% of used relays					
j)	Terminals of each type	-	10% of used terminals					
k)	Safety Barriers, Signal Converters, Trip Amplifiers, Relays etc	-	10% of used					
l)	Fuses of each rating	-	10% of used					
m)	Bulk power supply unit of each rating	-	1 nos. of each rating					
n)	Communication system components such as hubs, switches ,router etc	-	10% of used					
o)	Disks, disk drives, HMI, switches, lamps, push buttons, etc	-	10% of used					
p)	Consumable including printer cartridges, Paper or any other consumable items	-	Required					
q)	MCBs	-	10% of used MCBs					
r)	Any other items used but not mentioned specifically	-	10 % or min 1 no./lot					
	Bidder shall submit the spares BOM in the base offer along with the equipment.	-						
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	PPD. BY	RKS	RKS					
	CHD. BY	AM	AM					
	APD. BY	PSG	PSG					
	DATE	17-09-2024	25-09-2024					

PERFORMANCE GUARANTEE SCHEDULE								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT , KANSARIGUDA, RAYAG			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13833A	
SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
Section - I, GUARANTEES UNDER LIQUIDATED DAMAGES								
1.0	Steam Generator output at 100% BMCR for performance coal and for all coals in the range as specified in Chapter-2	TPH	300					
2.0	Gross STG power output at 100% TGMCR with design cooling water temperature and 0% cycle make-up	MW	30					
3.0	Plant auxiliary power consumption at 100% TGMCR	kW	By Bidder					
4.0	Plant gross cycle heat rate at 100% TGMCR with design cooling water temperature and 0% cycle make-up	kJ/kWh	By Bidder					
Section - II, GUARANTEES UNDER REJECTION								
5.0	NOx emission at stack (at 6% O2, Dry Basis)	mg/Nm3	≤ 100					
6.0	SOx emission at stack (at 6% O2, Dry Basis)	mg/Nm3	≤ 100					
7.0	Dust concentration at stack (at 6% O2, Dry Basis)	mg/Nm3	≤ 30					
8.0	Mercury emission at stack (at 6% O2, Dry Basis)	mg/nm3	<0.03					
9.0	Noise level from all the equipment @ 1m distance (Excluding equipment, used during emergency or abnormal operating conditions, such as, Safety Valves, start-up valves and pressure relief valves bypass)	dBA	< 85					
Section - III, GUARANTEES UNDER CORRECTION								
10.0	Plant Capability Maximum rate of loading Maximum step load change Capability for maintaining own house load on full load throw-off Vibration level Surface temperature of thermal insulation at 30 0C still ambient air							
11.0	Boiler & Accessories Steam generator efficiency Quality of steam from boiler outlet at 100% BMCR with any combination of specified fuel Unburnt combustibles as % of fly ash & bottom ash Superheater (SH) outlet temperature control range of 50% BMCR to 100% BMCR SH spray water quantity at 100% BMCR Total dissolved solids in steam leaving SG drum and silica in steam leaving final superheater Zero leakage at TAPH Minimum stable load of SG without oil support Flue gas temperature at TAPH outlet Combustor temperature Cyclone efficiency Ash cooler outlet temperature for bed ash Deaerator O2 & CO2 removable capability Demonstration of Boiler operation at rated parameter with 100% firing of each fuel specified Electrical and I&C System Trip of each major equipment, including demonstration of auto operation of standby equipment, to be developed and mutually agreed upon in the testing procedure. Auto runs back capability in case of equipment failure to be demonstrated							
12.0	Steam Turbine & Accessories							

PERFORMANCE GUARANTEE SCHEDULE								CONFIDENTIAL
CLIENT:	HINDALCO INDUSTRIES LIMITED			EQUIPMENT/SYSTEM:	Main Plant System			ATTACHMENT-1
PROJECT:	DE SERVICES FOR 60 MW CGPP FOR ADITYA ALUMINIUM PROJECT , KANSARIGUDA, RAYAG			ENQ. NO.:	TCE.13833A-ME-6002-6001	JOB NO.:	13833A	
SL.NO.	DETAILS	UNIT	BIDDER >> TCE SPEC. ↓	Bidder's Response	TCE/HIL Response	Bidder's Response	TCE/HIL Response	REMARKS
	Turbine cycle gross heat rate at 100% TGMCR with 0% makeup and design cooling water temperature TG VWO gross output with 0% makeup and design condenser cooling water inlet temperature Turbine Generator gross output at 100% TGMCR with 0% makeup and condenser cooling water inlet temperature Performance of CEP and condenser air evacuation equipment Temperature rise across condenser at TGMCR and design cooling water temperature Performance of oil purifier Pressure drop in cooling water across condenser at 100% TGMCR							
13.0	Generator a)Maximum generator temperature rise at full load at rated conditions: i)Stator windings ii) Rotor windings iii)Stator iron core in contact with insulated windings iv)Stator iron core not in contact with insulated windings b)Ratings: i)Generator maximum continuous rating (MW) ii)Generator short circuit ratio iii)Generator Capacitive MVAR rating c)Excitation system: i)Excitation system response ratio ii)Field forcing capability (in time) iii)AVR sensitivity d)Generator efficiency							
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REVISIONS	REV. NO.	P0	R0			TATA CONSULTING ENGINEERS LIMITED		
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	CHD. BY	AM	AM					
	APD. BY	PSG	PSG					
	DATE	17-09-2024	25-09-2024					



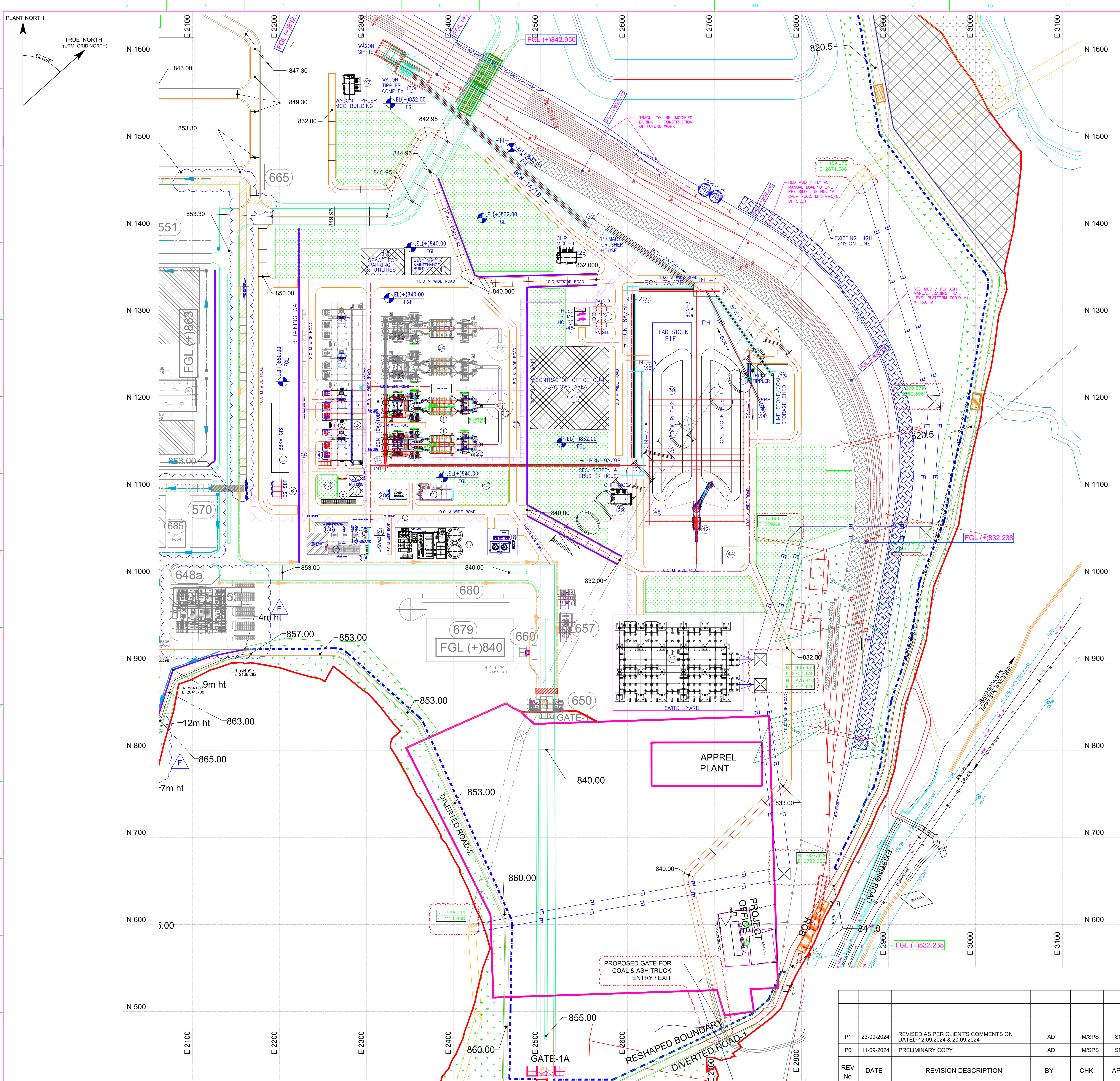
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TCE.13833A-ME-6002-6001, Rev-P0



TECHNICAL SPECIFICATION FOR MAIN PLANT SYSTEM

Page 1 of 1

ATTACHMENT-2 PRELIMINARY PLOT PLAN



BUILDING LIST

SL. No.	DESCRIPTION	PROPOSED FGL
1.	BOILER AREA	EL(+)840.00
2.	STG BUILDING	EL(+)840.00
3.	SWITCH GEAR/ CONTROL ROOM	EL(+)840.00
4.	TRANSFORMER AREA	EL(+)840.00
5.	33KV GIS	EL(+)850.00
6.	DG SET	EL(+)850.00
7.	O&M BUILDING	EL(+)840.00
8.	COVERED CAR PARKING	EL(+)840.00
9.	PIPE RACK	
10.	CHIMNEY	EL(+)840.00
11.	WARE HOUSE & MAINTENANCE BLDG.	EL(+)840.00
12.	COOLING TOWER	EL(+)840.00
13.	SSF	EL(+)840.00
14.	CHEMICAL DOSING SKID	EL(+)840.00
15.	CW PUMPS	EL(+)840.00
16.	ACW PUMPS	EL(+)840.00
17.	WTP AREA	EL(+)840.00
18.	FUEL OIL AREA	EL(+)840.00
19.	SPACE FOR PARKING & UTILITIES	EL(+)840.00
20.	AHS COMPRESSOR HOUSE	EL(+)840.00
21.	ESP CONTROL BUILDING	EL(+)840.00
22.	CEMS	EL(+)840.00
23.	AHS PIPE RACK	
24.	SPACE FOR FUTURE UNIT	EL(+)840.00
25.	CONTRACTOR OFFICE CUM LAYDOWN AREA	
26.	WTP & CT MCC BUILDING	EL(+)840.00
27.	WAGON TIPPLER MCC BUILDING	EL(+)832.00
28.	CHP 1 MCC BUILDING	EL(+)832.00
29.	CHP 2 MCC BUILDING	EL(+)832.00
30.	WAGON TIPPLER COMPLEX CUM SHIFTER	EL(+)832.00
31.	JNT-1	EL(+)832.00
32.	PRIMARY CRUSHER HOUSE	EL(+)832.00
33.	LIME STONE STORAGE SHED	EL(+)832.00
34.	EMERGENCY RECLAIM HOPPER	EL(+)832.00
35.	JNT-2	EL(+)832.00
36.	JNT-3	EL(+)832.00
37.	SECONDARY SCREEN & CRUSHER HOUSE	EL(+)832.00
38.	JNT-4	EL(+)840.00
39.	COAL STOCK PILE AREA	EL(+)832.00
40.	BELT CONVEYOR (BCN)	
41.	ASH SILO	EL(+)832.00
42.	STACKER CUM RECLAIMER	EL(+)832.00
43.	GREEN BELT	
44.	RUN OFF POND	
45.	HCSD PUMP HOUSE	EL(+)832.00
46.	TRUCK TRIPLE AREA	EL(+)832.00
47.	SWITCH YARD	EL(+)832.00
48.	SHED FOR STOCK PILE	EL(+)832.00

NOTE

1. ALL DIMENSIONS ARE IN MM & CO-ORDINTES ARE IN METERS.

LEGEND:

- PROPOSED NEW ROAD
- PROPOSED HIGH TENSION LINE



HINDALCO Ind. Ltd.



PROJECT 2x30 MW CO-GENERATION POWER PLANT KANSARIGUDA, ODISHA

Drawing Title PLOT PLAN (OPTION - 3)

REV No	DATE	REVISION DESCRIPTION	BY	CHK	APP	PRINC APP
P1	23-09-2024	REVISED AS PER CLIENT'S COMMENTS ON DATED 12.09.2024 & 20.09.2024	AD	IM/SPS	SN	
P0	11-09-2024	PRELIMINARY COPY	AD	IM/SPS	SN	

SHEET SIZE	DRAWING SCALE	AREA	WORK	DRAWING NUMBER	REVISION
A0	1:1500	XXX	X	TCE.13833A-ME-MP-60001	P1



Client – Hindalco Industries Ltd
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TCE.13833A-ME-6002-6001, Rev-P0



TECHNICAL SPECIFICATION FOR MAIN PLANT SYSTEM

Page 1 of 1

ATTACHMENT-3
VOID



Client – Hindalco Industries Ltd
Project - Aditya Alumina Refinery
TCE.13833A-ME-6002-6001, Rev-P0

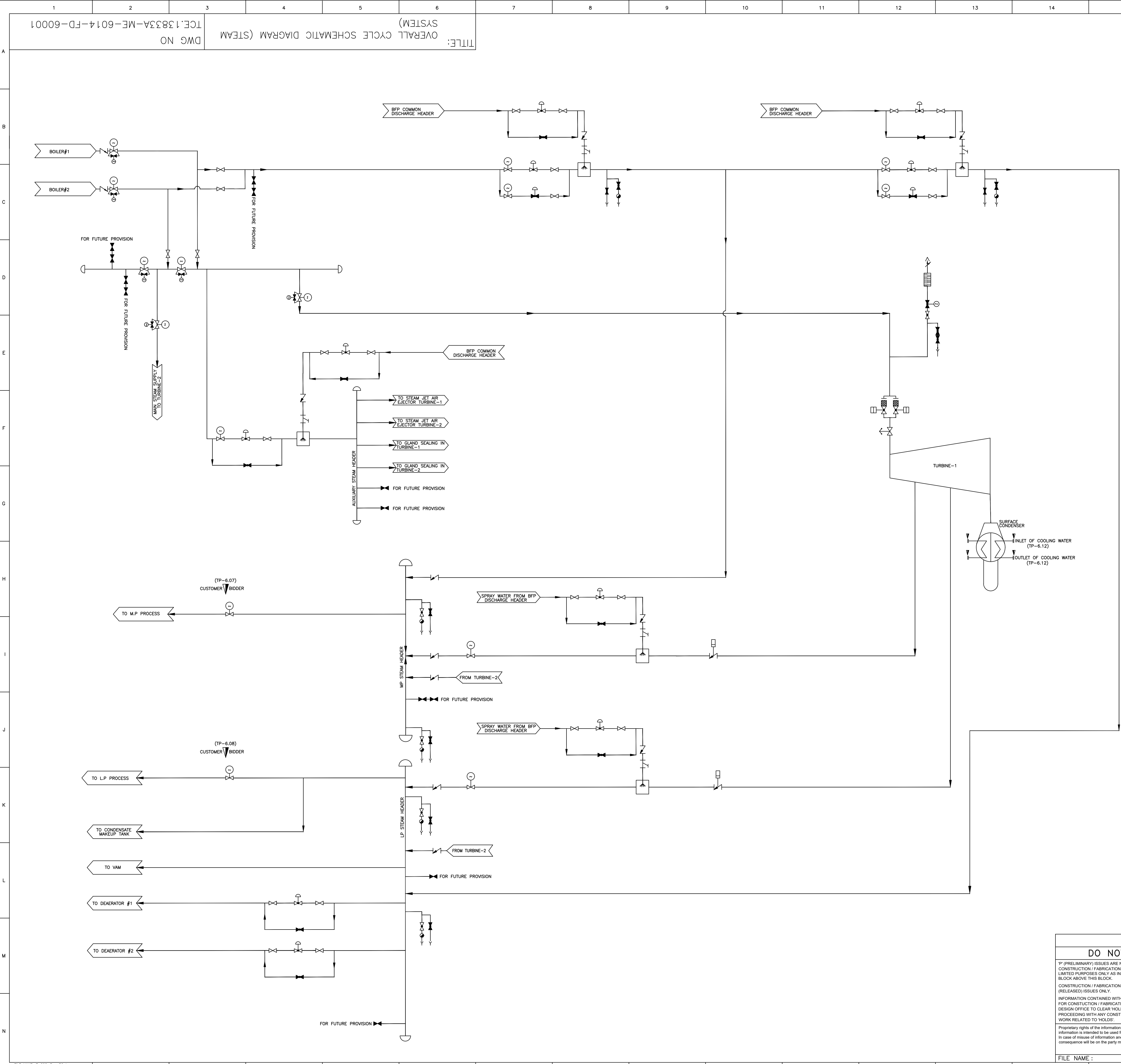


TECHNICAL SPECIFICATION FOR MAIN PLANT SYSTEM

Page 1 of 1

ATTACHMENT-2

OVERALL CYCLE SCHEMATIC DRAWING (STEAM SYSTEM)



LEGEND AND SYMBOLS

- GATE VALVE
- GLOBE VALVE
- NON RETURN VALVE
- PNEUMATIC OPERATED GLOBE VALVE
- MOTORIZED OPERATED GATE VALVE
- STEAM TRAP
- SILENCER
- QUICK CLOSING NON RETURN VALVE
- INTEGRAL BYPASS VALVE
- STUB
- CONTINUATION ARROWHEAD
- CUSTOMER BIDDER
- DESUPER HEATER

- NOTES:
- THIS IS BID PURPOSE PFD TO REPRESENT THE MINIMUM BASIC REQUIREMENT OF THE SYSTEM. BIDDER TO PROVIDE ALL NECESSARY VALVES AND INSTRUMENTS REQUIRED FOR THE COMPLETENESS AND TROUBLE FREE OPERATION OF THE ENTIRE SYSTEM.
 - THE COMMON STEAM HEADERS SHALL BE SIZED CONSIDERING BOTH THE UNITS ARE RUNNING TOGETHER. ALSO, THE HEADERS SHALL BE SUITABLE FOR SINGLE UNIT OPERATION UNDER ALL OPERATING CONDITION.
 - ELECTRO -MAGNETIC RELIEF VALVES TO BE CONSIDERED IN MP AND LP PROCESS STEAM HEADERS TO HANDLE IMMEDIATE FLUCTUATIONS FROM DOWNSTREAM SYSTEM.

PO	SIGN. INITIALS	KKS	RKS	AM											AM	PSG	17-09-2024
ISSUE		DRN	DSN	CHD	CV	EL	IC	ME							PE/PM	APPD	DATE
HINDALCO INDUSTRIES LIMITED KANSARIGUDA																	
OVERALL CYCLE SCHEMATIC DIAGRAM (STEAM SYSTEM)																	
TATA CONSULTING ENGINEERS LIMITED KOLKATA																	
SCALE :1:1 DWG. NO. TCE.13833A-ME-6014-FD-60001 ISSUE PO																	
FILE NAME : F-090-Ren-RD.dwg																	

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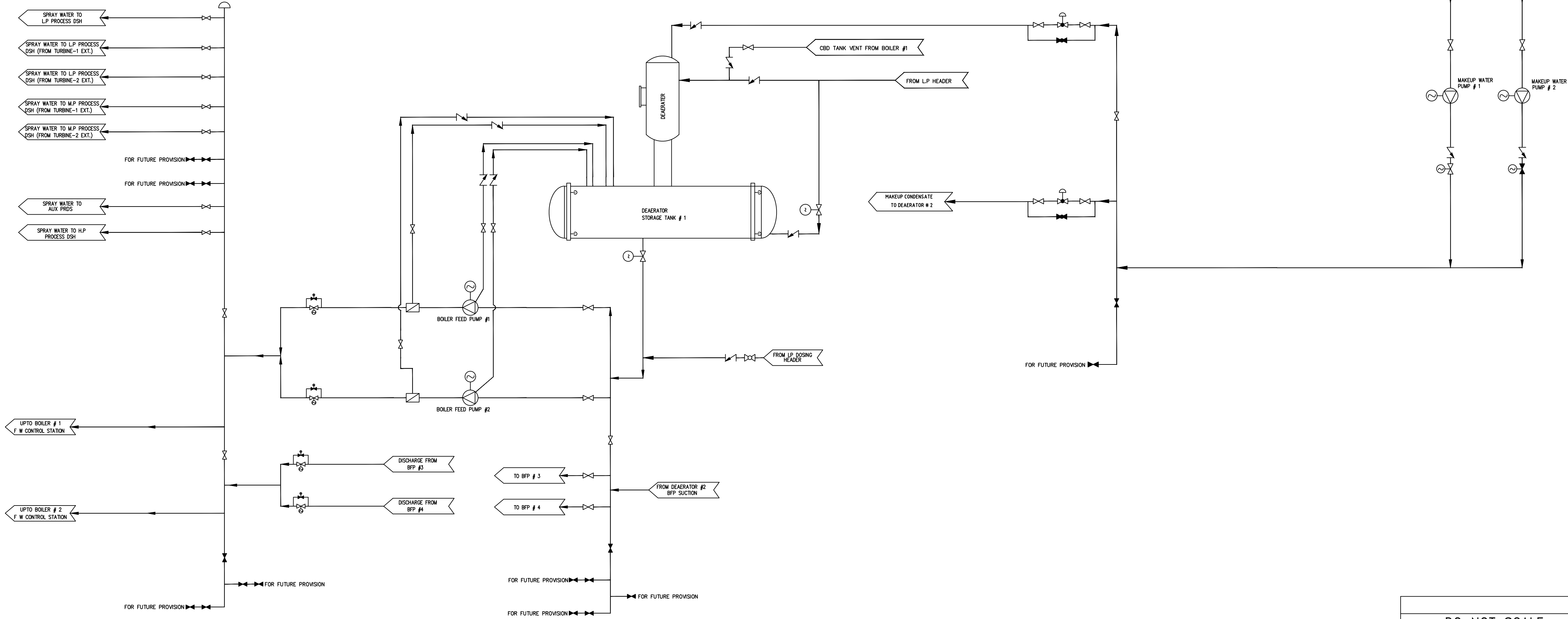
Client – Hindalco Industries Ltd
Project - Aditya Alumina Refinery
TCE.13833A-ME-6002-6001, Rev-P0



TECHNICAL SPECIFICATION FOR MAIN PLANT SYSTEM

Page 1 of 1

ATTACHMENT-5 OVERALL CYCLE SCHEMATIC DRAWING (FEEDWATER SYSTEM)



LEGEND AND SYMBOLS

	GATE VALVE
	GLOBE VALVE
	NON RETURN VALVE
	PNEUMATIC OPERATED GLOBE VALVE
	MOTORIZED OPERATED GATE VALVE
	MOTORIZED OPERATED PUMP
	STUB
	AUTOMATIC RECIRCULATION VALVE (ARC)
	INTEGRAL BYPASS VALVE
	CUSTOMER BIDDER

NOTES:

1. THIS IS BID PURPOSE PFD TO REPRESENT THE MINIMUM BASIC REQUIREMENT OF THE SYSTEM. BIDDER TO PROVIDE ALL NECESSARY VALVES AND INSTRUMENTS REQUIRED FOR THE COMPLETENESS AND TROUBLE FREE OPERATION OF THE ENTIRE SYSTEM.
2. THE COMMON BOILER FEEDWATER PUMP DISCHARGE HEADERS SHALL BE SIZED CONSIDERING BOTH THE UNITS ARE RUNNING TOGETHER. ALSO, THE HEADERS SHALL BE SUITABLE FOR SINGLE UNIT OPERATION UNDER ALL OPERATING CONDITION.

RO	SIGN. INITIALS	KKS	RKS	AM														17-09-2024
ISSUE		DRN	DSN	CHD	CV	EL	IC	ME							PE/PM	APPD		DATE

HINDALCO INDUSTRIES LIMITED
KANSARIGUDA

OVERALL CYCLE SCHEMATICS
DRAWING (FEEDWATER SYSTEM)



TATA CONSULTING ENGINEERS LIMITED
KOLKATA

SCALE :1:1		DWG NO.		ISSUE	
DC & DISC DEL-ME		TCE.13833A-ME-6014-FD-60002		P0	
16		17		18	19 TCE FORM NO. 090 R

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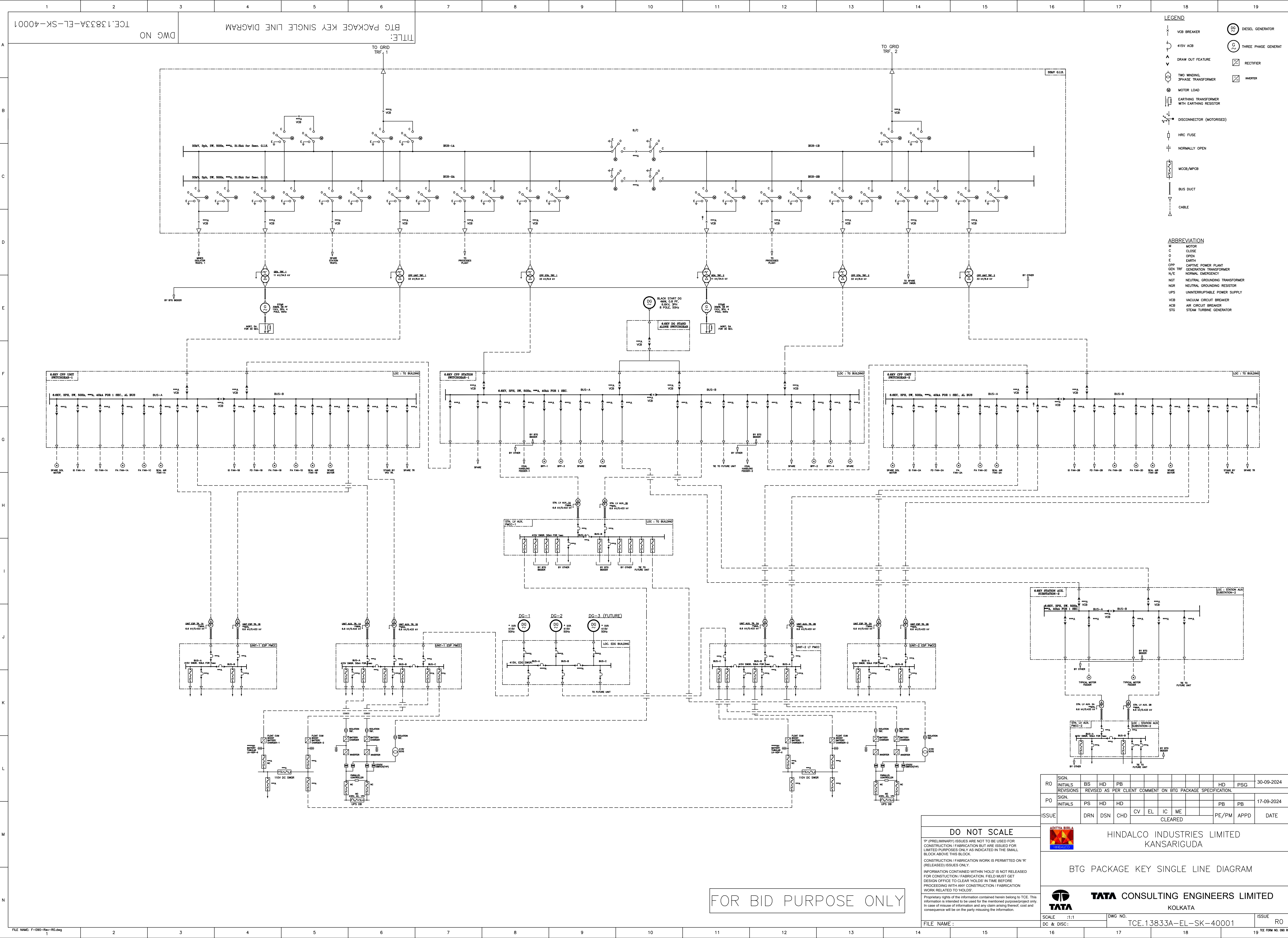
Client – Hindalco Industries Ltd
Project - Aditya Alumina Refinery
TCE.13833A-ME-6002-6001, Rev-P0



TECHNICAL SPECIFICATION FOR MAIN PLANT SYSTEM

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ATTACHMENT-6 ELECTRICAL SINGLE LINE DIAGRAM





Client – Hindalco Industries Ltd
Project - Aditya Alumina Refinery
TCE.13833A-ME-6002-6001, Rev-P0



TECHNICAL SPECIFICATION FOR MAIN PLANT SYSTEM

Page 1 of 1

ATTACHMENT-7 DCS SYSTEM CONFIGURATION DRWAING



Client – Hindalco Industries Ltd
Project - Aditya Alumina Refinery
TCE.13833A-ME-6002-6001, Rev-P0



TECHNICAL SPECIFICATION FOR MAIN PLANT SYSTEM

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ATTACHMENT-8
VOID



Client – Hindalco Industries Ltd
Project - Aditya Alumina Refinery
TCE.13833A-ME-6002-6001, Rev-P0



TECHNICAL SPECIFICATION FOR MAIN PLANT SYSTEM

Page 1 of 1

ATTACHMENT-9 LIST OF APPROVED SUB VENDOR LIST

Item Description	Vendor Name
MECHANICAL	
TURBINE	BHEL
	SIEMENS
	Mitsubishi
	Shin Nippon
Centrifugal Fans	TLT
	Howden
	BHEL
	Reitz
ESP	THERMAX/BALCKE DURR
	ALSTOM /ACC
	BHEL
Deaerator	Balcke Durr Gmbh
	Doosan
	WATCO Technics pvt ltd
	BHEL
	L&T
Boiler Feed Pumps	KSB
	Sulzer Pumps
	BHEL
Insulation	Lloyds
Aluminium Cladding	HINDALCO
	BALCO
	INDALCO
	NALCO
HP Valves	BHEL / CRANES
	L&T / Audco
LP Valves	L&T / Audco
	BHEL / DANFOSS
	KSB
Safety valves	BHEL
	FAINGER LAISER (INDIA)
	Tyco Sanmar
Butterfly valves	L&T

	Fouress
	Xomox
Silencers	Acoustic India
	Triveni Engineering
	Indira Industries
Chemical Dosing pumps	Gerb
	Milton Roy India (P) Ltd.
	Metering pump
	Enpro
Ball Valves	AUDCO
	L&T
	Klinger
Dampers	United Techonomac
	Fouress
PRDS	Control Component Inc.
	USA / COPES VULCAN
	KSB MIL
	Dresser
	SPX Flow Technology (India) Pvt Ltd
Elevators	Otis
	KONE
	Johnson
Pumps	KBL
	BHEL
	Sulzer
Strainer	Filtration Engineering
	Jaypee Industries
	Multiplex Filtration
	Otoklin
Steam Trap	Armstrong
	Uniklinger
	Spirax Marshall
Chain Pulley Block	
	Indef
	Kepto
	Ingersol Rand

Electrical Hoist	Hercules Hoist
	Eddy Crane
	KITO industries
	Anupam Cranes
	Reva Industries
Spring Hangers	Pipe supports India Pvt Ltd
	Spring supports
	Sarathi Engineering Pipe Supports (India)
Hangers & Supports	Bergen Pipe Support
	Pipe supports India Pvt Ltd
	Techno Industries
	AAA
	Pyrocon
Carbon steel and Alloy steel seamless pipes and tubes	Sumitomo
	JFE
	JINDAL SAW (INDIA)
	ISMT (INDIA)
	Bentler
	MAHARASHTRA SEAMLESS (INDIA)
Mechanical Seals	Eagle BurgMann
	Flowserve
	Leakproof
	John crane
Structural steel	SAIL
	TISCO
	Jindal
Oil Purification System	Alfa Laval
	Gea Westfalia
ME Bellows	SUR Industries
	Expansion Joints
	Fluid Line Engrs.
	Metallic Belows
	Munro & Miller Fittings
Bearings	SKF
	FAG

	TIMKEN
	NTN
Piping	Sumitomo
	Bentler
	Tata Steel
	JSW
	MSL
	ISMT
MS Pipes ERW and Seamless Pipes	Tisco
	Jindal Surya Roshani
	Maharashtra Seamless
	Indian Seamless
SS Pipes	JINDAL QUALITY TUBULARS (INDIA)
	HEAVY METALS AND TUBES LIMITED (INDIA)
	RATNAMANI METALS (INDIA)
	Sandvik
	Sumitomo
Welding Electrodes	
	D&H
	L&T
	ADOR
	ESAB
Miscellaneous Pumps Including Sump Pumps & Submersible Pumps	Kirloskar Brothers Ltd., Pune
	WPIL
	WILO pumps
Expansion Joints	KE Bergmann (India)
	James Walker Inmarco
	Cori Engineering, Chennai
Fluid Couplings	Voith
Flexible Couplings	Elecon
	Euroflex
	Rexnord
Lube Oil Purifier (Centrifuge)	Alfa Laval, India
	Stock Ridler

Gravimetric Feeder and Drag Chain Feeder and its Drives	Merric Industries Inc
Conveyor Belting	Nirlon, Mumbai
	Mrf, Chennai
	Phoenix
	Dunlop
Refractory	Calderys/Tata
	Carborandum
Burner	Wesman / Coin bharat
Knife edge gate valve	Vass (India)
	Orbinox (India)
Plug valves	Xomox (India)
	AUDCO
Guillotine Dampers	United Technomech (India)
	Fouress (India)
	Keld Elentoff (India)
	Mechwell Industries (India)
Butterfly dampers	Intervalve (India),
	Stafford (India)
	Ellomatic (India)
Gear Box	Flender - Graffenstaden
	Voith Turbo BHS - Getriebe GMBH
	SHI-GB, Japan
Gear Couplings	Euroflex
	Flender - Graffenstaden
	Voith Turbo BHS - Getriebe GMBH
	Eagle Industry
	SHI-GB, Japan
Lube Oil pumps and Emergency Oil Pumps (Centrifugal Pump)	Allweir/Tushaco
	Liestritz
	KSB Pumps
	Sulzer Pumps
	Kirloskar Ebara
Lube Oil pumps and Emergency Oil Pumps (Screw Pump)	Circor (Alweller)
	Liestritz
	Rotodel

Oil Vapour Extraction Fans	Hyderabad Pollution Controls
	S.K. Systems
	Patels Airflow
	CB Doctor Ventilators
	Nadi
Oil Purification Unit	GEA Westfalia Seperator
	Alfa-Laval
Duplex Filter (Lube Oil)	EPE Process Filters
	Hydac
	Pall India
Quick closing extraction non-return valves	BHEL
	Cesare Bonetti
	Adams Valve
	Utuse Valve
	Karatsu Valve
Turbine Thermal Insulation and Cladding	Lloyds
	Nichias (Japan portion)
Bearings	Michell Bearings
	Omega Industries
	Kanpur Metal Products
	Waukesha Bearings
	Kingsbury Inc.
Safety Valves	BHEL
	TYCO SANMAR
	Fainger Leser
GSC/VSC	BHEL
	L&T
	Godrej & Boyce
	Mazda
	Fitwell
	GE Godavari
	Newfield
Oil Purification Unit	Alfa Lawal

	GEA Westfalia
Lube Oil System	~~Southern Lubrication~~
	Hydac India
	~~Enpro Industries~~
	EPE
	Filsep
	Cenlub Industries
	Shin Thermo
Lube Oil 3-way valve (cooler / filter)	Flow Chem
	GEC
	Micro finish
Acoustic Enclosure	
	Llyod Insulation (India) Ltd.
	BBM Acoustic India Pvt Ltd.
PAINT	Acoustic India Pvt Ltd
	Birla OPUS
	Nerolac
	Berger
	Asian Paints
	Shalimar
	Indigo

ELECTRICAL SYSTEMS		
BATTERY CHARGER	• HBL NIFE • HITACHI-HIREL • AMARAJA	
BATTERY LEAD ACID	• AMCO • EXIDE • HBL NIFE	Only Dry cell
BATTERY SET NI CD	• HBL NIFE • AMCO SAFT	Electrolyte
BATTERY SET LITHIUM-ION	• HBL NIFE • EXIDE	
UPS SYSTEM	• HITACHI-HIREL • GUTOR	
CABLE - ITS HEAT SHRINKABLE	• RAYCHEM MAKE (TE Connectivity) • 3M	
CABLE ENTRY SEALING	• ROXTEC • HUMMEL	
CABLE GLANDS	• COMET • KRIP SURE • EATON • LEGRAND	
CABLE TRAYS - FRP	• BANSARI COMPOSITES • AGNI FIBRE • LOTUS FIBRE • KEMROCK • SUMIP	
CABLE TRAYS - GI	• GLOBE • CLIMAX • BM ENGG • SIDHHPURA ENGG	
CABLES - FLEXIBLE	• FINOLEX • NOBLE ELE • KEI • KEC	
CABLES - LT AND HT	• UNIVERSAL • KEI • KEC • CCI • T C Communication Pvt Ltd.	
CABLES - TELEPHONE	• DELTON CABLES	

	• RPG TELECOM • UNIVERSAL • PRAKRUTI TELECOME	
CAPACITORS - POWER	• UNIVERSAL • EATON • SCHNEIDER ELECTRIC	
CARBON BRUSHES	• ANUPAM CARBON • KIRLOSKAR • PATSON • ACE CARBON • BASIC MARKETING	
CLEANERS AND AROSOLS	• 3M • STANVAC • ACME	
D. G. SETS	• CUMMINS / SUDHIR • CUMMINS / JYOTI • KEC • WARTSILA • KIRLOSKAR OIL ENG	
DC STARTER	• MAKTEL • INTRELEC • PRIMA AUTOMATION • SWATI • HORIZON	
HOT DIP GALVANISED EARTHING MATERIAL	• GLOBE • CLIMAX • SIDHHPURA ENGG • BM ENGG	
RCCB	• HAGER • LEGRAND • ABB • SIEMENS • GE • L&T	
EMERGENCY LIGHTS	• GE • BAJAJ • CROMPTON • PHILIPS	
EMERGENCY SIREN	• STEAM AIRTRIC • TARGET ELE • KHERAJ • PROLITE SYSTEM	

	• NOBLE	
ENERGY METER	• ENERCON • SCHNEIDER ELECTRIC • RISHABH • HAVELL'S INDIA • SECURE METERS UDAIPUR • ELECTRONIC AND INST CO. • L&T	
FAN - CEILING	• ORIENT • CROMPTON • BAJAJ • HAVELLS • KHAITAN	
FAN - PEDESTAL	• BAJAJ • ELECTROMECH • CROMPTON • CALCUTTA FANS • ORIENT	
FAN - WALL	• ORIENT • CROMPTON • BAJAJ • KHAITAN • CALCUTTA FANS	
FIRE RETARDENT MATERIAL	• MULTIKIL • STAR BLAZE • VIJAY FIRE SYSTEM • NEWKEM • STANVAC	
FLAME PROOF LIGHT FITTING (LED ONLY)	• BALIGA LIGHT • FCG • SUDHIR SWITCHGEAR • FLEXPOR	
FLAME PROOF MOTORS	• BHARAT BIJLEE • FCG	
GRR	• PIONEER • ENTERPRISING ENGG	
GYSERS	• MERLONI • BAJAJ • RACOLD • SPEARHOT	

INDICATING LAMP - LED TPE	• SEEMACO AG (TEKNIC, ALTO) • RANJIT IRON (SIEMENS) • PATEL ELE (L&T) • NOBLE • V C PAREKH TRADING CO. • SIGMA LIGHTS	
INSULATORS	• ADITYA BIRLA INSULATORS • VODCA • JYOTI • L&T • BHEL • SAMPAT INSULATORS	
INVERTOR - DOMESTIC USE	• SU-KAM • PHILIPS • HI-LITE • JIT POWER • SOLO INVERTORS	
KIOSKS	• SWATI • HORIZON • PRIMA AUTOMATION	
LIGHT FITTIG - 24V HAND LAMP FLAME PROOF (ONLY LED)	• BALIGA LIGHT • FCG • SUDHIR SWITCHGEAR • FLEXPRO	
LIGHT FITTIG - 24V HAND LAMP SIMPLE (ONLY LED)	• BALIGA LIGHT • FCG • SUDHIR SWITCHGEAR • FLEXPRO • NOBLE	
LIGHT FITTIG - AVIATION LIGHT (ONLY LED)	• STEAM AIRTRIC • ALTOS • SPECTRUM • MIMIC	
LIGHT FITTIG – DECORATIVE (ONLY LED)	• BAJAJ • PHILIPS • HAVELLS • WIPRO • CROMPTON	

LIGHT FITTING - INDUSTRIAL (ONLY LED)	• BAJAJ • PHILIPS • HAVELLS • WIPRO • CROMPTON	
LIGHT FITTING - STREET LIGHT (ONLY LED)	• BAJAJ • PHILIPS • HAVELLS • WIPRO • CROMPTON	
LIGHT FITTING - FLOOD LIGHT (ONLY LED)	• BAJAJ • PHILIPS • HAVELLS • WIPRO • CROMPTON	
LIGHT FITTING – MV (ONLY LED)	• BAJAJ • PHILIPS • HAVELLS • WIPRO • CROMPTON	
LIGHTING ARRESTOR - POST TYPE	• CYCLO ELE • LAMCO • ELPRO INT • CAPE • DEHN	
LIGHTING ARRESTOR - SPIKE TYPE	• CYCLO ELE • GLOBE ELE • CAPE • DEHN	
SS LLP AND CHOKE BOXES (POLYCARBONATE)	• SWATI • HORIZON • PRIMA AUTOMATION • HENSEL • NAPTUNE • CAPE	
LOCAL CONTROL STATIONS (POLYCARBONATE)	• PUSHTRON • PARTH ELECTRICALS • LOTUS FIBRE • SUMIP • HENSEL • NAPTUNE • CAPE	

LRS	• PIONEER • ENTERPRISING ENGG	
LT SWITCHGEAR COMPONANTS	• SIEMENS • L&T LTD. • SCHNEIDER-ELECTRIC • ABB • GE	
LUGS AND CRIMPING TOOL	• COMET • SEEMACO AG • KRIP SURE • DOWELLS	
MEASURING INSTRUMENTS	• KUSUM MECO • MOTWANE • YOKOGAWA • RISHABH	
MOTOR - DC	• KIRLOSKAR • CROMPTON GREAVES LTD.	
MOTOR STARTERS - FIELD MOUNTED (POLYCARBONATE)	• NOBLE ELE • PATEL ELE • DHOOT BROTH • VICAS CORP • L&T • HENSEL • NAPTUNE • CAPE	
MOTORS - HT IE3 & IE4	• BHEL • SIEMENS • CROMPTON GREAVES LTD. • ABB	
MOTORS - LT IE3 & IE4	• SIEMENS • ABB • CROMPTON GREAVES LTD.	
NGR	• RSI SWG • KORES INDIA LTD • BEST & CROMPTON ENGG. LTD. • CROMPTON GREAVES LTD. • RSI SWITCHGEAR PVT. LTD.	

OIH LINE MATERIALS	- AHSMOR - CLIMAX - JYOTI - VODKA - VAIHSALI ELECTRICALS	
OIH LINE PCC POLES	- GONDAL PREST - BHIKHABHAI TRUST - VAIHSALI ELECTRICALS	
PANEL - HT VCB I VC	- SCHNEIDER-ELECTRIC - SIEMENS - ABB	SCHNEIDER-ELECTRIC (Preferred)
PANEL - LT	- L&T LTD. - SCHNEIDER-ELECTRIC - SIEMENS [I] LTD. - ABB	L&T LTD. (Preferred)
PANEL - MCC /PCC	- L&T LTD. - SIEMENS [I] LTD. - SCHNEIDER-ELECTRIC - ABB	L&T LTD. (Preferred)
DCDB	- SWATI SWITCHGEARS - HORIZON MICROTECH - PRIMA AUTOMATION	
RELAYS MICROPRO. BASED	- SEL - SCHNEIDER ELECTRIC - ABB	
INSULATING MATS	- KANTA RUBBER - ZENITH RUBBER - SINTEX 3M - RAYCHEM	
SILICA GEL (KC-TROCKENPERLEN ORANGE SILICA GEL)	- NOBLE ELE - PATEL ELE - V C PAREKH TRADING CO.	
SOLDER STICK	- NOBLE ELE - PATEL ELE - DHOOT BROTH - INDIANA ENGG - V C PAREKH TRADING CO.	
TELEPHONE HOOTER	- KHERAJ - TARGET ELE	
TELEPHONE INSTRUMENT	- BHARTI telecom - COMMUNICA ADDS	

	• GPS AGENCY • PANASONIC • USHA TELECOM	
TIMERS	• SIEMENS • L&T • ELECTRONIC AUTOMATION • PRIVATE LMTED	
TRANSFORMER	• BHEL • CGL • ABB-HITACHI • VOLTAMP	
GENERATOR	• BHEL • MITSUBISHI ELECTRIC • ABB • SIEMENS	
TROPOLINE	• URJA ENT. • TROPOCAST	
VAR SPEED DRIVE AC AND DC	• SIEMENS • ABB-HITACHI • MITSUBISHI ELECTRIC	
VARNISH (DR. BECK MAKE)	• NOBLE ELE • PATEL ELE • SEEMACO-AG • MAGNET WIRES AND INSULATION • INSULATION HOUSE	
WINDING PAPERS	• NOBLE ELE • PATEL ELE • VINUBHAI & CO. • INSULATION HOUSE	
WINDING WIRES	• NOBLE ELE • PATEL ELE • HINDUSTAN WIRES • VINUBHAI & CO. • GUJARAT CABLES	
FRP STREET LIGHT POLES	• SUMIP • LOTUS FIBRE • KEMROCK	
FRP DISTRIBUTION BOX	• SUMIP • LOTUS FIBRE • KEMROCK	

FRP JUNCTION BOX	• SUMIP • LOTUS FIBRE • KEMROCK	

<u>INSTRUMENTATION AND CONTROL</u>		
<u>CONTROL SYSTEMS</u>		
DCS		• Honeywell Automation India Ltd. • Yokogawa • ABB India Ltd • Emerson • Siemens
PLC		• Siemens • GE Fanuc Systems P. LTD • Rockwell automation India ltd
ELECTRONIC GOVERNING SYSTEM		• Woodward
VIBRATION MONITORING SYSTEM		• Bently Nevada (GE) • Schenk Avery Ltd. • Metrix Instrument Co.
<u>FIELD INSTRUMENTS</u>		
Pressure Gauges/ Differential Pressure / Temperature Gauges		• Gauges Bourdon (India) Ltd • Baumer Technologies India Pvt. Ltd • WIKA instruments india pvt. Ltd • Scientific Devices Pvt Ltd
Level gauges		• Gauges Bourdon (India) Ltd. • B.K. Equipment Pvt. Ltd. • Magnetrol Industrial inc. • Scientific Devices Pvt Ltd
Sight Flow Indicator		• Hydropneumatics • Chemtrols Samil • Eureka
Pressure/ Differential Pressure Switches		• Baumer Technologies India Pvt. Ltd. • Switzer Instruments Ltd. • Gauges Bourdon (India) Ltd.,
Level switch float type		• Levcon Instruments Pvt. Ltd. • Magnetrol • Pune Techtrol Pvt. Ltd. • SBEM Pvt. Ltd
Capacitance Level Switch		• Nivo Controls Pvt. Ltd

	• Pune Techtrol Pvt. Ltd. • SBEM Pvt. Ltd
Speed/Proximity switches	• IFM Electronic • P&F • Sick • —
Pull cord, Belt sway switches with belt watch system	• Jayashree Electrodevices • AG Switches • Sai Control System
Flow Switch (Only for oil applications)	• Honeywell Automation India Ltd. • IFM • Wika
Ultrasonic Level Transmitter	• Endress+Hauser (India) Pvt. Ltd. • Forbes Marshall (Ametek Drexelbrook) • Emerson Process Management • Siemens • VEGA India Level and Pressure Measurement Pvt. Ltd.
Microwave solid/liquid level measurement	• Endress & Hauser • Emerson • VEGA India Level and Pressure Measurement Pvt. Ltd.
Radar / Guided Wave Radar level transmitter	• Endress+Hauser (India) Pvt. Ltd. • Emerson • Siemens Ltd. • VEGA India Level and Pressure Measurement Pvt. Ltd.
3D Radar Level transmitter (for Solid)	• EIP enviro level controls Pvt. Ltd.
Mass Flowmeter	• Emerson Process Management (India) Pvt. Ltd. • Endress+Hauser (India) Pvt. Ltd. • Yokogawa
Vortex Flowmeter	• Emerson Process Management (India) Pvt. Ltd. • Endress+Hauser (India) Pvt. Ltd. • Yokogawa • Krohne (Forbes Marshall)
Variable Area Rotameter	• Brook Instrument India Pvt. Ltd. • Emerson Process Management (India) Pvt. Ltd. • EUREKA

	• Krohne
Magnetic Flowmeter (Only PFA liner)	• Endress & Hauser • Yokogawa • Emerson • Krohne (Forbes Marshall)
Flow element	• Baliga Lighting equipment pvt. Ltd. • Minco (India) Flow elements Pvt. Ltd. • Emerson Process Management (India) Pvt. Ltd.
Temperature elements (sensors-RTD, T/C) with Thermowell	• Pyro Electric Instruments Pvt. Ltd. • Detriv Instrumentation & Electronics • Tempsens • Pyrotech Controls (I) Pvt. Ltd.
Transmitters (Flow, Level, Pressure, Temperature & Differential Pressure)	• Emerson Process Management • Endress & Hauser (India) Pvt Ltd. • Yokogawa • Siemens • Krohne
Air filter regulators	• Placka Instruments & Controls • FESTO • Shavo Norgreen India Pvt. Ltd.
ANALYZERS	
Dew point / Moisture analyzer	• GE India • Michell Instruments Ltd.
SWAS	• Forbes Marshall • Emerson Process Management
Silica, Sodium analysers	• Hach • Emerson
pH, conductivity, dissolved oxygen and hydrazine analysers	• Yokogawa • Emerson Process Management • Endress & Hauser (India) Pvt Ltd.
SO ₂ , NO _x / CO/ CO ₂ analyser, extractive / sampling type analyser	• Yokogawa • Fuji • Sick Maihak • Teledyne Analytic
Oxygen [flue gas] analyser	• Yokogawa • Codel • Emerson Process Management (India) Pvt.
CO analyser	• Codel International Ltd • Teledyne Instruments • Sick Maihak

Dust density monitor	• Emerson Process • Durag • Codel International Ltd.
VALVES & ACCESSORIES	
Control Valves	• Metso Automation India Pvt. Limited (neles) • Tyco • Fischer Sanmar Ltd • Emerson Process Management (India) Pvt.
I/P converters	• Emerson Process Management • Yokogawa India Ltd
Solenoid Valves	• Asco (India) Ltd Festo • Rotex Automation Ltd. • HERION NORGREN
Valve Positioners (Pneumatic)	• Emerson Process Management (India) Pvt. Ltd • Foxboro (Schneider electric) • Fisher • Siemens
Limit Switches	• BALLUFF • Masibus Process Instruments Pvt. Ltd. • OMRON AUTOMATION PRIVATE LIMITED • OSNA Electronics Pvt. Ltd
Electrical Actuators	• Limitorque India Pvt Ltd. • Marsh Automation
Self actuated pressure control valve	• ARCA • Fisher • CCI
Position Transmitter	• Endress & Hauser • Siemens
Pneumatic actuator	• FESTO • ROTEX • Metso Automation India Pvt. Limited
PANELS & ACCESSORIES	
Junction boxes	• Rittal • HENSEL electric India Pvt. Ltd • Baliga
Control Panels	• Rittal • Pyrotech Controls Pvt Ltd.
Push Button, Selector Switch, Lamp	• Siemens

	• Telemecanique • TECNİK
Terminals	• Connectwell • Phoenix contacts (India) Pvt. Ltd. • Wago
Power supply units	• Cosel Asia Ltd. • Connectwell • Phoenix contacts (India) Pvt. Ltd. • Wago
Interposing relays	• Omron Automation Pvt. Ltd. • Jyoti Ltd • Connectwell • Wago
Signal Isolator	• MTL • P&F • Wago
Panel digital indicators	• YOKOGAWA • MTL • Ascon
CABLES & ACCESSORIES	
CABLES	• Cords Cable Industries Pvt. Ltd. • T C Communication Pvt Ltd. • Lapp India Pvt Ltd. • KEI
Fiber Optic cables	• Corning Inida • Finolex Cables Ltd. • Lapp india
Foundation field bus cable	• Belden • Kerpen Cables • Lapp India Pvt. Ltd
Foundation Field Bus Accessories	• MTL India Pvt Ltd • Pepprl+Fuchs Pvt. Ltd.
MISCELLANEOUS	
Impulse tubes & fittings	• Parker Hannifin • Swagelock • Astec Instruments Pvt. Ltd. • Fluid Controls Pvt. Ltd. • Excel Hydropneumatics Pvt. Ltd. • Fluid Controls
CCTV system	• Honeywell Automation India Ltd • Siemens Ltd. • CP Plus

Master Clock system	• Sertel Electronics Pvt. Ltd. • Masibus Process Instruments Pvt. Ltd.
HMI-PC	• Dell • HP
Server	• Dell • HP
Printers	• HP • Epson • Canon • TVSE (dot matrix)



Client – Hindalco Industries Ltd
Project - Aditya Alumina Refinery
TCE.13833A-ME-6002-6001, Rev-P0



TATA CONSULTING ENGINEERS LIMITED

TECHNICAL SPECIFICATION FOR MAIN PLANT SYSTEM

Page **1** of **1**

ATTACHMENT-10

MINIMUM INSPECTION REQUIREMENT

SPEC. NO. TCE.M4-185-04	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR HEADERS AND PIPING (IBR)	SHEET 1 OF 4

1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	All Materials	Material test certificates with IBR format	100%	C
1.2	Pipes	UT for pipes or Hydrostatic test	100%	C
1.3	Pipes 200 NB & above	Supplementary tests		
		S1. Product analysis [For all materials]	Per heat	C
		S2. Transverse tension test [For all materials]	25%*	C
		S3. Flattening test [For alloy steels]	25%*	C
		S5. Photomicrographs [For Grade 91, 92]	One sample per thickness/size/heat	C
		Impact testing [For Grade 91,92,23] as per specification	per heat	C
1.4	Tubes	UT for thickness 3.6 mm & greater / Eddy current test if thickness < 3.6 mm or Hydrostatic test	100%	C
1.5	Plates for lugs with thickness > 25 mm	UT	100%	C
1.6	FITTINGS:			
1.6.1				
a)	Material test certificates	Material test certificates with IBR format	100%	C
		Product analysis	Per heat	C
		Mother pipe test certificates with Hydrostatic test	100%	C
b)	NDT	MT (PT for Stainless steel)	100%	C
		UT (for all materials other than SS)	100%	C
c)	CSEF Steels	PMI	100%	C
		Photomicrographs (per grade/size)	Per HT batch	C
		Hardness check (per grade/size)	Each piece	C
2.0	<u>INPROCESS CONTROL</u>			
2.1	Welding qualification records	WPS, PQR, WPQ	100%	C
		(For CSEF material, WPS, PQR and WPQ shall be qualified with Impact testing)		

FILE NAME: M4-185-04-Rev-R06

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**ISSUE
R6**

SPEC. NO. TCE.M4--185-04	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR HEADERS AND PIPING (IBR)		SHEET 2 OF 4	
2.2 BENDS (COLD/HOT FORMED)				
2.2.1	Forming	Review of HT charts	100%	C
2.2.2	CSEF steel	MT/PT	100%	B
		Microstructure	1 per heat	C
		PMI	100%	B
		Dimensions and Hardness	100%	B
		Check		
2.2.3	Alloy steels bends	MT/PT	100%	B
		Dimensions and Hardness	10%	B
2.2.4	Carbon steels	MT/PT	10%	C
		Dimensions and Hardness	10%	C
2.3 WELD ENDS				
2.3.1	Carbon Steel - Gas cut & ground edges	MT/PT	100%	C
2.3.2	Carbon & Alloy steel - Machined & ground edges	MT/PT	10%	C
2.4	Welding process records	Preheating, interpass, post heating & PWHT charts (as applicable)	100%	C
2.5 NDT after PWHT				
2.5.1	For all Headers and IBR Class I piping			
a)	Butt welds - Alloy steel	MT	100%	A
		RT - Film Review > 100 NB	100%	C
		RT - Film Review <= 100 NB	10%	C
b)	Butt welds - Carbon steel	RT - Film Review > 100 NB	100%	C
		RT - Film Review <= 100 NB	10%	C
		<= 100 NB - MT	10%	A
c)	Full throat Nozzle welds	UT & MT	100%	B
d)	Fillet welds	MT - Alloy steel	10%	B
		MT- Carbon steel	10%	B
2.5.2 IBR Class II piping				
a)	Butt welds	RT - Film Review	10%	C
b)	Full throat Nozzle welds	UT & MT	10%	B
				ISSUE R 06

SPEC. NO. TCE.M4--185-04	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR HEADERS AND PIPING (IBR)		SHEET 3 OF 4	

2.6	Hardness test on butt welds	CSEF material Alloy steels	Each weld 10% @ random	B B

3.0 FINAL INSPECTION

3.1	Leak tightness	Hydrostatic Test (as per drawing at shop)	100%	A
3.2	Dimensional check	Number & height of stubs, field weld edge preparation, stub alignment, header bends , length, nozzle locations	100%	A
3.3	Pre-dispatch Check	Check for stamping details, finish painting, and end capping of stubs, axis marking, lifting location, and placing of silica gel. Documentation review as per IBR/stage inspection records	100%	C

* 2 samples / heat shall be tested if pipes are procured from Sumitomo, Productos Tubulares, Dalmine, Wyman Gordon, Benteler Stahl and Vallourec & Mannesmann

4.0 STANDARDS:

Materials	As per material specification
Welding	As per ASME BPVC
Non-Destructive Testing	As per ASME BPVC/ As per ASME BPVC/ ASME 31.1/ IBR / ASTM

5.0 INSPECTION CATEGORY:

A - Witness by TCE & Purchaser
B - Witness by TCE at the discretion of Purchaser
C - Certificates review by TCE / Purchaser

6.0 ABBREVIATIONS:

ASME - American Society of Mechanical Engineers
CSEF - Creep strength enhanced Ferritic Steels
HT- Heat Treatment
IBR - Indian Boiler Regulations
ID - Inner Diameter
MT - Magnetic Particle Testing
NDT - Non-Destructive Testing
OD - Outer Diameter
PMI - Positive Material Identification
PQR - Procedure Qualification Record

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SPEC. NO.
TCE.M4--185-04

TATA CONSULTING ENGINEERS LIMITED

SECTION:

MINIMUM INSPECTION REQUIREMENTS FOR HEADERS AND PIPING (IBR)

SHEET 4 OF 4

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ISSUE
R 06

SPEC. NO. TCE.M4-185-16	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR SAFETY VALVES AND SAFETY RELIEF VALVES	SHEET 1 OF 2

1.0	<u>Material</u>		Quantum	Inspection category
1.1	<u>Springs</u>			
1.1.1	Properties as per specification	Material test certificates	100%	C
1.1.2	NDT	MT (for Spring wire $\geq 25\text{mm}$)	100%	C
1.1.3	Hardness	Hardness testing	Each	C
1.1.4	Performance test	Spring constant, Scragg test, Dimensions and Squareness soundness	Each	C
1.2	<u>Casting:</u>			
1.2.1	Properties as per specification	Material test certificates, as applicable with IBR format	100%	C
1.2.2	Carbon Steel valves of 600# and above	RT Film review	Coverage as per ASNI 16.34	C
1.2.3	Alloy Steel valves	RT Film review	100%	C
1.2.4	Body and bonnet	MT	100%	C
1.3	<u>Forging:</u>			
1.3.1	Properties as per specification	Material test certificates	100%	C
1.3.2	Body and Bonnet for 1500# and above	UT	100%	C
1.3.3	Body and bonnet	MT	100%	C
1.3.4	Stem: rounds > dia. 50 mm	UT	100%	C
1.3.5	Nozzle	RT/UT	100%	C
2.0	<u>In-process control</u>			
2.1	Welding qualification records	WPS, PQR, WPQ	100%	C
2.2	Hard faced Seat surface & critical machined surfaces	PT	100%	C
2.3	Butt welds	RT Film review	100%	C
2.4	Post Welding Heat treatment	HT chart review	100%	C
2.5	Body Leak tightness	Hydro test	100%	B
3.0	<u>Final inspection</u>			
3.1	Seat tightness	Seat leak test	100%	A
3.2	Set Pressure test	Pop up test (with Steam for steam application)	100%	A
3.3	Valves with Bellows	Back pressure test	100%	A
3.4	Dimensional conformity	As per drawing	100%	A
3.5	Paint Check	Appearance & DFT	Random	C
3.6	Documentation review	As per stage inspection records	100%	C

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**ISSUE
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[illegible]

SPEC. NO. TCE.M4-185-17	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR VALVES ANSI 600 # and ABOVE RATING	SHEET 1 OF 3

1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	<u>CASTINGS</u>			
1.1.1	Properties as per specification	Material test certificates	one /heat	C
1.1.2	NDT for body and bonnet	RT - Film review	100%	C
1.1.3	Heat treatment	HT charts	100%	C
1.1.4	NDT after machining	MT/PT	100%	C
	Ref Notes for Gr 91			
1.2	<u>FORGINGS</u>			
1.2.1	Properties as per specification	Material test certificates	one /heat	C
1.2.2	Heat treatment	HT report	100%	C
1.2.3	NDT for all valves	MT/PT	100%	C
1.2.4	NDT for valves 1500 class and above	UT	100%	C
	Ref Notes for Gr 91			
1.3	<u>STEM</u>			
1.3.1	Properties as per specification	Material test certificates	one /heat	C
1.3.2	Heat treatment	HT report	100%	C
1.3.3	NDT if dia $\geq$ 50 mm	UT	100%	C
1.4	<u>BYPASS PIPE</u>			
1.4.1	Properties as per specification	Material test certificates	one /heat	C
1.4.2	NDT / Leak tightness	UT / Hydrostatic test	100%	C
2.0	<u>INPROCESS CONTROL</u>			
2.1	Welding & Hard facing qualification records	WPS, PQR, WPQ	100%	C
2.2	Butt welds	UT / RT - Film review	100%	C
2.3	Fillet welds	MT / PT	100%	C
2.4	PWHT	HT chart	100%	C
2.5	Hardness of welds (see Notes)	Hardness test	Each	C
2.6	Stem and gland sealing area	Visual, dimensional inspection and surface finish	100%	C
2.7	Seat & Backseat	Hardness test	On test coupon	C

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**ISSUE
R6**

FILE NAME: F-329-Rev-R7.docx

TCE FORM NO. 329 R7

SPEC. NO. TCE.M4-185-17	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR VALVES ANSI 600 # and ABOVE RATING		SHEET 2 OF 3	

2.8	Seat face, Hard faced areas & machined surfaces	PT	100%	C
3.0	<u>FINAL INSPECTION</u>			
3.1	Body Leak tightness	Hydro test	100%	A
3.2	All valves	Hydrostatic seat leak test	100%	A
3.3	Valves with back seat	Hydrostatic back seat leak test	100%	A
3.4	Globe valve/gate valve	Pneumatic seat test	10%	A
3.5	Check valve	Hydro test of seat at 100% and low pressure seat test at 25% of seat test pressure.	100%	A
3.6	Actuator operated valves	Performance test of valve with actuator	100%	A
3.7	Dimensional conformity	As per drawing	100%	A
3.8	Paint Check	Appearance & DFT	100%	C
3.9	Documentation review	As per stage inspection records	100%	C
4.0	<u>STANDARDS:</u>			
	Materials	As per material specification		
	Welding	As per ASME BPVC, IBR		
	Non-Destructive Testing Evaluation	As per Valve Design standard		
	Dimensional Tolerance	As per Valve Design standard		
	Valve Leakage	As per API 598/EN 12266/Data sheet		
5.0	<u>INSPECTION CATEGORY:</u>			
	A - Witness by TCE & Purchaser			
	B - Witness by TCE at the discretion of Purchaser			
	C - Certificates review by TCE / Purchaser			

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SPEC. NO. TCE.M4-185-17	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR VALVES ANSI 600 # and ABOVE RATING	SHEET 3 OF 3

6.0	<u>ABBREVIATIONS:</u>
	ASME - American Society of Mechanical Engineers
	CSEF - Creep strength enhanced Ferritic Steels (defined in ASME Sec IX)
	DFT - Dry Film Thickness
	HT - Heat treatment
	MT - Magnetic Particle Testing
	PQR - Procedure Qualification Record
	PT - Liquid Penetrant Testing
	PWHT - Post Welding Heat Treatment
	RT - Radiographic Testing
	UT - Ultrasonic Testing
	WPQ - Welder Performance Qualification
	WPS - Welding Procedure Specification
7.0	<u>NOTES:</u>
7.1	For Grade 91: Al 0.02% max, No delta ferrite, N/Al weight % ratio ≥ 3 , C+N weight % ≥ 0.14
7.2	Hardness of CSEF welds shall be 200 HB-250 HB
7.3	For all witness points, % specified shall be per size per class rating.
7.4	The codes and standards mentioned in the various specifications and requirements specified in the enquiry document shall be latest as on the day of award of contract of the works unless otherwise specified. Contractor shall be responsible to inform to the Consultant / Owner in case of any revision / re-affirmation / amendment in the relevant codes and standards after the date of award of contract within 30 days of the issue of such revision / re-affirm/amendment of the code / standard. Consultant / Owner may approve use of the earlier code / standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed.

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SPEC. NO. TCE.M4-185-21	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR STEAM TURBINE		SHEET 1 OF 4	

1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	<u>Rotor</u>			
1.1.1	Properties as per material specification	Material Properties- Tensile, Impact, Hardness, FATT, NDTT, Chemical properties	100%	C
1.1.2	Heat Treatment	Charts Review.	100%	C
1.1.3	NDT	Ultrasonic Test - After heat treatment, Surface NDT Test - MPT including Bore	100%	B
1.1.4	Residual stress	Measurement	each	C
1.1.5	Heat stability test	For HP & IP rotors	each	C
1.1.6	Metallography	Microstructure	each	C
1.2	<u>Stator & rotor blades</u>			
1.2.1	Properties as per material specification	Chemical properties, Material Properties.	100%	C
1.2.2	Heat Treatment	Record Review	100%	C
1.2.3	Hardness check	Measurement	10%	C
1.2.4	NDT on Forgings / bar stock / raw materials – (rough machined)	Ultrasonic Test	100%	B(rotor) C(Blades)
1.2.5	Crack detection on finished blades	MT	10%	B
1.2.6	Material identification	Spectroscope test / PMI	10%	B
1.2.7	Free standing blades	Vibration / Natural Frequency check	10%	B
1.2.8	Moment Weighing of LP blades	Measurement	100%	C
1.3	<u>HP & IP casings</u>			
1.3.1	Properties as per material specification	Mechanical, Chemical properties	100%	C
1.3.2	Casting Repair	Details of major weld along with defectogram (for all major repairs client prior concurrence shall be obtained)	100%	C
1.3.3	Heat Treatment	Charts Review	100%	C
1.3.4	Metallography	Microstructure	each	C
1.3.5	NDT	(RT / UT) and MT	100%	C
1.4	<u>LP casing</u>			
1.4.1	Properties as per material specification	Mechanical, Chemical properties	100%	C

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SPEC. NO. TCE.M4-185-21		TATA CONSULTING ENGINEERS LIMITED		SECTION:	
		MINIMUM INSPECTION REQUIREMENTS FOR STEAM TURBINE		SHEET 2 OF 4	
1.4.2	NDT of plates	UT for plate thickness above 25mm	100%	C	
1.5	<u>Valves</u>				
1.5.1	Properties as per material specification	Mechanical, Chemical properties	100%	C	
1.5.2	NDT of body & bonnet	UT (forging) /RT (for casting) & MT	100%	C	
1.5.3	NDT of Spindle	UT	100%	C	
1.6	<u>Disc and coupling</u>				
1.6.1	Properties as per material specification	Mechanical, Chemical properties	100%	C	
1.6.2	Heat Treatment	Charts Review	100%	C	
1.6.3	Metallography	Microstructure	each	C	
1.6.4	NDT	UT and MT	100%	C	
1.7	Bearing housing				
	Properties as per material specification	Mechanical, Chemical properties	100%	C	
1.8	Casing bolts and critical fasteners	Material certificate UT of forgings MT after thread forming	100%	C	
1.9	Spacers and keys	Material certificate UT on proof machining MT / PT after complete machining Dimensional check	100%	C	
2.0	<u>In-process control</u>				
2.1	<u>Rotor</u>				
2.1.1	After proof machining	MT	100%	A	
2.1.2	After machining	Visual, Dimensional, runout (radial and Axial)	each	A	
2.1.3	After blading	Run-out check (on Journal areas)	each	A	
2.1.4	Over speed test	@ 120% of rated speed	each	A	
2.1.5	Dynamic balancing	Unbalance correction & vibration monitoring.	each	A	
2.2	<u>HP & IP casing</u>				
2.2.1	NDT before groove cutting	UT	100%	B	
2.2.2	NDT of Weld joint	MT on all fillet welds and UT/ RT on butt welds	100%	B	
2.2.3	After final machining	Dimensional inspection	100%	B	
2.2.4	Leak tightness	Hydrostatic tests	100%	A	
2.2.5	Parting plane gap	Measurement in clamped condition.	100%	A	
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SPEC. NO. TCE.M4-185-21	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR STEAM TURBINE		SHEET 3 OF 4	

2.3	<u>LP casing</u>			
2.3.1	Welding records	WPS, PQR, WPQ	100%	C
2.3.2	Post weld heat treatment	HT charts	100%	C
2.3.3	Dimension	Measurement	100%	C
2.3.4	NDT of welds	RT on butt joints (film review)	10%	C
		MT	100%	B
2.3.5	Parting plane gap	measurement in clamped condition	100%	A
2.4	<u>Valves</u>			
2.4.1	NDT after Machining	PT on all machined areas	100%	C
2.4.2	NDT after Welding	RT/ UT on all butt welds and MT/PT on all fillet welds	100%	C
2.4.3	Dimensions	Measurement	100%	B
2.4.4	Valve Lift	Measurement	100%	A
2.5	<u>Bearing & bearing housing</u>			
2.5.1	Leak test of bearing house	Kerosene leak test.	100%	B
2.5.2	Internal piping	Hydrostatic test	100%	B
2.5.3	Babbitt bonding	UT	100%	B
2.5.4	Machined surface	PT	100%	B
2.5.5	Parting plane gap	measurement in clamped condition	100%	A
2.5.6	Surface finish of bearing lining	measurement	100%	A
3.0	<u>Final inspection</u>			
3.1	Turbine Assembly (HP, IP, LP casings with rotor)	Flow path clearance including radial clearance, axial clearance between rotor & casing	100%	A
3.2		Axial and radial blade clearances. shaft seal clearance check	100%	A
3.3		Casing bolts identification and tightening procedure verification	100%	A
3.4	Bump test	Measurement of clearance	100%	A
3.5	Performance test	No Load performance test, if applicable	100%	A
4.0	<u>Standards:</u>			
	Materials	As per material specification		
	Welding	As per ASME BPVC		
	Non-Destructive Testing	As per ASME BPVC		
	Dimensional Tolerance	As per Drawing		
	Dynamic Balancing	As per ISO 11342 & ISO 1940		
	Vibration	ISO 10816		

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SPEC. NO. TCE.M4-185-21	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR STEAM TURBINE	SHEET 4 OF 4

5.0 Inspection category:

- A - Witness by TCE & Purchaser
- B - Witness by TCE at the discretion of Purchaser
- C - Certificates review by TCE / Purchaser

6.0 Abbreviations:

- AWS - American Welding Society
- DFT - Dry Film Thickness
- MT - Magnetic Particle Testing
- PQR - Procedure Qualification Record
- PT - Liquid Penetrant Testing
- PWHT - Post Welding Heat Treatment
- RT - Radiographic Testing
- UT - Ultrasonic Testing
- WPQ - Welder Performance Qualification
- WPS - Welding Procedure Specification
- FATT - fracture appearance transition temperature
- NDTT- Nil Ductility transition Temperature

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SPEC. NO. TCE.M4-185-30	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR LP VALVES & SPECIALTIES (ANSI CLASS BELOW 600)	SHEET 1 OF 3

1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	<u>CASTINGS</u>			
1.1.1	Properties as per specification	Material test certificates	One / heat	C
1.1.2	NDT, based on casting quality factor	RT - Film review	100%	C
1.1.3	Heat treatment	HT charts	100%	C
1.1.4	NDT	MT/PT	100%	C
1.2	<u>FORGINGS</u>			
1.2.1	Properties as per specification	Material test certificates	One / heat	C
1.2.2	Heat treatment	HT report	100%	C
1.2.3	NDT for all valves	MT/PT	100%	C
1.3	<u>STEM</u>			
1.3.1	Properties as per specification	Material test certificates	One / heat	C
1.3.2	Heat treatment	HT report	100%	C
1.3.3	NDT if dia >= 50 mm	UT	100%	C
1.4	<u>DIAPHRAGM</u>			
1.4.1	Properties as per specification	Material test certificates	One / heat	C
1.4.2	Hardness test	Test report	per lot	C
1.4.3	Endurance test	Type test report	per size per type	C
2.0	<u>INPROCESS CONTROL</u>			
2.1	Welding & Hard facing qualification records	WPS, PQR, WPQ	100%	C
2.2	Weld joints	MT / PT	100%	C
2.3	Stem and gland sealing area	Visual, dimensional inspection and surface finish	10%	C
2.4	Seat & Backseat	Hardness test	On test coupon	C
2.5	Seat face, Hard-faced areas & machined surfaces	PT	100%	C

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SPEC. NO. TCE.M4-185-30	TATA CONSULTING ENGINEERS LIMITED			SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR LP VALVES & SPECIALTIES (ANSI CLASS BELOW 600)			SHEET 2 OF 3

3.0	<u>FINAL INSPECTION</u>			
3.1	Body Leak tightness	Hydro-test	100%	A
3.2	All valves	Hydrostatic seat leak test	100%	A
3.3	Valves with back seat	Hydrostatic back seat leak test	100%	A
3.4	Globe valve, ball valves, plug valves, diaphragm valves	Pneumatic seat test	100%	A
3.5	Gate valve	Pneumatic seat test	10%	A
3.6	Check valve	Hydro test of seat at 100% and 25% of seat test pressure.	100%	A
3.7	Actuator operated valves	Performance test of valve with actuator	100%	A
3.8	Steam Traps	Hydro test, Operation & Performance test	100%	B
3.9	Dimensional conformity	As per drawing	100%	A
3.10	Paint Check	Appearance & DFT	100%	C
3.11	Documentation review	As per stage inspection records	100%	C
4.0	<u>STANDARDS:</u>			
	Materials	As per material specification		
	Welding	As per ASME BPVC, IBR		
	Non-Destructive Testing Evaluation	As per Valve Design standard		
	Dimensional Tolerance	As per Valve Design standard		
	Valve Leakage	As per IS 6157/API 598		
5.0	<u>INSPECTION CATEGORY:</u>			
	A - Witness by TCE & Purchaser			
	B - Witness by TCE at the discretion of Purchaser			
	C - Certificates review by TCE / Purchaser			

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SPEC. NO. TCE.M4-185-31	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR BUTTERFLY VALVE	SHEET 1 OF 3

1.0	<u>MATERIALS</u>		Quantum of check	Inspection category
1.1	<u>CASTINGS</u>			
1.1.1	Properties as per specification	Material test certificates	One//heat	C
1.1.2	Stainless steel castings for Sea Water applications	IGC test	100%	C
1.1.3	NDT	MT/PT	100%	C
1.1.4	Heat treatment	HT charts	100%	C
1.2	<u>SHAFT</u>			
1.2.1	Properties as per specification	Material test certificates	One//heat	C
1.2.2	Heat treatment	HT report	100%	C
1.2.3	NDT if dia $\geq$ 50 mm	UT	100%	C
1.3	<u>PLATES for FABRICATION</u>			
1.3.1	Properties as per specification	Material test certificates	One//heat	C
1.3.2	NDT	UT	100%	C
1.3.3	Stainless steel welds, for sea water application	IGC test	100%	C
1.4	<u>SEALS</u>			
1.4.1	Rubber	Material test certificate	100%	C
1.4.2	Hardness Test	Hardness report	each	C
1.5	Gear box, Actuator	Manufacturer no load certificate	100%	B
1.6	Hydraulic power pack with control panels	Pressure test, Performance, simulation test	100%	B
2.0	<u>INPROCESS CONTROL</u>			
2.1	Welding qualification records	WPS, PQR, WPQ	100%	C
2.2	All Butt welds	UT / RT - Film review	100%	C
2.3	All welds	MT for magnetic materials PT for non-magnetic materials	100%	C
2.4	Stem and gland sealing area	Visual, dimensional inspection and surface finish	100%	C

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SPEC. NO. TCE.M4-185-31	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR BUTTERFLY VALVE		SHEET 2 OF 3	

2.5	PWHT	HT chart	100%	C
2.6	Machined surfaces and seat face	PT	100%	C
3.0	<u>FINAL INSPECTION</u>			
3.1	Body Leak tightness	Hydro-test	100%	A
3.2	Seat leak test with actuator	Forward and reverse Seat Leakage Test	100%	A
3.3	Disc strength test	Forward & Reverse Disc Strength Test for valve size $\geq 14"$ / 350 NB	100%	A
3.4	Valve unseating at normal working pressure	Smooth unseating after drop tightness of seal at working pressure	100%	A
3.5	Operational Check with actuator	Approved test procedure	100%	A
3.6	Dimensional conformity	As per drawing	100%	A
3.7	Paint Check	Appearance & DFT	100%	C
3.8	Documentation review	As per stage inspection records	100%	C
4.0	<u>STANDARDS:</u>			
	Materials	As per material specification		
	Welding	As per ASME BPVC		
	Non-Destructive Testing Evaluation	As per ASME BPVC		
	IGC test	As per ASTM A 262 for castings and ASME Sec. VIII Div. 1 clause UHA 108 for welding		
	Valve Leakage	As per EN 593/AWWA C 504/ AWWA C516		
	Note :-			
The codes and standards mentioned in the various specifications and requirements specified in the enquiry document shall be latest as on the day of award of contract of the works unless otherwise specified. Contractor shall be responsible to inform to the Consultant / Owner in case of any revision / re-affirmation / amendment in the relevant codes and standards after the date of award of contract within 30 days of the issue of such revision / re-affirm/amendment of the code / standard. Consultant / Owner may approve use of the earlier code / standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed.				

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SPEC. NO. TCE.M4-185-32	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR CENTRIFUGAL PUMP	SHEET 1 OF 2

Sr. No.	Stage / component	Inspection / test	Extent of inspection	Inspection category
1.0	<u>RAW MATERIALS</u>			
1.1	<u>Casting</u>			
1.1.1	Impellers			
a)	Properties as per specification	Material test certificates	100%	C
b)	Heat treatment	HT charts	100%	C
c)	Sea water application (Austenitic stainless steel)	IGC test and microstructure as per ASTM A 262 Practice E	One per heat	C
d)	NDT	NDT-RT	100% coverage (as per design standard)	C
1.1.2	Wearing Rings	Material test certificates	100%	C
1.1.3	Sealing Rings	Material test certificates	100%	C
1.1.4	Diffuser and Casing	Material test certificates	100%	C
1.2	<u>Forgings</u>			
1.2.1	Impeller			
a)	Properties as per specification	Material Test Certificates	100%	C
b)	NDT	PT/MT	100%	C
c)	For Sea Water Application (austenitic stainless steel)	IGC test and microstructure as per ASTM A 262 Practice E	Per heat /HT batch	C
1.2.2	Shaft	Material Test Certificates	100%	C
		UT of Shaft (for > 50 mm dia.)	100%	C
2.0	<u>INPROCESS CONTROL</u>			
2.1	Casing	a) PT on Machined Area	100%	C
		b) Hydro Test	100%	B
2.2	Shafts	a) PT after Machining	100%	C
		b) Run-out check	100%	B
2.3	Impellers	a) PT after Machining	100%	C
		b) Dynamic Balancing	100%	B
2.4	<u>Motors</u>			
2.4.1	For motors > 30KW	a) Type test	100%	C
		b) Routine test	100%	C
3.0	<u>FINAL INSPECTION</u>			
3.1	Performance test	a) Performance Test- Q Vs. Head, Q Vs efficiency & Q Vs. Power	100%	A
		b) Noise Level Check	100%	A
		c) Vibrations Check	100%	A
		d) Paint check (DFT)	Random	C
		e) Dimensional Check	100%	C

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**ISSUE
R7**

SPEC. NO. TCE.M4-185-38	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR POWER PLANT PIPING (NON IBR)		SHEET 1 OF 3	

1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	Pipes	Material test certificates verification	Each heat	C
1.1.1		Hydrostatic test at shop/mill or UT for > 3.2 mm thk./ ECT <=3.2 mm thk	100%	C
1.2	<u>INPROCESS CONTROL</u>			
1.2.1	Welding	WPS, PQR,WPQ review	100%	C
1.2.2	Bends	Heat treatment chart review as per ASME B 31.1	100%	C
1.2.3		Bend Area MT & Thickness measurement	10%	C
1.2.4	Weld ends	Visual inspection		C
		MT/PT	10%	C
1.2.5	Finished weld			
1.2.5.1	Piping with design pressure >17.6 kg/cm ² (g) or design temp. > 218°C : [including HP RO plant lines]	Butt welds > 100 NB	100% RT & 100% MT/PT	A
1.2.5.2		Butt welds ≤ 100 NB	10% RT & 10% MT/PT	A
1.2.5.3		Alloy Steel Nozzle & Branch welds for size > 100 NB	100% RT/UT & 100% MT/PT	A
1.2.5.4		Carbon Steel Nozzle & Branch welds for size > 100 NB & thk > 19mm	100% UT & 100% MT/PT	B
1.2.5.5		All other attachment welds	10% MT/PT	B
1.2.6	Piping with design temp. ≤ 218°C and Design Pressure ≤ 17.6 kg/cm ² (g) ; Piping under Vacuum (including Cooling Water Line, Instrument Air, Service Air & Miscellaneous Water Lines)	Circum to longitudinal weld joint [T] intersections	100% RT	A
1.2.6.1		Mitre bends and Butt welds > 100 NB	10% RT & 10% MT/PT	A

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ISSUE R6

FILE NAME: F-329-Rev-R6.docx

TCE FORM NO. 329 R6

SPEC. NO. TCE.M4-185-38	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR POWER PLANT PIPING (NON IBR)		SHEET 2 OF 3	

1.2.6.2		All other attachment welds MT/PT	10%	C
1.2.7	LP Piping			
1.2.7.1	Mitre Bends	Visual inspection for profile and surface defect	100%	C
1.2.7.2		Butt weld	10% (including Tee joints)	C
1.2.7.3	Rolled and welded Pipe spool	Butt joint-Circumferential weld	10%RT	C
1.2.7.4		Butt joint - Longitudinal weld	10%RT	C
1.2.7.5	Pipe fabrication	Butt joint	10%RT	C
1.2.7.6		Fillet joint	10% MT/LPT	C
1.2.7.7		Dimensional check	10%	B
3.0	<u>STANDARDS:</u>			
	Materials	As per material specification		
	Welding	As per ASME BPVC		
	Non-Destructive Testing	As per ASME BPVC		
	Dimensional Tolerance	As per Drawing		
	Design, Fabrication	ASME BPVC Sec VIII Div 1 / API 662		
	Testing	ASME BPVC Sec VIII Div 1 / API 662		
	Structure Fabrication	AWS D 1.1		
4.0	<u>INSPECTION CATEGORY:</u>			
	A - Witness by TCE / Inspection agency & Purchaser			
	B - Witness by TCE / Inspection agency at the discretion of Purchaser			
	C - Certificates review by TCE / Inspection agency / Purchaser			
5.0	<u>ABBREVIATIONS:</u>			
	ASME - American Society of Mechanical Engineers			
	API - American Petroleum Institute			
	AWS - American Welding Society			
	DFT - Dry Film Thickness			
	HT - Heat treatment			
	MT - Magnetic Particle Testing			
	PQR - Procedure Qualification Record			
	PT - Liquid Penetrant Testing			
	RT - Radiographic Testing			
	UT - Ultrasonic Testing			
	WPQ - Welder Performance Qualification			
	WPS - Welding Procedure Specification			

**ISSUE
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SPEC. NO. TCE.M4-185-38	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR POWER PLANT PIPING (NON IBR)	SHEET 3 OF 3

The codes and standards mentioned in the various specifications and requirements specified in the enquiry document shall be latest as on the day of award of contract of the works unless otherwise specified. Contractor shall be responsible to inform to the Consultant / Owner in case of any revision / re-affirmation / amendment in the relevant codes and standards after the date of award of contract within 30 days of the issue of such revision / re-affirm/amendment of the code / standard. Consultant / Owner may approve use of the earlier code / standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed.

ISSUE
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SPEC. NO. TCE.M4-185-45	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR GEAR BOX	SHEET 1 OF 2

1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	<u>GEAR BLANKS</u>			
1.1.1	Properties as per specification	Material test certificates	one/heat	C
1.1.2	Heat treatment	HT report	100%	C
1.1.3	NDT	UT	100%	C
1.1.4	Gear tooth	PT	100%	C
1.1.5	Hardened and ground gears	Hardness Check, Case depth	100%	C
1.2	<u>PLATES for FABRICATION</u>			
1.2.1	Properties as per specification	Material test certificates	One /heat	C
1.2.2	NDT	UT for thickness > 25mm	100%	C
1.3	<u>CASTING</u>			
1.3.1	Properties as per specification	Material test certificates	One /heat	C
1.3.2	NDT	MT	100%	C
1.3.3	Heat treatment	HT charts	100%	C
1.4	<u>SHAFT</u>			
1.4.1	Properties as per specification	Material test certificates	01/heat	C
1.4.2	Heat treatment	HT report	100%	C
1.4.3	NDT if dia >= 50 mm	UT	100%	C
2.0	<u>INPROCESS CONTROL</u>			
2.1	Welding qualification records	WPS, PQR, WPQ	100%	C
2.2	Shaft Machined surface	PT	100%	C
2.3	Butt welds	UT / RT - Film review	100%	C
2.4	All welds	MT for magnetic materials PT for non-magnetic materials	100%	C
2.5	PWHT	HT chart	100%	C
2.6	Dimensional conformity	As per drawing	100%	C
2.7	Leak tightness of casing	Hydrostatic test	100%	C
2.8	Shaft assembly	Run out and Dynamic balancing	100%	C
2.9	Gear Box assembly	Bearing clearance, Backlash, Gear tooth contact, Axial clearance,	100%	B

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R 6**

SPEC. NO. TCE.M4-185-45	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR GEAR BOX		SHEET 2 OF 2	

3.0	<u>FINAL INSPECTION</u>			
3.1	Mechanical Run test	Noise level, Vibration, Oil pressure, Bearing temperature rise	100%	A
3.2	Dimensional conformity	As per drawing	100%	A
3.3	Paint Check	Appearance & DFT	100%	C
3.4	Documentation review	As per stage inspection records	100%	C
4.0	<u>STANDARDS:</u>			
	Materials	As per material specification		
	Welding	As per ASME BPVC		
	Non-Destructive Testing	As per ASME BPVC		
	Dimensional Tolerance	As per Drawing		
	Dynamic Balancing	As per ISO 1940		
	Noise Level	Max. 85 dB at 1.0 m distance		
	Vibration	ISO 10816-part 3		
5.0	<u>INSPECTION CATEGORY:</u>			
	A - Witness by TCE & Purchaser			
	B - Witness by TCE at the discretion of Purchaser			
	C - Certificates review by TCE / Purchaser			
6.0	<u>ABBREVIATIONS:</u>			
	ASME - American Society of Mechanical Engineers			
	DFT - Dry Film Thickness			
	HT - Heat treatment			
	MT - Magnetic Particle Testing			
	PQR - Procedure Qualification Record			
	PT - Liquid Penetrant Testing			
	PWHT - Post Welding Heat Treatment			
	RT - Radiographic Testing			
	UT - Ultrasonic Testing			
	WPQ - Welder Performance Qualification			
	WPS - Welding Procedure Specification			
7.0	<u>NOTES:</u>			
7.1	Weld repair of Cast Iron / Ductile Iron casting is not acceptable			

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SPEC. NO. TCE.M4-185-53	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR CONTROL VALVES	SHEET 1 OF 2

1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	<u>CASTINGS</u>			
1.1.1	Properties as per specification	Material test certificates	One /heat	C
1.1.2	Carbon steel and stainless-steel valves of 600 class and greater & Alloy steel valves of all class	RT - Film review	100%	C
1.1.3	Heat treatment	HT charts	100%	C
1.1.4	NDT	MT - Magnetic materials / PT - Non-Magnetic materials	100%	C
1.2	<u>FORGINGS</u>			
1.2.1	Properties as per specification	Material test certificates	One /heat	C
1.2.2	Heat treatment	HT report	100%	C
1.2.3	NDT for all valves	MT - Magnetic materials / PT - Non-Magnetic materials	100%	C
1.2.4	NDT for valves 1500 class and above	UT	100%	C
1.3	<u>STEM</u>			
1.3.1	Properties as per specification	Material test certificates	One /heat	C
1.3.2	Heat treatment	HT report	100%	C
1.3.3	NDT if dia >= 50 mm	UT	100%	C
1.4	<u>DIAPHRAGM</u>			
1.4.1	Properties as per specification	Material test certificates	One /heat	C
1.4.2	Hardness test	Test report	Random	C
1.4.3	Endurance test	Type test report	per size per type	C
1.5	Electrical / Pneumatic / Hydraulic actuators	Supplier test certificate	100%	C
1.6	Springs	Material test certificates, spring constant, scragging test	100%	C
2.0	<u>INPROCESS CONTROL</u>			
2.1	Welding & Hard facing qualification records	WPS, PQR, WPQ	100%	C

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ISSUE
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SPEC. NO. TCE.M4-185-53		TATA CONSULTING ENGINEERS LIMITED		SECTION:	
		MINIMUM INSPECTION REQUIREMENTS FOR CONTROL VALVES		SHEET 2 OF 3	

2.2	Butt welds	UT / RT - Film review	100%	C
2.3	Fillet welds	MT / PT	100%	C
2.4	PWHT	HT chart	100%	C
2.5	Hardness of welds – see Notes	Hardness test	Each	C
2.6	Stem and gland sealing area	Visual, dimensional inspection and surface finish	10%	C
2.7	Seat & Backseat	Hardness test	On test coupon	C
2.8	Seat face, Hard faced areas & machined surfaces	PT	100%	C
3.0	<u>FINAL INSPECTION</u>			
3.1	Body Leak tightness	Hydrotest	100%	A
3.2	Seat tightness	Hydrostatic seat leak test / Pneumatic seat leak test	100%	A
3.3	Actuator	Actuator leak test	100%	A
3.4	Performance test	Hysteresis, Repeatability, dead band, linearity, Sensitivity, accuracy, operating time, fail safe position, flow direction	100%	A
		Cv test (see notes)	Per size per type	A
3.5	Accessories	Performance test	100%	A
3.6	Dimensional conformity	Critical Dimensions	100%	A
3.7	Paint Check	Appearance & DFT	100%	C
3.8	Documentation review	As per stage inspection records	100%	C
4.0	<u>STANDARDS:</u>			
	Materials	As per material specification		
	Welding	As per ASME BPVC, IBR		
	Non-Destructive Testing	As per ASME BPVC, IBR		
	Dimensional Tolerance	As per Valve Design standard		

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SPEC. NO. TCE.M4-185-64	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR GEAR AND SCREW PUMPS		SHEET 1 OF 3	

1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	<u>CASTING</u>			
1.1.1	Properties as per specification	Material test certificates	100%	C
1.1.2	NDT	MT	100%	C
1.2	<u>FORGING</u>			
1.2.1	Properties as per specification	Material test certificates	100%	C
1.2.2	NDT	UT	100%	C
1.3	<u>PLATES</u>			
1.3.1	Properties as per specification	Material test certificates	100%	C
1.3.2	NDT	UT	100%	C
1.4	<u>PIPES & TUBES</u>			
1.4.1	Properties as per specification	Material test certificates	100%	C
1.4.2	NDT	UT	100%	C
1.5	Coupling	Supplier certificate	100%	C
2.0	<u>INPROCESS CONTROL</u>			
2.1	<u>CASINGS</u>			
2.1.1	Machined areas	PT	100%	C
2.1.4	Leak tightness	Hydrostatic test	100%	C
2.2	<u>SCREWS & GEARS</u>			
2.2.1	Surface Hardness	Measurement	each	C
2.2.2	Machined surface	PT	100%	C
2.3	<u>SHAFT</u>			
2.3.1	Machined areas	PT	100%	C
2.3.2	Ovality	Run-out check	100%	C
2.4	<u>ROTOR</u>			
2.4.1	Unbalance correction	Dynamic Balancing	100%	C
2.5	<u>MOTORS</u>			
2.5.1	For motors > 30KW	Type test	100%	C
		Routine test	100%	A
2.5.2	For motors <= 30KW	Routine test	100%	C

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ISSUE R6

SPEC. NO. TCE.M4-185-64	TATA CONSULTING ENGINEERS LIMITED			SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR GEAR AND SCREW PUMPS			SHEET 2 OF 3

2.6	<u>ASSOCIATED PIPING</u>			
2.6.1	Welding Records	WPS, PQR & WPQ	100%	C
2.6.2	NDT on Welds	PT	10%	C
		Butt welds RT -Film review	10%	C
2.6.3	Leak tightness	Pneumatic testing	100%	C
3.0	<u>FINAL INSPECTION</u>			
3.1	Run test & Performance test	As per approved Characteristics	100%	A
3.2	Noise level check	Measurement	100%	A
3.3	Vibrations check	Measurement	100%	A
3.4	Dimensional check	Measurement	100%	A
3.5	Painting	Appearance & DFT	100%	C
3.6	Documentation review	As per stage inspection records.	100%	C
4.0	<u>STANDARDS</u>			
	Materials	As per material specification		
	Welding	As per ASME BPVC		
	Non-Destructive Testing	As per ASME BPVC		
	Dimensional Tolerance	As per Drawing		
	Dynamic Balancing	As per ISO 1940		
	Noise Level	Max. 85 dB at 1.0 m distance		
	Vibration	ISO 10816		
	Performance test	IS 10069 / ISO 4409		
5.0	<u>INSPECTION CATEGORY</u>			
	A - Witness by Purchaser & Inspection Agency			
	B - Witness at the discretion of Purchaser / Inspection Agency			
	C - Certificates review by Purchaser / Inspection Agency			
6.0	<u>ABBREVIATIONS</u>			
	ASME - American Society of Mechanical Engineers			
	API - American Petroleum Institute			
	DFT - Dry Film Thickness			
	HT - Heat treatment			
	MT - Magnetic Particle Testing			
	PQR - Procedure Qualification Record			

ISSUE
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SPEC. NO. TCE.M4-185-64	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR GEAR AND SCREW PUMPS	SHEET 3 OF 3

PT - Liquid Penetrant Testing
PWHT - Post Welding Heat Treatment
RT - Radiographic Testing
UT - Ultrasonic Testing
WPQ - Welder Performance Qualification
WPS - Welding Procedure Specification

7.0 **NOTES**

1. Weld repair of Steel castings shall be documented. All major repairs shall be with Purchaser's concurrence.
2. Plugging / Weld repair of Cast Iron / Ductile Iron castings not permitted.

ISSUE
R6

SPEC. NO. TCE.M4-185-91	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR LUBE OIL CENTRIFUGE	SHEET 1 OF 2

1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	Bowl body, bowl, hood, top disc, bowl, Spindle, horizontal shaft, impeller, pump Housing, heater tubes, gear, screws, Valve body, all rotating parts, etc.	Material test certificates	100%	C
	Pipe, tube material	Material test certificates	100%	C
1.2	Bought-outs			
1.2.1	Pressure gauges, Temperature Indicator, flow Meter, level witch, Level gauge, motor etc.	Manufacturer test certificate.	100%	C
1.2.2	Strainer	Hydro test	100%	C
2.0	<u>INPROCESS CONTROL</u>			
2.1	Welding qualification records	WPS, PQR, WPQ	100%	C
2.2	NDT	PT	10%	C
		RT	10%	C
2.3	Rotating parts	Dynamic Balancing test	100%	C
3.0	<u>FINAL INSPECTION</u>			
3.1	Functional test	Visual and dimensional	100%	A
		Capacity testing	Measurement	A
3.2	Mechanical run test	Moisture content in oil before & after separation	100%	A
		Particle size at inlet & outlet of centrifuge (as per ISO 4406)	100%	A
		Noise level, Vibrations,	100%	A
		Vapor tightness	Measurement	A
		System interlocks and alarm	100%	A
3.3	Paint Check	Paint thickness, identification	100%	C

FILE NAME: M4-185-91-Rev-R2

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ISSUE
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SPEC. NO. TCE.M4-185-15	TATA CONSULTING ENGINEERS LIMITED			SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR BOILER STRUCTURES			SHEET 1 OF 2

1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	Plates, Rolled Sections and. Circular Hollow Section	Material test certificates.	100%	C
1.2	Plates > 40 mm thickness	UT as per ASTM SA 578, Level B	100%	C
2.0	<u>INPROCESS CONTROL</u>			
2.1	Welding qualification records	WPS, PQR, WPQ	100%	C
2.2	Gas cut edges > 36 mm thick	PT	100%	C
2.4	Butt Welds:			
2.4.1	Welds > 25 mm	MT/PT	100%	C
2.4.2	Weld thickness of Carbon steel > 32 m	RT Film review	100%	C
2.5	Fillet Welds:			
2.5.1	Both plates are > 25 mm thick	MT/PT	10%	C
2.5.2	Fillet welds between tension flanges and webs	MT/PT	10%	C
2.6.0	PWHT for Carbon steel $\geq$ 50 mm thick and Alloy steel plates of all thickness	HT charts	100%	C
2.6.1	Lifting lugs	MT/PT	100%	C
2.6.2	Alloy steel plates of all thickness	HT charts	100%	C
2.6.5	Test Coupon for Auto Welding only	Macro Etch Test	Sample	A
3.0	<u>FINAL INSPECTION</u>			
3.1	Final inspection of single piece, column, Beam, Bracing, Girder	Visual check Dimensional check	100% for ceiling girder	

FILE NAME: M4-185-15-Rev-R6

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ISSUE R 6

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TATA CONSULTING ENGINEERS LIMITED

MINIMUM INSPECTION REQUIREMENTS FOR BOILER STRUCTURES

SHEET 2 OF 2

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ISSUE
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SPEC. NO. TCE.M4-185-02	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR BOILER DRUM AND ONCE THROUGH BOILER SEPARATOR-STORAGE TANK	SHEET 1 OF 3

1.0	<u>MATERIALS</u>		<u>Quantum</u>	<u>Inspection category</u>
1.1	Plates	Material test certificates with IBR format	100%	C
		UT	100%	C
		Bend test	IBR	C
		Hot tensile test as per ASME SA 20, S7	1/ heat	C
1.2	Forgings	Material test certificates with IBR format	100%	C
		UT and MT	100%	C
1.3	Pipes	Material test certificates with IBR format	100%	C
		UT or Hydro test	100%	C
Note: IF CSEF pipe materials are used (for Separator and storage tank) then following tests shall be carried out: Product analysis, Transverse tension test, flattening test (pipes), Photomicrographs & Impact testing - Records shall be submitted for review				
2.0	<u>INPROCESS CONTROL</u>			
2.1	Dished ends			
2.1.1	Forming	Review of HT charts	100%	C
2.1.2	Inner & outer surface	MT	100%	C
2.1.3	Mechanical test	Tensile test & bend test	100%	C
2.2	Welding qualification records	WPS, PQR, WPQ	100%	C
		(For CSEF material, WPS, PQR and WPQ shall be qualified with Impact testing)		
2.3	Weld joints	Fit up	100%	C
2.4	NDT before PWHT - Butt welds	RT - Film Review	100%	C
2.5	Welding process records	Preheating, interpass, post heating & PWHT charts (as applicable)	100%	C
2.6	Weld production test coupon	Mechanical test	IBR	C

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SPEC. NO. TCE.M4-185-02	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR BOILER DRUM AND ONCE THROUGH BOILER SEPARATOR-STORAGE TANK		SHEET 2 OF 3	

2.8	NDT after PWHT			
2.8.1	Butt joints & Full throat Nozzle	UT & MT	100%	A
2.8.2	Other attachment welds	MT	100%	A
2.9	Alloy steel Separators	Hardness test	random	A
		PMI of material used	100%	A
3.0	<u>FINAL INSPECTION</u>			
3.1	Leak tightness	Hydrostatic Test	100%	A
3.2	Internal Assembly	Leak tightness test of separating chamber/shroud assembly (as per drawing)	100%	A
3.3	Dimensional check	Ovality, Thickness, ID, Length, Nozzle orientation	100%	A
3.4	Expansion holes (if applicable)	Check for hole ID, hole finish, pitch, expansion procedure	100%	A
3.5	Pre-dispatch Check	Check for stamping details, finish painting, and end capping of stubs, axis marking, lifting location, and placing of silica gel.	100%	C
		Documentation review as per IBR/stage inspection records.	100%	C
4.0	STANDARDS:			
	Materials	IBR with applicable Material specifications, Approved Datasheets and Drawings		
	Welding	As per ASME Section-IX / IBR		
	Non-Destructive Testing	As per ASME BPVC/ IBR		
5.0	<u>INSPECTION CATEGORY:</u>			
	A - Witness by TCE & Purchaser			
	B - Witness by TCE at the discretion of Purchaser			
	C - Certificates review by TCE / Purchaser			

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SPEC. NO. TCE.M4-185-02	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR BOILER DRUM AND ONCE THROUGH BOILER SEPARATOR-STORAGE TANK	SHEET 3 OF 3

6.0

ABBREVIATIONS:

ASME - American Society of Mechanical Engineers

CSEF - Creep strength enhanced Ferritic Steels

HT- Heat Treatment

IBR - Indian Boiler Regulations

ID - Inner Diameter

MT - Magnetic Particle Testing

NDT - Non-Destructive Testing

OD - Outer Diameter

PMI - Positive Material Identification

PQR - Procedure Qualification Record

PT - Liquid Penetrant Testing

PWHT - Post Welding Heat Treatment

RT - Radiographic Testing

UT - Ultrasonic Testing

WPQ - Welder Performance Qualification

WPS - Welding Procedure Specification

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SPEC. NO. TCE.M4-185-10	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR AXIAL AND RADIAL FANS		SHEET 1 OF 3	

1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	Plates for Diffuser, Suction, impeller and fan casing			
1.1.1	Chemical & Mechanical Properties as per specification	Material test certificates	100%	C
1.1.2	NDT if thickness > 40 mm	UT	100%	C
1.2	Rotor Forging			
1.2.1	Chemical & Mechanical Properties as per specification	Material test certificates	100%	C
1.2.2	Heat treatment	Test report	100%	C
1.2.3	Hardness	Test report	100%	C
1.2.4	NDT	UT	100%	C
1.3	Hub			
1.3.1	Chemical & Mechanical Properties as per specification	Material test certificates	100%	C
1.3.2	NDT	UT	100%	C
1.3.3	Post Weld Heat Treatment	Stress Relieving Chart	100%	C
1.3.4	NDT on welds (if applicable)	UT (for butt joint) & MT (for fillet welds)	100%	C
1.4	Blades			
1.4.1	Chemical & Mechanical Analysis for blade	Material test certificates	100%	C
1.4.2	Heat treatment	Test report	100%	C
1.4.3	Profile and dimensional check	Measurement	100%	C
1.4.4	NDT, as applicable	RT / UT and MT	100%	C
1.4.5	Hardness, as applicable	Test report	100%	C
1.5	Bearings and bearing housing			
1.5.1	Tightness test of housing	Hydrostatic test	100%	C
1.5.2	Spin Test	Hub spin test, operation test and temperature rise check	100%	A
1.6	Coupling			
1.6.1		Supplier certificate	100%	C
1.6.2		Dynamic balancing	100%	C
1.7	Motors			
1.7.1	For motors > 30KW	Type test	100%	C
1.7.2		Routine test	100%	A

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SPEC. NO. TCE.M4-185-10		TATA CONSULTING ENGINEERS LIMITED		SECTION:
		MINIMUM INSPECTION REQUIREMENTS FOR AXIAL AND RADIAL FANS		SHEET 2 OF 3
1.8	Hydraulic power unit:			
1.8.1		Leak tightness	100%	B
1.8.2		Run test	100%	B
1.8.3		Functional check of instruments	100%	B
1.9	Hydraulic Cylinder			
1.9.1		Manufacture test certificate	100%	C
2.0	<u>INPROCESS CONTROL</u>			
2.1	Welding qualification records	WPS, PQR, WPQ	100%	C
2.2	Casings			
2.2.1	Fillet weld	PT	10%	C
2.2.2	Butt welds, if any	RT - Film review	100%	C
2.2.3	Dimensional conformity	As per drawing	100%	C
2.3	Impeller			
2.3.1	Weld joints	MT / PT	100%	C
2.3.2	PWHT	HT Charts	100%	C
2.4	Blades			
2.4.1		Moment balancing of complete set of blades	100%	C
2.4.2		Natural Frequency test	100%	C
2.5	Rotor shaft			
2.5.1	Machined surface	PT	100%	C
2.5.2	Concentricity	Runout check	100%	B
2.6	Assembly			
2.6.1	Unbalance correction			
	• Hub	Dynamic balancing	100%	C
	• Blades + hub	Dynamic balancing	100%	C
	• Blades+ Hub + Rotor	Dynamic balancing	100%	A
3.0	<u>FINAL INSPECTION</u>			
3.1	Variable pitch mechanism	Blade tilting & actuator stroke measurement	100%	A
3.2	Trial assembly	Tip clearance check	100%	A
3.3	IGV (as applicable)	Operation test	100%	A
3.4	Assembled fan			
3.4.1		Mechanical run test	100%	A
3.4.2		Performance test	100%	A
		• Flow VS Static pressure		
		• Flow VS efficiency		
		• Flow VS power		

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SPEC. NO. TCE.M4-185-10	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR AXIAL AND RADIAL FANS		SHEET 3 OF 3	

3.5	Paint Check	Appearance & DFT	100%	C
3.6	Documentation review	As per stage inspection records.	100%	C
4.0	<u>STANDARDS:</u>			
	Materials	As per material specification		
	Welding	As per ASME BPVC		
	Non-Destructive Testing	As per ASME BPVC		
	Dimensional Tolerance	As per Drawing		
	Dynamic Balancing	As per ISO 1940		
	Noise Level	Max. 85 dB at 1.0 m distance		
	Vibration	ISO 10816		
	Design, Fabrication, Run Test	AMCA		
5.0	<u>INSPECTION CATEGORY:</u>			
	A - Witness by TCE & Purchaser			
	B - Witness by TCE at the discretion of Purchaser			
	C - Certificates review by TCE / Purchaser			
6.0	<u>ABBREVIATIONS:</u>			
	ASME - American Society of Mechanical Engineers			
	DFT - Dry Film Thickness			
	HT - Heat treatment			
	MT - Magnetic Particle Testing			
	PQR - Procedure Qualification Record			
	PT - Liquid Penetrant Testing			
	PWHT - Post Welding Heat Treatment			
	RT - Radiographic Testing			
	UT - Ultrasonic Testing			
	WPQ - Welder Performance Qualification			
	WPS - Welding Procedure Specification			
	ASME - American Society of Mechanical Engineers			

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SPEC. NO. TCE.M4-185-11	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR AIR-PREHEATER		SHEET 1 OF 3	

1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	<u>Plates</u>			
1.1.1	Properties as per specification	Material test certificates	100%	C
1.1.2	NDT if thickness > 40 mm	UT	100%	C
1.2	<u>Forgings</u>			
1.2.1	Properties as per specification	Material test certificates	100%	C
1.2.2	Heat treatment	HT report	100%	C
1.2.3	NDT	UT & (MT/PT)	100%	C
1.3	<u>Casting</u>			
1.3.1	Properties as per specification	Material test certificates	100%	C
1.3.2	NDT	MT / PT	100%	C
1.3.3	Heat treatment	HT charts	100%	C
1.4	Bearings (Guide & Support)	Supplier certificate review	100%	C
1.5	<u>Gear reducer</u>			
1.5.1	Forging Pinion & Gear blanks	NDT-UT	100%	C
		Teeth Contact – blue matching	100%	C
1.5.2	Gear tooth	Hardness	100%	C
1.5.3	Motors	Type test	100%	C
		Routine test	100%	C
1.6	Basket Heating element	Chemical composition	100%	C
1.7	Air motor	Supplier certificate	100%	C
1.8	Lube oil system (pump, motor, cooler, tanks)	Supplier certificates	100%	C
2.0	<u>In-process control</u>			
2.1	Welding qualification records	WPS, PQR, WPQ	100%	C
2.2	<u>NDT:</u>			
2.2.1	Butt Welds of rotor post shell	RT / UT- RT Film review	100%	C
		MT/PT	100%	C
2.2.2	Diaphragm plate to rotor post welding	PT	100%	C

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SPEC. NO. TCE.M4-185-11	TATA CONSULTING ENGINEERS LIMITED			SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR AIR-PREHEATER			SHEET 2 OF 3

2.2.3	Other weld joints	PT	10%	C
2.2.4	Machined surfaces	PT	10%	C
2.3	<u>Heat treatment:</u>			
2.3.1	Inner rotor	HT chart	100%	C
2.3.2	Bearing housing (support and guide)	HT chart	100%	C
2.4	Bearing housing	Pressure test	100%	C
3.0	<u>FINAL INSPECTION</u>			
3.1	Rotor drive assembly (Gear reducer)	Run test	100%	A
3.2	Trial assembly of Rotor segments	Visual and Dimensional	100%	A
3.3	Heating element baskets trial assembly	Visual	10 %	A
3.4	Controls	Functional test	100%	A
3.5	Paint Check	Appearance & DFT	100%	C
3.6	Documentation review	As per stage inspection records.	100%	C
<u>B. RECUPERATIVE (TUBULAR) AIR PREHEATER</u>				
1.0	<u>Materials</u>		Quantum	Inspection category
1.1	Sheets, Plates, Strips & Rolled Sections	Material test certificates	100%	C
1.2	Plates > 40 mm thickness	UT	100%	C
1.3	<u>Pipes & tubes</u>			
1.3.1	Properties as per specification	Material test certificates	100%	C
1.3.2	NDT	UT	100%	C
1.3.3	Leak tightness	Hydrostatic test	100%	C
2.0	<u>In-process control</u>			
2.1	Welding qualification records	WPS, PQR, WPQ	100%	C

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SPEC. NO. TCE.M4-185-11		TATA CONSULTING ENGINEERS LIMITED		SECTION:	
		MINIMUM INSPECTION REQUIREMENTS FOR AIR-PREHEATER		SHEET 3 OF 3	

2.2	NDT of welds	MT/PT	10%	B
2.3	Mock-up test of Tube to tube sheet Joint	% tube Thinning, Hammer test, Kerosene leak test	per type / fabricator	A
2.4	Tube sheet	Tube sheet drilling, surface finish of drilled holes and dimensional check	10%	B
2.5	Tube fixing in the tube sheet and tube expansion	Tube projection beyond tube sheet face, % Thinning check, Hammer test	Random 10%	A
3.0	<u>Final inspection</u>			
3.1	Visual Inspection	Dimension, Weld quality, workmanship	100%	A
3.2	Paint Check	Appearance & DFT	100%	C
3.3	Documentation review	As per stage inspection records.	100%	C
4.0	<u>Standards:</u>			
	Materials	As per material specification		
	Welding	As per ASME BPVC/AWS		
	Non-Destructive Testing	As per ASME BPVC		
	Dimensional Tolerance	As per Drawing		
5.0	<u>Inspection category:</u>			
	A - Witness by TCE & Purchaser			
	B - Witness by TCE at the discretion of Purchaser			
	C - Certificates review by TCE / Purchaser			
6.0	<u>Abbreviations:</u>			
	ASME - American Society of Mechanical Engineers			
	DFT - Dry Film Thickness			
	HT - Heat treatment			
	MT - Magnetic Particle Testing			
	PQR - Procedure Qualification Record			
	PT - Liquid Penetrant Testing			
	RT - Radiographic Testing			
	UT - Ultrasonic Testing			
	WPQ - Welder Performance Qualification			
	WPS - Welding Procedure Specification			

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SPEC. NO. TCE.M4-185-08	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR SOOTBLOWERS AND THERMOPROBE	SHEET 1 OF 2

1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	Lance Tubes, Flanges, Nozzle, Valve, Nozzle, Feed tube, Probe Tube (for Thermo probe)	Material test certificates	100%	C
1.2	Lance tube and Feed tube	UT Hydrostatic test	100%	C
1.3	Valve	Hydro test for body and seat	100%	C
		RT above # 600 class	100%	C
		Hardness test on Gr. 91 castings	Each valve	C
1.4	Motor	Routine test	100%	C
1.5	Gear Box & Travelling carriage	Run test	100%	C
2.0	<u>INPROCESS CONTROL</u>			
2.1	Welding qualification records	WPS, PQR, WPQ	100%	C
2.2	Butt Welds	RT/ UT	100%	C
2.3	Nozzle / Flange Welds	PT	100%	C
3.0	<u>FINAL INSPECTION</u>			
3.1	Leak tightness of valve	Hydrostatic Test & Seat leak test	100%	A
3.2	Soot blower assembly run test (including Power Pack, Traveling Carriage Assembly, Rack Gear Housing, Gear Box drawn Clutch Assemblies)	- Smooth movement, - valve open/close time & operation, - Current Drawn	100%	A
3.2.1	Thermo probe operation check	Run test	100%	A

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SPEC. NO. TCE.M4-185-08	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR SOOTBLOWERS AND THERMOPROBE	SHEET 2 OF 2

3.3	Paint Check	Appearance & DFT	100%	B
3.4	Documentation review	As per stage inspection records.	100%	C
4.0	<u>STANDARDS:</u>			
	Materials	As per applicable Material specifications, Approved Datasheets and Drawings		
	Welding	As per ASME BPVC/IBR		
	Non-Destructive Testing	As per ASME BPVC/IBR		

5.0 **INSPECTION CATEGORY:**

- A - Witness by TCE & Purchaser
B - Witness by TCE at the discretion of Purchaser
C - Certificates review by TCE / Purchaser

6.0 **ABBREVIATIONS:**

DFT - Dry Film Thickness
HI - Hydraulic Institute
HT - Heat treatment
PQR - Procedure Qualification Record
PT - Liquid Penetrant Testing
PWHT - Post Welding Heat Treatment
RT - Radiographic Testing
UT - Ultrasonic Testing
WPQ - Welder Performance Qualification
WPS - Welding Procedure Specification

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SPEC. NO. TCE.M4-185-25	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR DEAERATOR & PRESSURE VESSEL		SHEET 1 OF 2	

1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	<u>PLATES</u>			
1.1.1	Properties as per specification	Material test certificates	100%	C
1.1.2	NDT	UT	100%	C
1.2	<u>PIPES</u>			
1.2.1	Properties as per specification	Material test certificates	100%	C
1.2.2	NDT	UT (ECT if thickness < 3.6 mm)	100%	C
1.2.3	Leak tightness	Hydrostatic test	100%	C
1.3	<u>DISHED ENDS</u>			
1.3.1	Properties as per specification	Material test certificates	100%	C
1.3.2	Heat Treatment	HT chart review	100%	C
1.3.3	Dimension check	Thickness, ovality check	100%	C
1.3.4	Knuckle portion and weld edges	PT	100%	C
1.3.5	Butt welded joints, if any	RT Film review	100%	C
1.4	<u>NOZZLES</u>			
1.4.1	Properties as per specification	Material test certificates	100%	C
1.4.2	NDT	UT (for forging) & MT	100%	C
1.5	Tray Assemblies	Material test certificates	100%	C
1.6	Spray Valves	test certificates	100%	C
2.0	<u>INPROCESS CONTROL</u>			
2.1	Welding qualification records	WPS, PQR, WPQ	100%	C
2.2	Longitudinal & circumferential butt joints	RT Film review	See Notes	C
2.3	All weld joints	PT	100%	C
2.4	Post Welding Heat treatment, See notes	HT chart review	100%	C
2.5	Assembly of deaerator and storage tank	Trial assembly or Matching of fixture with nozzles of heater and Storage tank	per set	A
3.0	<u>FINAL INSPECTION</u>			
3.1	RF pad welds	Pneumatic test	100%	B

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FILE NAME: F-329-Rev-R7.docx

TCE FORM NO. 329 R7

SPEC. NO. TCE.M4-185-25	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR DEAERATOR & PRESSURE VESSEL		SHEET 2 OF 2	

3.2	Leak tightness	Hydrostatic test	100%	A
3.3	Dimensional conformity	As per drawing	100%	A
3.4	Paint Check	Appearance & DFT	100%	C
3.5	Documentation review	As per stage inspection records.	100%	C
4.0	<u>STANDARDS:</u>			
	Materials	Tubes: SA 213 / SA-688 -Shell, Tube-sheet etc. as per material specification		
	Welding	As per ASME BPVC, IBR, HEI		
	Non-Destructive Testing	As per ASME BPVC, IBR, HEI		
5.0	<u>INSPECTION CATEGORY:</u>			
	A - Witness by TCE / Inspection agency & Purchaser			
	B - Witness by TCE / Inspection agency at the discretion of Purchaser			
	C - Certificates review by TCE / Purchaser			
6.0	<u>ABBREVIATIONS:</u>			
	ASME - American Society of Mechanical Engineers			
	DFT - Dry Film Thickness			
	ECT - Eddy Current Testing			
	HEI - Heat Exchange Institute			
	HT - Heat treatment			
	IBR - Indian Boiler Regulations			
	ID - Internal Diameter			
	IGC - Intergranular corrosion			
	MT - Magnetic Particle Testing			
	PMI - Positive Material Identification			
	PQR - Procedure Qualification Record			
	PT - Liquid Penetrant Testing			
	PWHT - Post Welding Heat Treatment			
	RT - Radiographic Testing			
	TEMA - Tubular Exchanger Manufacturers Association			
	UT - Ultrasonic Testing			
	WPQ - Welder Performance Qualification			
	WPS - Welding Procedure Specification			
7.0	<u>NOTES:</u>			
	Deaerator: 100% RT for all butt joints,			
	Deaerator: All welds shall be Post Weld Heat treated irrespective of thickness. Soaking time and temperature shall be as per ASME Sec VIII Div. I.			
	Storage tank and Pressure vessels: RT % shall be as per design code			

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SPEC. NO. TCE.M4-185-06	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR BOILER FEED PUMP / BOILER FEED BOOSTER PUMP / CONDENSATE EXTRACTION PUMP	SHEET 1 OF 3

1.0	MATERIALS		Quantum	Inspection category
1.1	<u>CASTING</u>			
1.1.1	Properties as per specification	Material test certificates	100%	C
1.1.2	Heat treatment	HT records	100%	C
1.1.3	NDT	RT / UT	100%	C
		MT after proof machining (all accessible areas)	100%	C
1.2	<u>FORGING</u>			
1.2.1	Properties as per specification	Material test certificates	100%	C
1.2.2	Heat treatment	HT records	100%	C
1.2.3	NDT (after proof machining)	UT	100%	C
		MT	100%	C
1.3	Bearings, couplings	Supplier certificate	100%	C
1.4	<u>MOTORS</u>			
1.4.1	For motors > 30KW	Type test	100%	C
		Routine test	10%	A
1.4.2	For motors <= 30KW	Routine test	100%	C
2.0	<u>INPROCESS CONTROL</u>			
2.1	Welding qualification records	WPS, PQR, WPQ	100%	C
2.1.1	Overlaid areas	PT	100%	C
2.2	<u>CASINGS</u>			
2.2.1	Machined areas	PT	100%	C
2.2.2	Butt / Full penetration welds	RT - Film review / UT	100%	C
2.2.3	Other Welds	PT	100%	C
2.2.4	Heat treatment	HT chart	100%	C
2.2.5	Leak tightness	Hydrostatic test	100%	A
2.2.6	Dimensional conformity	As per drawing	100%	C
2.3	<u>IMPELLERS</u>			
2.3.1	Cast impellers	RT - Film review	100%	C
2.3.2	Unbalance correction	Dynamic Balancing	100%	C

FILE NAME: M4-185-06-Rev-R06

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**ISSUE
R6**

SPEC. NO. TCE.M4--185-06	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR BOILER FEED PUMP / BOILER FEED BOOSTER PUMP / CONDENSATE EXTRACTION PUMP		SHEET 2 OF 3	

2.4	<u>SHAFT</u>			
2.4.1	Machined areas	PT	100%	C
2.4.2	Ovality	Run-out check	100%	C
2.7	<u>ROTOR</u>			
2.7.1	Unbalance correction	Dynamic Balancing	100%	A
3.0	<u>FINAL INSPECTION</u>			
3.1	Clearance check	Visual and measurement	100%	B
3.2	Pump characteristics	Performance test	100%	A
		NPSH test	One / type	A
3.3	Noise level check	Measurement	100%	A
3.4	Vibrations check	Measurement	100%	A
3.5	Lube Oil Parameters	Pressure and Temperature	100%	A
3.6	Pump	Strip down test	100%	A
3.7	Paint Check	Appearance & DFT	100%	C
3.8	Documentation review	As per stage inspection records.	100%	C
4.0	<u>STANDARDS:</u>			
	Materials	Applicable Material specifications, Approved Datasheets and Drawings		
	Welding	As per ASME Section-IX		
	Non-Destructive Testing	As per ASME BPVC		
	Dimensional Tolerance	As per Drawing		
	Dynamic Balancing	As per ISO 1940		
	Performance test	HIS		
5.0	<u>INSPECTION CATEGORY:</u>			
	A - Witness by TCE & Purchaser			
	B - Witness by TCE at the discretion of Purchaser			
	C - Certificates review by TCE / Purchaser			

ISSUE R 06

SPEC. NO. TCE.M4--185-06	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR BOILER FEED PUMP / BOILER FEED BOOSTER PUMP / CONDENSATE EXTRACTION PUMP	SHEET 3 OF 3

6.0 ABBREVIATIONS:

ASME - American Society of Mechanical Engineers

DFT - Dry Film Thickness

HT - Heat treatment

MT - Magnetic Particle Testing

NDT - Non-Destructive Testing

NPSH - Net Positive Suction Head

PQR - Procedure Qualification Record

PT - Liquid Penetrate Testing

PWHT - Post Welding Heat Treatment

RT - Radiographic Testing

UT - Ultrasonic Testing

WPQ - Welder Performance Qualification

WPS - Welding Procedure Specification

ISSUE
R 06

SPEC NO. TCE.M4-185-33	TATA CONSULTING ENGINEERS LIMITED	SECTION: D
	MINIMUM INSPECTION REQUIREMENTS FOR DOSING PUMP	SHEET 1 OF 1

Sr. No.	Stage / component	Inspection / test	Extent of inspection	Inspection category
1.0	MATERIALS			
1.1	Raw materials (Head, worm shaft, worm gear and housing)	Chemical Properties	100%	C
		Mechanical Properties	100%	C
		Bar / forging > 50 mm dia. – UT	100%	C
2.0	IN PROCESS INSPECTION			
2.1	Casings	PT on machined area	100%	C
2.1.1		Hydro test	100%	C
2.2	Piston	PT on machined area	100%	C
2.3	Crank Shaft	PT after machining	100%	C
2.4	Motors	Routine Test	100%	C
2.5	Pulsation Damper	Pressure Test	100%	B
3.0	FINAL INSPECTION			
3.1	Performance test (Cap/stroke, Accuracy, Repeatability, linearity, Power drawn at 100% stroke)	Measurement @ 25%, 50%, 75% and 100% load	100%	A
3.2	Leak tightness	Hydrostatic test	100%	A
3.3	Noise level check	Measurement	100%	A
3.4	Vibrations check	Measurement	100%	A
3.5	Dimensional check	Measurement	100%	B
4.0	STANDARDS			
	Materials	As per Material specifications, Approved Datasheets and Drawings		
	Welding	As per ASME Section-IX		
	Non-Destructive Testing	As per ASME Section-V		
	Dimensional Tolerance	As per Drawing		
	Noise Level	Max. 85 dB at 1.0 m distance		
	Vibration	ISO 10816		
	Design, Fabrication and Test	API 675 / HI		
5.0	INSPECTION CATEGORY			
	A - Witness by TCE & Purchaser			
	B - Witness by TCE at the discretion of Purchaser			
	C - Certificates review by TCE / Purchaser			
6.0	ABBREVIATIONS			
	ASME - American Society of Mechanical Engineers			
	API - American Petroleum Institute			
	HI – Hydraulic Institute			
	PT - Liquid Penetrant Testing			

FILE NAME: M4-185-36-Rev-R7

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**ISSUE
R7**

SPEC. NO. TCE.M4-185-20	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR DAMPERS AND GATES		SHEET 1 OF 2	

1.0	<u>Materials</u>		Quantum	Inspection category
1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	Frame, Gate Plates, Blade Plates, Shafts	Material test certificates	100%	C
1.2	Rounds > dia. 50 mm	UT	100%	C
1.3	Seals	Material test certificates	100%	C
1.4	Gear Box	No load performance test	100%	C
1.5	Actuator (Electric / Pneumatic)	Manufacturer test certificate	100%	C
1.6	Seal Air Fan	Manufacturer test certificate	100%	C
		Performance Test	100%	B/C
2.0	<u>INPROCESS CONTROL</u>			
2.1	Welding qualification records	WPS, PQR, WPQ	100%	C
2.2	All weld joints	PT	10%	C
2.3	Butt joints in tension flange	RT Film Review	100%	C
2.4	Lifting lug welds	PT	100%	C
3.0	<u>FINAL INSPECTION</u>			
3.1	Gates	Seal tightness check (with feeler gauge)	100%	A
3.2	Damper Sealing efficiency	With seal air fan & Without seal air fan	100%	A
3.3	Trial operation	Smooth operation, Opening and closing time	100%	A
3.4	Paint check	Appearance & DFT	100%	C
3.5	Documentation review	As per stage inspection records.	100%	C

FILE NAME: M4-185-20-Rev-R06				
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[illegible]

SPEC. NO. TCE.M4-185-45	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR GEAR BOX	SHEET 1 OF 2

1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	<u>GEAR BLANKS</u>			
1.1.1	Properties as per specification	Material test certificates	one/heat	C
1.1.2	Heat treatment	HT report	100%	C
1.1.3	NDT	UT	100%	C
1.1.4	Gear tooth	PT	100%	C
1.1.5	Hardened and ground gears	Hardness Check, Case depth	100%	C
1.2	<u>PLATES for FABRICATION</u>			
1.2.1	Properties as per specification	Material test certificates	One /heat	C
1.2.2	NDT	UT for thickness > 25mm	100%	C
1.3	<u>CASTING</u>			
1.3.1	Properties as per specification	Material test certificates	One /heat	C
1.3.2	NDT	MT	100%	C
1.3.3	Heat treatment	HT charts	100%	C
1.4	<u>SHAFT</u>			
1.4.1	Properties as per specification	Material test certificates	01/heat	C
1.4.2	Heat treatment	HT report	100%	C
1.4.3	NDT if dia >= 50 mm	UT	100%	C
2.0	<u>INPROCESS CONTROL</u>			
2.1	Welding qualification records	WPS, PQR, WPQ	100%	C
2.2	Shaft Machined surface	PT	100%	C
2.3	Butt welds	UT / RT - Film review	100%	C
2.4	All welds	MT for magnetic materials PT for non-magnetic materials	100%	C
2.5	PWHT	HT chart	100%	C
2.6	Dimensional conformity	As per drawing	100%	C
2.7	Leak tightness of casing	Hydrostatic test	100%	C
2.8	Shaft assembly	Run out and Dynamic balancing	100%	C
2.9	Gear Box assembly	Bearing clearance, Backlash, Gear tooth contact, Axial clearance,	100%	B

FILE NAME: M4-185-45-Rev-R6

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**ISSUE
R 6**

SPEC. NO. TCE.M4-185-45	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR GEAR BOX		SHEET 2 OF 2	

3.0	<u>FINAL INSPECTION</u>			
3.1	Mechanical Run test	Noise level, Vibration, Oil pressure, Bearing temperature rise	100%	A
3.2	Dimensional conformity	As per drawing	100%	A
3.3	Paint Check	Appearance & DFT	100%	C
3.4	Documentation review	As per stage inspection records	100%	C
4.0	<u>STANDARDS:</u>			
	Materials	As per material specification		
	Welding	As per ASME BPVC		
	Non-Destructive Testing	As per ASME BPVC		
	Dimensional Tolerance	As per Drawing		
	Dynamic Balancing	As per ISO 1940		
	Noise Level	Max. 85 dB at 1.0 m distance		
	Vibration	ISO 10816-part 3		
5.0	<u>INSPECTION CATEGORY:</u>			
	A - Witness by TCE & Purchaser			
	B - Witness by TCE at the discretion of Purchaser			
	C - Certificates review by TCE / Purchaser			
6.0	<u>ABBREVIATIONS:</u>			
	ASME - American Society of Mechanical Engineers			
	DFT - Dry Film Thickness			
	HT - Heat treatment			
	MT - Magnetic Particle Testing			
	PQR - Procedure Qualification Record			
	PT - Liquid Penetrant Testing			
	PWHT - Post Welding Heat Treatment			
	RT - Radiographic Testing			
	UT - Ultrasonic Testing			
	WPQ - Welder Performance Qualification			
	WPS - Welding Procedure Specification			
7.0	<u>NOTES:</u>			
7.1	Weld repair of Cast Iron / Ductile Iron casting is not acceptable			

ISSUE
R 6

SPEC. NO. TCE.M4-185-64	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR GEAR AND SCREW PUMPS		SHEET 1 OF 3	

1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	<u>CASTING</u>			
1.1.1	Properties as per specification	Material test certificates	100%	C
1.1.2	NDT	MT	100%	C
1.2	<u>FORGING</u>			
1.2.1	Properties as per specification	Material test certificates	100%	C
1.2.2	NDT	UT	100%	C
1.3	<u>PLATES</u>			
1.3.1	Properties as per specification	Material test certificates	100%	C
1.3.2	NDT	UT	100%	C
1.4	<u>PIPES & TUBES</u>			
1.4.1	Properties as per specification	Material test certificates	100%	C
1.4.2	NDT	UT	100%	C
1.5	Coupling	Supplier certificate	100%	C
2.0	<u>INPROCESS CONTROL</u>			
2.1	<u>CASINGS</u>			
2.1.1	Machined areas	PT	100%	C
2.1.4	Leak tightness	Hydrostatic test	100%	C
2.2	<u>SCREWS & GEARS</u>			
2.2.1	Surface Hardness	Measurement	each	C
2.2.2	Machined surface	PT	100%	C
2.3	<u>SHAFT</u>			
2.3.1	Machined areas	PT	100%	C
2.3.2	Ovality	Run-out check	100%	C
2.4	<u>ROTOR</u>			
2.4.1	Unbalance correction	Dynamic Balancing	100%	C
2.5	<u>MOTORS</u>			
2.5.1	For motors > 30KW	Type test	100%	C
		Routine test	100%	A
2.5.2	For motors <= 30KW	Routine test	100%	C

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ISSUE R6

SPEC. NO. TCE.M4-185-64	TATA CONSULTING ENGINEERS LIMITED			SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR GEAR AND SCREW PUMPS			SHEET 2 OF 3

2.6	<u>ASSOCIATED PIPING</u>			
2.6.1	Welding Records	WPS, PQR & WPQ	100%	C
2.6.2	NDT on Welds	PT	10%	C
		Butt welds RT -Film review	10%	C
2.6.3	Leak tightness	Pneumatic testing	100%	C
3.0	<u>FINAL INSPECTION</u>			
3.1	Run test & Performance test	As per approved Characteristics	100%	A
3.2	Noise level check	Measurement	100%	A
3.3	Vibrations check	Measurement	100%	A
3.4	Dimensional check	Measurement	100%	A
3.5	Painting	Appearance & DFT	100%	C
3.6	Documentation review	As per stage inspection records.	100%	C
4.0	<u>STANDARDS</u>			
	Materials	As per material specification		
	Welding	As per ASME BPVC		
	Non-Destructive Testing	As per ASME BPVC		
	Dimensional Tolerance	As per Drawing		
	Dynamic Balancing	As per ISO 1940		
	Noise Level	Max. 85 dB at 1.0 m distance		
	Vibration	ISO 10816		
	Performance test	IS 10069 / ISO 4409		
5.0	<u>INSPECTION CATEGORY</u>			
	A - Witness by Purchaser & Inspection Agency			
	B - Witness at the discretion of Purchaser / Inspection Agency			
	C - Certificates review by Purchaser / Inspection Agency			
6.0	<u>ABBREVIATIONS</u>			
	ASME - American Society of Mechanical Engineers			
	API - American Petroleum Institute			
	DFT - Dry Film Thickness			
	HT - Heat treatment			
	MT - Magnetic Particle Testing			
	PQR - Procedure Qualification Record			

ISSUE
R6

SPEC. NO. TCE.M4-185-64	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR GEAR AND SCREW PUMPS	SHEET 3 OF 3

PT - Liquid Penetrant Testing
PWHT - Post Welding Heat Treatment
RT - Radiographic Testing
UT - Ultrasonic Testing
WPQ - Welder Performance Qualification
WPS - Welding Procedure Specification

7.0 **NOTES**

1. Weld repair of Steel castings shall be documented. All major repairs shall be with Purchaser's concurrence.
2. Plugging / Weld repair of Cast Iron / Ductile Iron castings not permitted.

ISSUE
R6

SPEC. NO. TCE.M4-185-49	TATA CONSULTING ENGINEERS LIMITED	SECTION: D
	MINIMUM INSPECTION REQUIREMENTS FOR ATMOSPHERIC TANK	SHEET 1 OF 2

<u>SR. NO.</u>	<u>STAGE / COMPONENT</u>	<u>RECORD FORMAT</u>	<u>EXTENT OF INSPECTION</u>	<u>INSPECTION CATEGORY</u>
1.0	<u>RAW MATERIALS</u>			
	Plates, Nozzle pipes, Forgings (Flanges and fittings), Sections, Bars	a) Chemical Composition & Mechanical Properties	100%	C
		b) UT for plates ≥ 25 mm thick	100%	C
2.0	<u>IN PROCESS INSPECTION</u>			
	Fit-ups	Bottom plates, Shell to bottom, Shell L.S and C.S, shell to roof, Nozzles to tank, roof curb angle fit-ups	100%	C
	Welding	a) Welding procedure & welder's performance qualification		C
		b) Butt welds 10% of total vertical seam length, 10% of total horizontal seam length and all T joints	RT	C
		c) Annular plates	10% RT	C
		d) Shell to Bottom plate - Kerosene Test	100%	B
3.0	<u>FINAL INSPECTION</u>			
		a) Reinforcement Pads – Pneumatic Test	100%	A
		b) Water fill test	100%	A
		c) Roof & Bottom – Vacuum / Pneumatic Test	100%	A
		d) Dimensional Check (Including roundness, verticality (plumb), peaking and banding Checks	100%	A
		e) PWHT	100%	C
		f) Surface Preparation and Painting – DFT	10%	C
4.0	<u>INSPECTION CATEGORY</u>			
	A - Witness by TCE & Purchaser			
	B - Witness by TCE at the discretion of Purchaser			
	C - Certificates review by TCE / Purchaser			

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**ISSUE
R6**

SPEC. NO. TCE.M4-185-49	TATA CONSULTING ENGINEERS LIMITED	SECTION: WRITE-UP
	MINIMUM INSPECTION REQUIREMENTS FOR ATMOSPHERIC TANK	SHEET 2 OF 2

5.0 **ABBREVIATIONS**

ASME - American Society of Mechanical Engineers

DFT - Dry Film Thickness

PWHT – Post Weld Heat treatment

MT - Magnetic Particle Testing

PT - Liquid Penetrant Testing

RT - Radiographic Testing

UT - Ultrasonic Testing

WPQ - Welder Performance Qualification

WPS - Welding Procedure Specification

PQR - Procedure Qualification Record

L.S – Longitudinal Seam

C.S – Circumferential Seam

6.0 **ACCEPTANCE NORMS:**

Materials

As per applicable material specifications

Welding

As per ASME Section-IX

Non-Destructive Testing

As per ASME Section -V/ API 650 / IS 803 / IS 805

ISSUE
R6

SPEC. NO. TCE.M4-185-19	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR EOT CRANES & HOISTS	SHEET 1 OF 3

1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	Plate for girder, End carriage trolley & gear box casing			
1.1.1	Properties as per specification	Material test certificates	100%	C
1.1.2	NDT if > 25 mm thick	UT	100%	C
1.2	Forging (CT wheels, LT wheels, shaft, gears etc.)			
1.2.1	Properties as per specification	Material test certificates	100%	C
1.2.2	Heat treatment	HT report	100%	C
1.2.3	NDT	UT & (MT/PT)	100%	C
1.2.4	Hardness	Test report	100%	C
1.3	Hook	Visual, chemical, Mechanical, hardness, Proof load test, UT after Proof load test, Permanent set after proof load test	100%	C
1.4	<u>CASTING</u>			
1.4.1	Properties as per specification	Material test certificates	100%	C
1.4.2	NDT	MT / PT	100%	C
1.4.4	Heat treatment	HT charts	100%	C
1.5	Wire rope, rails	Supplier certificate	100%	C
1.6	Rope drum	Dimensional, conformity, Chem. Properties, 100% RT & DP on weld seam if fabricated	100%	C
1.7	For motors > 30KW	Type test	100%	C
		Routine test	100%	A
	For motors <= 30KW	Routine test	100%	C
1.8	Control panel /Pendent	Routine tests, BOM, HV, IR, functional tests, etc.	100%	C
2.0	<u>INPROCESS CONTROL (AS APPLICABLE)</u>			
2.1	Welding qualification records.	WPS, PQR, WPQ	100%	C

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ISSUE
R06

SPEC. NO. TCE.M4-185-19		TATA CONSULTING ENGINEERS LIMITED		SECTION:
		MINIMUM INSPECTION REQUIREMENTS FOR EOT CRANES & HOISTS		SHEET 2 OF 3
2.2	<u>NDT:</u>			
2.2.1	Butt Welds in tension flanges, web plates	RT - Film review	100%	C
2.2.2	All Butt welds and Fillet welds between tension flanges and webs	PT	100%	C
2.2.3	All other welds	PT	10%	C
2.2.4	Machined surfaces (Wheels, Gears, Pinions, and Shaft etc.)	PT	100%	C
2.3	<u>HEAT TREATMENT:</u>			
2.3.1	Gears & wheels	Hardness check	each	C
2.3.2	Fabricated Gear box housing	HT charts	100%	C
2.3.3	Fabricated Rope drum	HT charts	100%	C
2.4	Gear Box	Gear Ratio, Back Lash NO load test run for 4 hours Check for Oil Leakage, Vibration, Noise Temp. Rise	100%	B
3.0	<u>FINAL INSPECTION</u>			
3.1	Visual Inspection	Oil leakage, Cross travel motion, wheel alignment, bolt hole alignment	100%	A
3.2	Dimensional Inspection	Dimension (span) level, edge clearance, Rail Gauge dimension, wheel base, alignment, Hook Approach, head room	100%	A
3.3	No load running, No Load Current of hoist & CT Motor panel & Pendant,	Measurement	100%	A
3.4	Full load Current at hoist and CT, Control with panel & Pendant,	Measurement	100%	A
3.5	Hoist and CT speed.	Measurement	100%	A
3.6	Full load and overload test for, Hoist & CT, control with panel & Pendant	Load test and deflection test	100%	A
3.7	Functioning of Hoist & C, brake application operation, Control with panel & Pendant & limit switch Operation	Functional check	100%	A

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SPEC. NO. TCE.M4-185-68	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR LP STRAINERS AND FILTERS	SHEET 1 OF 3

1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	<u>PLATES</u>			
1.1.1	Properties as per specification	Material test certificates	100%	C
1.1.2	Volumetric examination if thick > 25 mm	UT	100%	C
1.2	<u>PIPES</u>			
1.2.1	Properties as per specification	Material test certificates	100%	C
1.2.2	NDT	UT (ECT if thickness < 3.6 mm)	100%	C
1.2.3	Leak tightness	Hydrostatic test	100%	C
1.3	<u>DISHED ENDS</u>			
1.3.1	Properties as per specification	Material test certificates	100%	C
1.3.2	NDT before forming	UT	100%	C
1.3.3	Heat Treatment	HT chart review	100%	C
1.3.4	Dimension check	Thickness, ovality check	100%	C
1.3.5	Knuckle portion and weld edges	MT/PT	100%	C
1.3.6	Butt welded joints, if any	RT Film review	100%	C
1.4	<u>NOZZLES</u>			
1.4.1	Properties as per specification	Material test certificates	100%	C
1.4.2	NDT	UT & MT	100%	C
1.5	Strainer/ filtering media	Material test certificates, mesh size	100%	C
2.0	<u>INPROCESS CONTROL</u>			
2.1	Welding qualification records	WPS, PQR, WPQ	100%	C
2.2	NDT after back chipping	PT	100%	C
2.3	Longitudinal & circumferential butt joints	RT Film review	See Notes	C
2.4	All weld joints	MT/PT	100%	C
2.5	Post Welding Heat treatment, See notes	HT chart review	100%	C

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SPEC. NO. TCE.M4-185-68	TATA CONSULTING ENGINEERS LIMITED			SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR LP STRAINERS AND FILTERS			SHEET 2 OF 3

3.0	<u>FINAL INSPECTION</u>			
3.1	RF pad welds	Pneumatic test	100%	B
3.2	Leak tightness of shell	Hydrostatic test	100%	A
3.3	Change over valve	Seat leak test	100%	A
3.4	Pressure drop test	Across filter in clean & clogged condition	100%	A
3.5	Dimensional conformity	As per drawing	100%	A
3.6	Paint Check	Appearance & DFT	100%	C
3.7	Documentation review	As per stage inspection records.	100%	C
4.0	<u>STANDARDS:</u>			
	Materials	As per material specification		
	Welding	As per ASME BPVC		
	Non-Destructive Testing	As per ASME BPVC		
	Dimensional Tolerance	As per ASME BPVC		
5.0	<u>INSPECTION CATEGORY:</u>			
	A - Witness by TCE & Purchaser			
	B - Witness by TCE at the discretion of Purchaser			
	C - Certificates review by TCE / Purchaser			
6.0	<u>ABBREVIATIONS:</u>			
	ASME - American Society of Mechanical Engineers			
	DFT - Dry Film Thickness			
	ECT - Eddy Current Testing			
	HT - Heat treatment			
	MT - Magnetic Particle Testing			
	PQR - Procedure Qualification Record			
	PT - Liquid Penetrant Testing			
	ASME - American Society of Mechanical Engineers			
	DFT - Dry Film Thickness			
	ECT - Eddy Current Testing			

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SPEC. NO. TCE.M4-185-68	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR LP STRAINERS AND FILTERS	SHEET 3 OF 3

	HT - Heat treatment
	PWHT - Post Welding Heat Treatment
	RT - Radiographic Testing
	UT - Ultrasonic Testing
	WPQ - Welder Performance Qualification
	WPS - Welding Procedure Specification

7.0 NOTES:

PWHT, % of joints for RT shall be as per design code

The codes and standards mentioned in the various specifications and requirements specified in the enquiry document shall be latest as on the day of award of contract of the works unless otherwise specified. Contractor shall be responsible to inform to the Consultant / Owner in case of any revision / re-affirmation / amendment in the relevant codes and standards after the date of award of contract within 30 days of the issue of such revision / re-affirm/amendment of the code / standard. Consultant / Owner may approve use of the earlier code / standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed.

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SPEC. NO. TCE.M4-185-71	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR THERMAL INSULATION	SHEET 1 OF 2

	<u>MATERIALS</u>		Quantum & Acceptance	Inspection category
1.0	<u>BONDED MINERAL (ROCK) WOOL MATTRESSES</u>			
1.1	Bulk Density	Test Reports	as per IS 8183	B
1.2	Shot Content	Test Reports	as per IS 8183	B
1.3	Linear Shrinkage	Test Reports	as per IS 8183	B
1.4	Tensile Strength	Test Reports	as per IS 8183	B
1.5	Fibre Diameter	Test Reports	as per IS 8183	B
1.6	Thermal Conductivity	Test Reports	as per IS 8183	B
1.7	Chemical Composition	Test Reports	as per IS 8183	B
1.8	Chloride content	Test Reports	as per IS 8183	B
1.9	Heat resistance	Test Reports	as per IS 8183	B
1.10	Moisture content	Test Reports	as per IS 8183	B
1.11	Moisture absorption	Test Reports	as per IS 8183	B
1.12	Recovery after compression	Test Reports	as per IS 8183	B
1.13	Resistance to vibration	Test Reports	as per IS 8183	B
1.14	Resistance to jottling	Test Reports	as per IS 8183	B
1.15	Incombustibility	Test Reports	as per IS 8183	B
1.16	Sulphur content	Test Reports	as per IS 8183	B
1.17	Alkalinity	Test Reports	as per IS 8183	B
1.18	Dimensions	Inspection Reports	as per IS 8183	B
1.19	Appearance	Inspection Reports	Free from crack and voids	B
2.0	<u>PREFORMED CALCIUM SILICATE INSULATION</u>			
2.1	Bulk Density	Test Reports	as per IS 8154	B
2.2	Compressive Strength	Test Reports	as per IS 8154	B
2.3	Flexural Strength	Test Reports	as per IS 8154	B
2.4	Heat Resistance	Test Reports	as per IS 8154	B
2.5	Thermal Conductivity	Test Reports	as per IS 8154	B
2.6	Moisture Content	Test Reports	as per IS 8154	B
2.7	Alkalinity	Test Reports	as per IS 8154	B
2.8	Dimension	Inspection Reports	as per IS 8154	B
2.9	Appearance	Inspection Reports	Free from crack and voids, Uniformity	B

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SPEC. NO. TCE.M4-185-71	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR THERMAL INSULATION	SHEET 2 OF 2

3.0	<u>GALVANISED STEEL & STAINLESS STEEL WIRE MESH</u>			
3.1	Tensile	Test Reports	as per IS 280 / IS 6528	C
3.2	Chemical	Test Reports	as per IS 280 / IS 6528	C
3.3	Wrapping test	Test Reports	as per IS 280 / IS 6528	C
3.4	Bend test / Reverse bend test	Test Reports	as per IS 280 / IS 6528	C
3.5	Gauge diameter	Inspection Reports	as per IS 3150	C
3.6	Dimension	Inspection Reports	as per IS 3150	C
3.7	Coating for GS wire	Inspection Reports	as per IS 4826	C

4.0	<u>INSPECTION CATEGORY:</u>	
	A - Witness by TCE & Purchaser	
	B - Witness by TCE at the discretion of Purchaser	
	C - Certificates review by TCE / Purchaser	

5.0	<u>ABBREVIATIONS:</u>	
	IS - Indian Standard	

6.0	<u>NOTES:</u>	

	For other types of insulation, QAP shall be reviewed and approved by Purchaser
	The codes and standards mentioned in the various specifications and requirements specified in the enquiry document shall be latest as on the day of award of contract of the works unless otherwise specified. Contractor shall be responsible to inform to the Consultant / Owner in case of any revision / re-affirmation / amendment in the relevant codes and standards after the date of award of contract within 30 days of the issue of such revision / re-affirm/amendment of the code / standard. Consultant / Owner may approve use of the earlier code / standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed.

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SPEC. NO. TCE.M4-185-53	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR CONTROL VALVES	SHEET 1 OF 2

1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	<u>CASTINGS</u>			
1.1.1	Properties as per specification	Material test certificates	One /heat	C
1.1.2	Carbon steel and stainless-steel valves of 600 class and greater & Alloy steel valves of all class	RT - Film review	100%	C
1.1.3	Heat treatment	HT charts	100%	C
1.1.4	NDT	MT - Magnetic materials / PT - Non-Magnetic materials	100%	C
1.2	<u>FORGINGS</u>			
1.2.1	Properties as per specification	Material test certificates	One /heat	C
1.2.2	Heat treatment	HT report	100%	C
1.2.3	NDT for all valves	MT - Magnetic materials / PT - Non-Magnetic materials	100%	C
1.2.4	NDT for valves 1500 class and above	UT	100%	C
1.3	<u>STEM</u>			
1.3.1	Properties as per specification	Material test certificates	One /heat	C
1.3.2	Heat treatment	HT report	100%	C
1.3.3	NDT if dia >= 50 mm	UT	100%	C
1.4	<u>DIAPHRAGM</u>			
1.4.1	Properties as per specification	Material test certificates	One /heat	C
1.4.2	Hardness test	Test report	Random	C
1.4.3	Endurance test	Type test report	per size per type	C
1.5	Electrical / Pneumatic / Hydraulic actuators	Supplier test certificate	100%	C
1.6	Springs	Material test certificates, spring constant, scragging test	100%	C
2.0	<u>INPROCESS CONTROL</u>			
2.1	Welding & Hard facing qualification records	WPS, PQR, WPQ	100%	C

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SPEC. NO. TCE.M4-185-53		TATA CONSULTING ENGINEERS LIMITED		SECTION:
		MINIMUM INSPECTION REQUIREMENTS FOR CONTROL VALVES		SHEET 2 OF 3
2.2	Butt welds	UT / RT - Film review	100%	C
2.3	Fillet welds	MT / PT	100%	C
2.4	PWHT	HT chart	100%	C
2.5	Hardness of welds – see Notes	Hardness test	Each	C
2.6	Stem and gland sealing area	Visual, dimensional inspection and surface finish	10%	C
2.7	Seat & Backseat	Hardness test	On test coupon	C
2.8	Seat face, Hard faced areas & machined surfaces	PT	100%	C
3.0	<u>FINAL INSPECTION</u>			
3.1	Body Leak tightness	Hydrotest	100%	A
3.2	Seat tightness	Hydrostatic seat leak test / Pneumatic seat leak test	100%	A
3.3	Actuator	Actuator leak test	100%	A
3.4	Performance test	Hysteresis, Repeatability, dead band, linearity, Sensitivity, accuracy, operating time, fail safe position, flow direction	100%	A
		Cv test (see notes)	Per size per type	A
3.5	Accessories	Performance test	100%	A
3.6	Dimensional conformity	Critical Dimensions	100%	A
3.7	Paint Check	Appearance & DFT	100%	C
3.8	Documentation review	As per stage inspection records	100%	C
4.0	<u>STANDARDS:</u>			
	Materials	As per material specification		
	Welding	As per ASME BPVC, IBR		
	Non-Destructive Testing	As per ASME BPVC, IBR		
	Dimensional Tolerance	As per Valve Design standard		
				ISSUE R 6

SPEC. NO. TCE.M4-185-38	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR POWER PLANT PIPING (NON IBR)		SHEET 1 OF 3	

1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	Pipes	Material test certificates verification	Each heat	C
1.1.1		Hydrostatic test at shop/mill or UT for > 3.2 mm thk./ ECT <=3.2 mm thk	100%	C
1.2	<u>INPROCESS CONTROL</u>			
1.2.1	Welding	WPS, PQR,WPQ review	100%	C
1.2.2	Bends	Heat treatment chart review as per ASME B 31.1	100%	C
1.2.3		Bend Area MT & Thickness measurement	10%	C
1.2.4	Weld ends	Visual inspection		C
		MT/PT	10%	C
1.2.5	Finished weld			
1.2.5.1	Piping with design pressure >17.6 kg/cm ² (g) or design temp. > 218°C : [including HP RO plant lines]	Butt welds > 100 NB	100% RT & 100% MT/PT	A
1.2.5.2		Butt welds ≤ 100 NB	10% RT & 10% MT/PT	A
1.2.5.3		Alloy Steel Nozzle & Branch welds for size > 100 NB	100% RT/UT & 100% MT/PT	A
1.2.5.4		Carbon Steel Nozzle & Branch welds for size > 100 NB & thk > 19mm	100% UT & 100% MT/PT	B
1.2.5.5		All other attachment welds	10% MT/PT	B
1.2.6	Piping with design temp. ≤ 218°C and Design Pressure ≤ 17.6 kg/cm ² (g) ; Piping under Vacuum (including Cooling Water Line, Instrument Air, Service Air & Miscellaneous Water Lines)	Circum to longitudinal weld joint [T] intersections	100% RT	A
1.2.6.1		Mitre bends and Butt welds > 100 NB	10% RT & 10% MT/PT	A

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SPEC. NO. TCE.M4-185-38	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR POWER PLANT PIPING (NON IBR)		SHEET 2 OF 3	

1.2.6.2		All other attachment welds MT/PT	10%	C
1.2.7	LP Piping			
1.2.7.1	Mitre Bends	Visual inspection for profile and surface defect	100%	C
1.2.7.2		Butt weld	10% (including Tee joints)	C
1.2.7.3	Rolled and welded Pipe spool	Butt joint-Circumferential weld	10%RT	C
1.2.7.4		Butt joint - Longitudinal weld	10%RT	C
1.2.7.5	Pipe fabrication	Butt joint	10%RT	C
1.2.7.6		Fillet joint	10% MT/LPT	C
1.2.7.7		Dimensional check	10%	B
3.0	<u>STANDARDS:</u>			
	Materials	As per material specification		
	Welding	As per ASME BPVC		
	Non-Destructive Testing	As per ASME BPVC		
	Dimensional Tolerance	As per Drawing		
	Design, Fabrication	ASME BPVC Sec VIII Div 1 / API 662		
	Testing	ASME BPVC Sec VIII Div 1 / API 662		
	Structure Fabrication	AWS D 1.1		
4.0	<u>INSPECTION CATEGORY:</u>			
	A - Witness by TCE / Inspection agency & Purchaser			
	B - Witness by TCE / Inspection agency at the discretion of Purchaser			
	C - Certificates review by TCE / Inspection agency / Purchaser			
5.0	<u>ABBREVIATIONS:</u>			
	ASME - American Society of Mechanical Engineers			
	API - American Petroleum Institute			
	AWS - American Welding Society			
	DFT - Dry Film Thickness			
	HT - Heat treatment			
	MT - Magnetic Particle Testing			
	PQR - Procedure Qualification Record			
	PT - Liquid Penetrant Testing			
	RT - Radiographic Testing			
	UT - Ultrasonic Testing			
	WPQ - Welder Performance Qualification			
	WPS - Welding Procedure Specification			

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SPEC. NO. TCE.M4-185-38	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR POWER PLANT PIPING (NON IBR)	SHEET 3 OF 3

The codes and standards mentioned in the various specifications and requirements specified in the enquiry document shall be latest as on the day of award of contract of the works unless otherwise specified. Contractor shall be responsible to inform to the Consultant / Owner in case of any revision / re-affirmation / amendment in the relevant codes and standards after the date of award of contract within 30 days of the issue of such revision / re-affirm/amendment of the code / standard. Consultant / Owner may approve use of the earlier code / standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed.

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SPEC. NO. TCE.M4-185-04	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR HEADERS AND PIPING (IBR)	SHEET 1 OF 4

1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	All Materials	Material test certificates with IBR format	100%	C
1.2	Pipes	UT for pipes or Hydrostatic test	100%	C
1.3	Pipes 200 NB & above	Supplementary tests		
		S1. Product analysis [For all materials]	Per heat	C
		S2. Transverse tension test [For all materials]	25%*	C
		S3. Flattening test [For alloy steels]	25%*	C
		S5. Photomicrographs [For Grade 91, 92]	One sample per thickness/size/heat	C
		Impact testing [For Grade 91,92,23] as per specification	per heat	C
1.4	Tubes	UT for thickness 3.6 mm & greater / Eddy current test if thickness < 3.6 mm or Hydrostatic test	100%	C
1.5	Plates for lugs with thickness > 25 mm	UT	100%	C
1.6	FITTINGS:			
1.6.1				
a)	Material test certificates	Material test certificates with IBR format	100%	C
		Product analysis	Per heat	C
		Mother pipe test certificates with Hydrostatic test	100%	C
b)	NDT	MT (PT for Stainless steel)	100%	C
		UT (for all materials other than SS)	100%	C
c)	CSEF Steels	PMI	100%	C
		Photomicrographs (per grade/size)	Per HT batch	C
		Hardness check (per grade/size)	Each piece	C
2.0	<u>INPROCESS CONTROL</u>			
2.1	Welding qualification records	WPS, PQR, WPQ	100%	C
		(For CSEF material, WPS, PQR and WPQ shall be qualified with Impact testing)		

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SPEC. NO. TCE.M4--185-04	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR HEADERS AND PIPING (IBR)		SHEET 2 OF 4	
2.2 BENDS (COLD/HOT FORMED)				
2.2.1	Forming	Review of HT charts	100%	C
2.2.2	CSEF steel	MT/PT	100%	B
		Microstructure	1 per heat	C
		PMI	100%	B
		Dimensions and Hardness Check	100%	B
2.2.3	Alloy steels bends	MT/PT	100%	B
		Dimensions and Hardness Check	10%	B
2.2.4	Carbon steels	MT/PT	10%	C
		Dimensions and Hardness Check	10%	C
2.3 WELD ENDS				
2.3.1	Carbon Steel - Gas cut & ground edges	MT/PT	100%	C
2.3.2	Carbon & Alloy steel - Machined & ground edges	MT/PT	10%	C
2.4	Welding process records	Preheating, interpass, post heating & PWHT charts (as applicable)	100%	C
2.5 NDT after PWHT				
2.5.1	For all Headers and IBR Class I piping			
a)	Butt welds - Alloy steel	MT	100%	A
		RT - Film Review > 100 NB	100%	C
		RT - Film Review <= 100 NB	10%	C
b)	Butt welds - Carbon steel	RT - Film Review > 100 NB	100%	C
		RT - Film Review <= 100 NB	10%	C
		<= 100 NB - MT	10%	A
c)	Full throat Nozzle welds	UT & MT	100%	B
d)	Fillet welds	MT - Alloy steel	10%	B
		MT- Carbon steel	10%	B
2.5.2	IBR Class II piping			
a)	Butt welds	RT - Film Review	10%	C
b)	Full throat Nozzle welds	UT & MT	10%	B
				ISSUE R 06

SPEC. NO. TCE.M4--185-04	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR HEADERS AND PIPING (IBR)		SHEET 3 OF 4	

2.6	Hardness test on butt welds	CSEF material Alloy steels	Each weld 10% @ random	B B

3.0 FINAL INSPECTION

3.1	Leak tightness	Hydrostatic Test (as per drawing at shop)	100%	A
3.2	Dimensional check	Number & height of stubs, field weld edge preparation, stub alignment, header bends , length, nozzle locations	100%	A
3.3	Pre-dispatch Check	Check for stamping details, finish painting, and end capping of stubs, axis marking, lifting location, and placing of silica gel. Documentation review as per IBR/stage inspection records	100%	C

* 2 samples / heat shall be tested if pipes are procured from Sumitomo, Productos Tubulares, Dalmine, Wyman Gordon, Benteler Stahl and Vallourec & Mannesmann

4.0 STANDARDS:

Materials	As per material specification
Welding	As per ASME BPVC
Non-Destructive Testing	As per ASME BPVC/ As per ASME BPVC/ ASME 31.1/ IBR / ASTM

5.0 INSPECTION CATEGORY:

A - Witness by TCE & Purchaser
B - Witness by TCE at the discretion of Purchaser
C - Certificates review by TCE / Purchaser

6.0 ABBREVIATIONS:

ASME - American Society of Mechanical Engineers
CSEF - Creep strength enhanced Ferritic Steels
HT- Heat Treatment
IBR - Indian Boiler Regulations
ID - Inner Diameter
MT - Magnetic Particle Testing
NDT - Non-Destructive Testing
OD - Outer Diameter
PMI - Positive Material Identification
PQR - Procedure Qualification Record

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SPEC. NO.
TCE.M4--185-04

TATA CONSULTING ENGINEERS LIMITED

SECTION:

MINIMUM INSPECTION REQUIREMENTS FOR HEADERS AND PIPING (IBR)

SHEET 4 OF 4

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SPEC. NO. TCE.M4-185-05	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR TUBES & TUBULAR ELEMENTS	SHEET 1 OF 3

1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	All Materials	Material test certificates with IBR format.	100%	C
1.2	Tubes	T23 tubes shall be procured only from Sumitomo or Vallourec & Mannesmann UT for thickness 3.6 mm & greater / Eddy current test if thickness < 3.6 mm or Hydrostatic test	100%	C
1.3	Plates for lugs with thickness > 25 mm	UT	100%	C
2.0	<u>INPROCESS CONTROL</u>			
2.1	Welding qualification records	WPS, PQR, WPQ	100%	C
2.2	Macro etch test (before production fabrication)	Fusion welded and fin welded panel	Sample	B
2.3	<u>NDT on welds</u>			
2.3.1	Butt welds for CSEF materials	RT/UT	100%	C
2.3.2	Butt welds for non-CSEF materials	RT/UT	10%	C
2.3.3	Load bearing attachment	MT/PT	100%	C
2.3.4	Fin welds & attachment	MT/PT	10%	C
2.4	Bending	First off trial check	Sample	B
2.5	PWHT	HT chart review	100%	C
2.6	Hardness check	for alloy steel welds	10% per HT batch	B
2.7	PMI check on alloy steel	Material identification	at random	B

FILE NAME: M4-185-05-Rev-R06

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SPEC. NO. TCE.M4--185-05	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR TUBES & TUBULAR ELEMENTS		SHEET 2 OF 3	

3.0	<u>FINAL INSPECTION</u>			
3.1	Leak tightness	Hydrostatic Test	100%	A
3.2	Dimensional check	Inspection in Layout	100%	A
3.3	Clear passage	Sponge test of coils	100%	A
3.4	Ovality and bend profiles	Steel Ball test (for flash butt welding, straight tube butt welding, Fusion and Fin welded panels)	100%	A
3.5	Pre-dispatch Check	Check for stamping details, finish painting, and end capping of stubs, axis marking, lifting location, and placing of silica gel.	100%	B
		Documentation review as per IBR/stage inspection records.	100%	C
4.0	<u>STANDARDS:</u>			
	Materials	As per applicable Material specifications, Approved Datasheets and Drawings		
	Welding	As per ASME Section-IX & IBR		
	Non-Destructive Testing	As per ASME BPVC/ IBR / ASTM		
5.0	<u>INSPECTION CATEGORY:</u>			
	A - Witness by TCE & Purchaser			
	B - Witness by TCE at the discretion of Purchaser			
	C - Certificates review by TCE / Purchaser			
6.0	<u>ABBREVIATIONS:</u>			
	ASME - American Society of Mechanical Engineers			
	CSEF - Creep strength enhanced Ferritic Steels (defined in ASME Sec IX)			
	HT- Heat Treatment			
	IBR - Indian Boiler Regulations			
	MT - Magnetic Particle Testing			
	NDT - Non-Destructive Testing			
	PMI - Positive Material Identification			
	PQR - Procedure Qualification Record			
	PT - Liquid Penetrant Testing			
	PWHT - Post Welding Heat Treatment			

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SPEC. NO. TCE.M4--185-05	TATA CONSULTING ENGINEERS LIMITED MINIMUM INSPECTION REQUIREMENTS FOR TUBES & TUBULAR ELEMENTS	SECTION: SHEET 3 OF 3
RT - Radiographic Testing UT - Ultrasonic Testing WPQ - Welder Performance Qualification WPS - Welding Procedure Specification ISSUE R 06		

SPEC.NO. TCE.M4-102-01	TATA CONSULTING ENGINEERS LIMITED	SECTION: D
	WELDED UNFIRED PRESSURE VESSELS	SHEET 1 OF 10

1.0

SCOPE

This specification covers the general design, preparation of general arrangement & detailed fabrication drawings for review and approval, supply of materials, fabrication, stage-wise inspection, final inspection, testing, packing, forwarding, transportation and delivery at site of welded unfired pressure vessels.

2.0

CODES AND STANDARDS

2.1

The design, materials, fabrication, inspection, testing and performance of welded unfired pressure vessels shall comply with all currently applicable design codes and standards, statutes, regulations and safety codes in the locality where the equipment is to be installed. The equipment shall also conform to the latest applicable Indian or equivalent standards. Other international standards are also acceptable, if these are established to be equal, or superior to the listed standards. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility.

2.2

The codes and standards mentioned in the various specifications and requirements specified in the enquiry document shall be latest as on the day of award of contract of the works unless otherwise specified. Contractor shall be responsible to inform to the Consultant / Owner in case of any revision / re-affirmation / amendment in the relevant codes and standards after the date of award of contract within 30 days of the issue of such revision / re-affirm/amendment of the code / standard. Consultant / Owner may approve use of the earlier code / standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed.

2.3

If statutory approvals like IBR, PED, U stamping etc. are specified in data sheet A, the VENDOR shall be responsible for obtaining all approvals on design, materials, stage-wise inspection, final inspection and testing of the vessel.

3.0

MATERIALS

3.1

All materials used in the fabrication of pressure vessels shall be as specified in the Mechanical Data Sheets (MDS). Equivalent materials are acceptable only when approved by the PURCHASER in writing.

3.2

All plates shall be ultrasonically tested as follows;

(a)

For nominal thickness 20 mm and higher when used for fabrication of dished ends

(b)

For nominal thickness 40 mm and higher when used for fabrication of shells

(c)

For nominal thickness 50 mm and higher when used for blind flanges

(d)

All thicknesses, when used for body flanges

3.3

The VENDOR shall ensure that code mandatory requirements of impact testing are met in accordance with the minimum design temperatures specified in the data sheets.

FILE NAME: TCE.M4-102-01-Rev-R6.DOCX

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TCE FORM NO. 329 R7

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3.4 The VENDOR shall ensure that code mandatory requirements of PWHT (Post Weld Heat Treatment), solution annealing etc are met. 3.5 The extent of radiography shall be as specified in mechanical data sheet. In no case shall the radiographic examination shall be less than that specified in the code. However, spot radiography is the minimum requirement for all vessels. 3.6 All the supplementary requirements for the material as mentioned in the MDS and elsewhere in the tender documents shall be complied with. 3.7 Any non-pressure parts such as cleats, reinforcement (R/F) pads at support lugs or legs, wear plates at saddles and pads at pipe supports etc., welded directly on to the pressure parts, shall be of the same material as the pressure parts. 3.8 Reinforcement pads at nozzles and other load bearing locations shall be of the same material and nominal thickness as the pressure part. 3.9 Material for skirt in case of alloy steel vessels and columns shall be the same as that of pressure part at least for a minimum length of 500 mm from bottom tan-line. The rest of the skirt part shall be of Carbon steel. 3.10 <u>ALLOY STEEL PROTECTIVE LINING AND CLADDING</u> 3.10.1 Lining is defined as loose strip lining and bush lining. Cladding may be by weld deposit overlay or explosion bonding or roll bonding. 3.10.2 Clad plate or lining shall conform to the following requirements; (a) Clad plate thickness shall be minimum 3 mm, unless specified otherwise. (b) Clad plate made either by the explosion bonding process or reduction roll bonding process is acceptable. (c) Clad plate shall meet the ASME code requirements of SA263, SA264, SA265 including bond test or AD-Merkblatter W-8. The shear bond test shall be executed as per SA264, Figure 1. Ultrasonic inspection shall be carried out in accordance with SA 578, acceptance level S-6. (d) For ensuring that cladding thickness of reduction roll-bonded clad plates is not less than 3 mm, each plate shall be inspected at the mill using a "coating gauge". Plates shall be scanned on at least three edges and one across the width of the plate. Thickness shall be plotted at points not more than 600 mm apart. The VENDOR shall furnish a mill certificate, showing an outline of the plate and the points at which readings were taken together with the results. (e) Instead of lining, weld deposit overlay may also be considered. (f) At weld deposit overlay or clad-restoring welds, at least the same chemical composition shall be present at 3 mm depth, to be analysed by the welding procedure qualification in advance. (g) Weld deposit over-lay and clad-restoring welds shall be dye penetrant tested and shall be crack-free. (h) Weld deposit overlay and clad-restoring welds as a minimum, shall be qualified as per ASME Section IX.		
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SPEC.NO. TCE.M4-102-01	TATA CONSULTING ENGINEERS LIMITED WELDED UNFIRED PRESSURE VESSELS	SECTION: D SHEET 3 OF 9
3.10.3 Alloy steel lining shall not be used when cladding is specified. Alloy steel lining, when specified, shall be so designed that the distance between attachments does not exceed 150 mm. 3.10.4 The minimum required thickness of pressure parts shall exclude cladding or lining. 3.10.5 Cladding or lining requirements discussed in this specification are using low and high alloy steels only. For cladding or lining using non-ferrous and other materials, when specified, the VENDOR shall furnish on his drawings all details, including Welding Procedure Specification (WPS), for review and approval. 4.0 <u>MINIMUM THICKNESS</u> 4.1 The thicknesses of the pressure parts as shown in the data sheets or drawings are the minimum acceptable thicknesses after manufacture, even though the code may permit a lesser thickness. The minimum acceptable thickness includes specified corrosion allowance. 4.2 The VENDOR shall be responsible for proper selection of plate thickness considering the fabrication and forming allowances, mill under-tolerances etc., to meet the minimum thickness requirements as specified. 5.0 <u>SHELLS</u> Shell courses shall be of the largest possible dimensions to minimise the number of circumferential and longitudinal weld seams and minimise wastage of material in case the material is free issue to the VENDOR. 6.0 <u>HEADS AND REDUCING SECTIONS</u> 6.1 Heads shall be of 2:1 ellipsoidal or equivalent ellipsoidal type (crown radius $R = 0.9D$, knuckle radius $r = 0.17D$), unless specified otherwise, where D is the inside diameter of the shell. 6.2 Reducing sections or conical bottoms shall have a knuckle radius of $r = 0.06D$, unless specified otherwise. However, knuckle radius shall not be less than 50 mm. 6.3 Dished ends shall be seamless or 100% radiographed when made from more than one piece. 6.4 In case of mounded or mounted bullets the heads shall be hemispherical and shall be made of crown and petal. All the weld joints shall be 100% radiographed. 7.0 <u>AGITATOR ASSEMBLY</u> 7.1 Agitator assembly shall be complete with drive motor, mechanical seal with seal housing, bearings, gear box, agitator shaft with impellers, foot-step bearing with support, rigid coupling between agitator shaft and gear box output shaft with spool piece, flexible couplings between gear box and drive motor, suitable base plate and supporting structure for agitator drive arrangement and necessary fasteners etc. so as to make it complete in all respects. 7.2 Drive motor and gear box shall be mounted on a common base frame and duly coupled and aligned through flexible couplings.		
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SPEC.NO. TCE.M4-102-01	TATA CONSULTING ENGINEERS LIMITED WELDED UNFIRED PRESSURE VESSELS	SECTION: D SHEET 4 OF 9
	7.3 Agitator shaft and gear box output shaft shall be coupled through a rigid coupling with split ring locking arrangement to ensure that agitator shaft does not fall into the vessel during operation. 7.4 Agitator, shaft and impeller assembly shall be statically and dynamically balanced. 7.5 The VENDOR shall obtain necessary approvals from the seal manufacturer regarding arrangement of assembly and application of API cooling plan etc. for the mechanical seal. 7.6 The gear box shall be rated for heavy duty agitator service, continuously working for 24 hours a day and shall be suitable to withstand static and dynamic loads and bending moment on the gear box due to agitator shaft. 7.7 Drive motor and gear box unit shall be provided with a suitable lifting eye hook. 7.8 There shall be no oil spillage from gear box on to the vessel. 7.9 Base frame shall be provided with suitable lifting lugs suitably designed for lifting complete agitator assembly. 8.0 <u>NOZZLES AND MANHOLES</u> 8.1 Nozzles made from pipe shall be of seamless construction. 8.2 Nozzles fabricated from plates are acceptable for sizes larger than 250 mm NB in case of carbon and low alloy steels and 150 mm NB in case of high alloy steels. However, this is to be done with prior approval from the PURCHASER and subject to all welds being 100% radiographed. 8.3 All nozzle sizes and quantities indicated in the data sheets are tentative and for bid purpose only. Final sizes and quantities are subject to confirmation during review of fabrication drawings and issuance of nozzle orientation drawings. The BIDDER shall include and confirm in his BID, that changes, to the extent of one size lower or higher for each nozzle and quantities plus or minus one number for each size, are acceptable at no extra cost to the PURCHASER. 8.4 All nozzles with butt-welding end connections shall have edge preparation as per ANSI B16.25 suitable for connected piping inside diameter. Such nozzles shall have 100 mm extra stub length with pipe caps for hydro test purpose. 8.5 All nozzles of sizes 40 mm NB and below shall be gusseted as per the companion specification TCE.M4-102-34. 8.6 All openings in pressure parts shall be compensated for the area of opening as per code. Minimum width of pad shall be 50 mm. 8.7 All load bearing areas in pressure parts shall be verified for buckling and local stresses. Adequate reinforcement shall be provided as necessary. 8.8 Nozzle and manhole necks shall be flushed with the inside surface of vessel, unless specified otherwise. Inside edges of manholes shall be smooth and rounded-off with a radius of 3 mm. 8.9 Nozzle projection shall be 150 mm for 6" & below and 250 mm for larger nozzles.	
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SPEC.NO. TCE.M4-102-01	TATA CONSULTING ENGINEERS LIMITED WELDED UNFIRED PRESSURE VESSELS	SECTION: D SHEET 5 OF 9
	8.10 Local stress analysis for loads due to piping and supported equipment etc. shall be carried out for all equipment as per WRC 107 and 297 as applicable. Critical equipment shall be analysed by using finite element analysis method (FEM) in case the design code does not have such provisions. 8.11 VENDOR shall provide in his general arrangement drawing of the pressure vessel the allowable nozzle loads of all the nozzles for which piping is connected and the equipment is mounted (Agitator, heat exchanger etc). 9.0 <u>FLANGES</u> 9.1 Unless specified otherwise, all nozzles shall be provided with rated flanges only, from consideration of interchangeability, as per the dimensional standards indicated in the data sheets. 9.2 Bolt holes shall straddle the main vessel axes, unless specified otherwise. 9.3 All flanges on nozzles shall be of forged construction with integral hubs. Plate or plate type forged flanges are not acceptable in place of forged flanges with integral hubs. 9.4 All slip-on type flanges of sizes larger than 50 mm NB and girth flanges shall be provided with adequate venting arrangement during welding. 9.5 Girth flanges, if made from multiple plates, shall be maximum of three segments. All welds shall be 100% radio graphed. Pre-heating and post weld heat treatment shall be carried out as per code. 9.6 Companion flanges specified with alloy steel liner shall be supplied with 100 mm long alloy steel stub ends with butt-welding edge preparation to suit connected pipe thickness. 9.7 When companion flanges are of welded neck type, the same shall suit bore of connected pipe. However, this information shall be provided by the PURCHASER, during review of drawings. 9.8 Blind flanges and covers intended for inspection or access openings shall be provided with adequate arrangement to facilitate opening and closing without undue effort. 9.9 Unless specified otherwise, seating surfaces for non-metallic gaskets shall have stock or serrated finish. For other types of gaskets, the type of finish shall be furnished by the VENDOR on the drawings for review and approval. 9.10 When flanges specified are of tongue and groove or male and female type, groove or female face shall be on the nozzle flanges and tongue or male face on the companion flanges. 9.11 The type of flange (Slip on, Weld Neck, Tongue & Groove, Male-Female or ring type joint) and rating of flange shall be as specified in the data sheet and shall be complied with by the BIDDER. 10.0 <u>GASKETS</u> 10.1 Gasket shall conform to ASME B16.20 and ASME B16.21.	

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SPEC.NO. TCE.M4-102-01	TATA CONSULTING ENGINEERS LIMITED WELDED UNFIRED PRESSURE VESSELS	SECTION: D SHEET 6 OF 9
	10.2 Service gasket supplied shall not be used for hydrostatic testing. Gasket used for hydrostatic test shall be same as that of service gasket. 11.0 <u>SUPPORTS</u> 11.1 All skirt supports shall have at least one access opening and adequate vent holes at the top of skirt. 11.2 Skirt shall be provided with adequate holding and climbing rungs inside, above and below the skirt opening. Details shall be furnished by the VENDOR on the drawings for review and approval. 11.3 Unless otherwise specified, corrosion allowance of 1 mm shall be considered for skirt. 11.4 VENDOR shall supply the template of base plate (fixing the bolt circle diameter, no. of bolt holes and bolt diameter) prior to the construction of equipment foundation. 11.5 BIDDER to include the load cell cover plate in his bid for equipment mounted on load cells. 11.6 If fire proofing of the skirt is specified, the studs shall be welded to the skirt inside as well as outside as indicated in mechanical Data sheet. 12.0 <u>MISCELLANEOUS</u> 12.1 The sizing of vessel internals shall be such that all removable parts can be passing through manholes. 12.2 Wherever applicable and unless specified otherwise in data sheets all support rings, bolting bar for internals such as trays, tower packing's, down comers etc. shall be in the scope of the VENDOR. 12.3 Internal baffles, tray support beams of other internals spanning a chord or diameter of the vessel shall be provided with a means for allowing differential expansion between the part and the vessel shell. 12.4 Unless specified otherwise, baffles or weir plates shall not be welded directly to the shell or dished end of the vessel. These shall be bolted to the support attachments which are welded to the shell or dished end. 12.5 The BIDDER shall include two (2) numbers stainless steel name plates in his scope. This requirement is exclusive of manufacturer's name plate. The details on name plate shall be furnished during review of fabrication drawings. 12.6 Lifting lugs and tailing shall be provided for all vessels. For heavy and tall vessels, the lifting and tailing lugs shall be provided based on the approved methodologies. Lifting lugs shall be designed with impact factor of 2. Details are subject to review and approval. The local stresses on shell or dish ends arising out of the lifting lugs shall also be submitted for review / approval. 12.7 Earthing cleats as per companion specification TCE.M4-102-43 shall be provided at the approved locations. 12.8 All reinforcement pads at nozzles, supports etc. shall be provided with a tell-tale hole at the bottom-most location, which shall be tested with air at 1.0 kg/cm²(g) and	ISSUE R6

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checked with soap solution for leakages if any. Such tell-tale holes shall be plugged with either hard grease or cap after satisfactory testing. 12.9 For insulated or fire proofed vessels, insulation or fire proofing supports as per enclosed companion specification shall be provided by the VENDOR. 12.10 Wherever platforms and ladders are specified in the data sheets, necessary supports shall be provided by the VENDOR as per details which shall be made available during review of drawings. 12.11 Where materials are "free issue" as indicated in the enquiry specification or data sheet, the BIDDER shall furnish along with the technical BID, a firm Bill of Materials (BOM) of all "free issue" items and indicate cutting and wastage allowances both accountable and unaccountable. 12.12 Nitrogen blanketing shall be provided for the critical vessels that are being transported though high seas. 12.13 Vendor to perform transportation saddle analysis for long / tall vessels. 13.0 <u>ANCHOR BOLTS</u> Anchor bolts are not included in the scope of supply of the VENDOR, unless specified otherwise in the data sheets. 14.0 <u>FABRICATION</u> 14.1 All welders, WPS and Procedure Qualification Records (PQR) shall meet the requirements of the specified code irrespective of pressure service or non-pressure service. 14.2 Before welding, edges shall be checked in order to ascertain the absence of flaking, irregularities or serious defects. 14.3 Stainless steel and high alloy steel fabrication shall have independent set of tools, grinding wheels, rollers and wire brushes etc. 14.4 Welding shall be executed by qualified welders only and for the qualified positions only. 14.5 Butt-welds shall have full penetration. Single sided welds shall be chipped back to sound metal and re-welded from the other side. Wherever chipping is not possible, root run shall be by TIG. Backing strip shall not be used without prior approval. 14.6 Openings, reinforcing pads and attachments shall clear longitudinal and circumferential weld seams as per the stipulations of the design code. 14.7 Circumferential welds shall be situated 100 mm above or below the support rings and packing support rings meant for supporting internals, if specified. 14.8 Circumferential and longitudinal weld seams shall clear saddles and support lugs. Longitudinal seams, in case of horizontal vessels, shall be at least 150 mm above saddle wear plate. 14.9 Nozzle and reinforcement pads, where applicable, shall be set-in type and attached to the vessel by full penetration welds.		
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SPEC.NO. TCE.M4-102-01	TATA CONSULTING ENGINEERS LIMITED WELDED UNFIRED PRESSURE VESSELS	SECTION: D SHEET 8 OF 9
14.10 Skirt to vessel heads joints shall have continuous flat-faced weld matching with outer diameter of the vessel. The width of the weld shall be equal to skirt thickness and height of weld shall be twice the width. 14.11 All welds shall be de-burred, free from under cuts, overlap ridges and valleys. 14.12 No welding shall be carried out after stress relieving and/or post weld heat treatment and hydro testing of the vessel. All flange faces shall be suitably protected against oxidation during heat treatment. 15.0 <u>INSPECTION</u> 15.1 VENDOR shall submit the quality assurance plan (QAP) for review and approval of the purchaser or his authorised inspection agency. 15.2 All vessels shall be offered for inspection to purchaser or his authorised inspector as per the approved QAP 15.3 Inspector shall have free access to all workshops of contractors & sub-contractors. 15.4 Inspection shall be carried out during material procurement, fit-up, fabrication and before delivery and for sub ordered materials, if any. 16.0 <u>HYDROSTATIC TEST</u> 16.1 Hydrostatic test shall be conducted at pressure mentioned in mechanical data sheet after complete fabrication and post weld heat treatment. After hydrostatic testing, vessel shall be thoroughly cleaned and dried. 16.2 Clean potable water shall be used for hydro-test. Sea water shall not be used. 16.3 During hydro-test, care shall be taken to avoid local stresses in shell from exceeding 90% of the yield strength of material. 16.4 Hydro-test of the tall vessels can be performed in horizontal position provided the static head of the tall vessel shall be added to the hydro-test pressure. 17.0 <u>FIELD ERECTION</u> 17.1 Where size or shape of vessel makes it impossible to transport it in one piece for erection by others, the VENDOR shall transport the largest shop fabricated sections suitable for shipment and ease of handling for field erection and assembly. Fabrication and erection of the vessel shall be completed at the site by the VENDOR. 17.2 All pieces shall be shop fit-up into sections and each section shall be fit to adjacent section and all pieces shall be match marked. 17.3 The width of permissible gap during fit-up shall be in accordance with approved drawings and welding procedures and shall generally be 3 mm maximum with a tolerance of plus 0.8 mm to minus 0.0 mm. 17.4 Flame cut edges shall be ground by the VENDOR as required to remove slag, detrimental discoloration and non-uniformity of edges. 17.5 All radiographic requirements for welds completed in shop shall be made by the VENDOR before the parts of section leave the shop.		
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17.6 All the non-destructive testing shall be carried out on the site weld joints and the hydro-test of the completed vessel shall be performed at site on foundation by the VENDOR. 18.0 <u>PAINING</u> 18.1 Except for machined surfaces, all exterior surfaces of vessels and columns including skirts and supports shall be painted to prevent rust, corrosion and damage during transit & storage. 18.2 Surface cleaning and painting shall be as per enquiry specification/ mechanical data sheet. 18.3 Unless otherwise specified, all carbon steel exteriors shall be descaled, edges de-burred and wire brushed. Subsequently, all such surfaces shall be painted with two coats of red oxide primer. 19.0 <u>ESSENTIAL AND RECOMMENDED SPARES</u> 19.1 The BIDDER shall include following essential spares in his scope of supply; (a) Two (2) gaskets as spares for each nozzle (b) Three (3) gaskets as spares for body or girth flanges (c) 10% spare fasteners of each size and length. However, the minimum quantity shall be four (4) for each size and length. 19.2 In addition to essential spares as indicated in para 19.1, the BIDDER may recommend additional spares considered as necessary by him, for three (3) year trouble-free operation. 19.3 The BIDDER shall include essential spares as indicated in para 19.1 and recommended spares as considered necessary by him, in TCE.M4-993-01 "Schedule of Essential and Recommended Spares". Total value of such spares shall not be included in the quoted price for supply of equipment. This value shall be considered for BID evaluation.		
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	WELDED UNFIRED PRESSURE VESSELS	SHEET 1 OF 1

DATA SHEET C

**DATA TO BE FURNISHED BY THE VENDOR AFTER THE
ISSUE OF PURCHASE ORDER**

1. Schedule of complete design calculations, drawings and documents to be submitted along with submission dates
2. Quality Assurance Plan (QAP)
3. Complete design calculations for pressure and non-pressure parts
4. General arrangement drawing indicating overall dimensions, complete design data, general notes, bill of materials, specifications of each of the pressure and non-pressure parts, nozzle schedule with nozzle tag number, service, size, nozzle wall thickness or schedule, complete end connection details, nozzle elevations, locations, and orientation, allowable nozzle loads table, support details, locations and orientation etc. Operating weight, erection weight and weight filled with water shall be indicated. Foundation loading forces and moments shall also be specified.
5. Detailed fabrication drawing for each part and welding details
6. Details of internals and supports for internals
7. Details of external cleats and structural
8. Shell development drawing showing interference, if any, with nozzles, pads, attachments etc.
9. Transportation drawings (if required) along with calculation
10. Welding procedure
11. Plate cutting layouts in case of plates are FIM by purchaser.

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SPEC. NO. TCE.M4-185-12	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR ELECTROSTATIC PRECIPITATORS	SHEET 1 OF 2

1.0	<u>Casings, ridges, walls, roof beams & panels, internals, frames, rapping hammers & shock bars</u>			
1.1	<u>Materials</u>		Quantum	Inspection category
1.1.1	Beam, Plate, Angle, Channel, Pipe	Material test certificates	100%	C
1.2	<u>In process control</u>			
1.2.1	Welding qualification records	WPS, PQR, WPQ	100%	C
1.2.2	NDT for welds			
a)	Butt welds of beams in tension	RT	100%	C
b)	Butt welds in tension	MT/PT	100%	C
c)	Fillet Welds Between Tension Flanges and Webs	PT	10%	C
1.3	<u>Final inspection</u>			
1.3.1	Welding quality & dimensions	Visual inspection	100%	A
1.3.2	Trial assembly - Hopper	Visual inspection	1 / unit	A
1.3.3	Paint Check	Appearance & DFT	Random	C
2.0	<u>Collecting electrodes</u>			
2.1	<u>Materials</u>			
2.1.1	Plates	Material test certificates	100%	C
	Collecting electrode Plate	Hardness	Sample	C
2.2	<u>In process control</u>			
2.2.1	Welding qualification records	WPS, PQR, WPQ	100%	C
2.3	<u>Final inspection</u>			
2.3.1	Welding quality & dimensions	Visual inspection	100%	A
2.3.2	NDT for welds	MT/PT	10%	C
2.3.3	Stage inspection records	Verification	100%	C
2.3.4	Rolling & Dimensional Control	Profile, camber, Bend (long), length, profile width, Transverse Bend, Twist & Waviness Finish, Preservation	10%	A
3.0	<u>Emitting electrodes</u>			
3.1	<u>Materials (stainless steel)</u>			
3.1.1	Rolled Sections	Material test certificates	100%	C
3.1.2	Metallographic test (Ref note)	Microstructure (carbide precipitation check)	Ref note 2	C

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**ISSUE
R06**

SPEC. NO. TCE.M4--185-12		TATA CONSULTING ENGINEERS LIMITED		SECTION:	
		MINIMUM INSPECTION REQUIREMENTS FOR ELECTROSTATIC PRECIPITATORS		SHEET 2 OF 2	

			Quantum	Inspection category
3.1.3	Chemical test	Chloride ion check (max. 0.2 mg/dm ²)	100%	C
3.1.4	Surface defect check	PT (max. 20 μ depth)	100%	C
3.2	<u>Final inspection</u>			
3.2.1	Stage inspection records	Verification	100%	C
3.2.2	Coiled electrodes	No of turns & End Construction Spring back Test, retention Force, initial Tension test, Surface condition	1/ lot	A
3.2.3	Gas Distribution Test	Certificate verification	Per design	C
	Note;			
	1. Microstructure showing cold worked austenite without any carbide precipitation in the grain boundaries			
	2. For each batch of 1000 kg of finished wires One longitudinal & one transverse micrograph (magnification 250X)			
4.0	<u>Standards:</u>			
	Materials	As per applicable Material specifications, Approved Datasheets and Drawings		
	Welding	As per AWS D 1.1		
	Non-Destructive Testing	As per ASME BPVC / AWS D 1.1		
5.0	<u>Inspection category:</u>			
	A - Witness by Inspection agency & Purchaser			
	B - Witness by Inspection agency at the discretion of Purchaser			
	C - Certificates review by Inspection agency / Purchaser			
6.0	<u>ABBREVIATIONS:</u>			
	ASME - American Society of Mechanical Engineers			
	DFT- Dry Film Thickness			
	MT - Magnetic Particle Testing			
	PQR - Procedure Qualification Record			
	PT - Liquid Penetrant Testing			
	UT - Ultrasonic Testing			
	WPQ - Welder Performance Qualification			
	WPS - Welding Procedure Specification			
	WPS - Welding Procedure Specification			

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SPEC. NO. TCE.M4-185-39	TATA CONSULTING ENGINEERS LIMITED	SECTION: D
	MINIMUM INSPECTION REQUIREMENTS FOR BLOWERS	SHEET 1 OF 2

1.0	<u>MATERIALS</u>	TESTS	QUANTUM	INSPECTION CATEGORY
1.1	<u>CASTING</u>			
1.1.1	Body casing, Housing, Impeller, and end cover lobes (Properties as per specification)	Foundry test certificate for Mechanical and hardness properties, Heat Treatment records or charts	one/heat	C
1.2	<u>FORGING</u>			
1.2.1	Gears	Mill /Lab test certificate for Chemical properties Heat Treatment records or charts	one/heat	C
1.2.2	Hub, Shaft, Shaft Sleeves as Applicable	Mill /Lab Material test certificates Heat Treatment records or charts	one/heat	C
1.2.3	NDT if > 50 mm dia	UT	100%	C
1.3	Plates (silencer and frame)	Material test certificates	one/heat	C
2.0	<u>BOUGHT OUTS</u>			
2.1	V belt, Pulley, Coupling	Test /compliance certificate	100%	C
2.2	For motors > 30KW	Type test	100%	C
		Routine test	100%	C
2.3	For motors < 30KW	Routine test	100%	C
3.0	<u>INPROCESS CONTROL</u>			
3.1	Casing Integrity check	Hydro test	100%	C
3.2	Gears	Hardness check	Random	C
3.3	Rotor assembly	Dynamic balancing	100%	C
3.4	Shaft	Mechanical Run out Test	100%	C
3.5	PMI Test for all Stainless Steel & Alloy Steel	PMI Test	100%	C
4.0	<u>FINAL INSPECTION</u>			
4.1	Performance test	Free Air delivery, power, RPM, Discharge pressure, temperature rise, noise level, Vibration, and efficiency	100%	A
4.2	Surface Preparation /Paint Check	Appearance & DFT	100%	C
4.3	Documentation review	As per QC Dossier / Manufacturing Record Book	100%	C

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SPEC. NO. TCE.M4-185-39	TATA CONSULTING ENGINEERS LIMITED	SECTION: D
	MINIMUM INSPECTION REQUIREMENTS FOR BLOWERS	SHEET 2 OF 2

5.0 **STANDARDS**

Materials	As per material specification
Welding	As per ASME BPVC/ AWS
Non-Destructive Testing	As per ASME BPVC/ AWS
Dimensional Tolerance	As per Drawing
Performance test	ISO 1217/BS 1571 part II
Dynamic Balancing	As per ISO 21940 /API 560
Noise Level	Max. 85 dB at 1.0 m distance

6.0 **INSPECTION CATEGORY**

- A - Witness by TCE & Purchaser
- B - Witness by TCE at the discretion of Purchaser
- C - Certificates review by TCE / Purchaser

7.0 **ABBREVIATIONS**

- ASME - American Society of Mechanical Engineers
- DFT - Dry Film Thickness
- HT - Heat treatment
- MT - Magnetic Particle Testing
- PQR - Procedure Qualification Record
- PT - Liquid Penetrant Testing
- PWHT - Post Welding Heat Treatment
- RT - Radiographic Testing
- UT - Ultrasonic Testing
- WPQ - Welder Performance Qualification
- WPS - Welding Procedure Specification
- API – American Petroleum Institute
- AWS - American Welding Society
- PMI – Positive Material Identification

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SPEC. NO. TCE.M4-185-09	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR WINDBOX AND COAL BURNERS		SHEET 1 OF 2	

1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	Plates, Bars, Rounds & Castings, burner tips	Material test certificates	100%	C
1.2	Plates > 40 mm thick & Rounds > dia. 50 mm	UT	100%	C
1.3	Pneumatic cylinder with positioner, position transmitter, solenoid valve etc	• Functional check • Hysteresis • Leak test	100%	C
2.0	<u>INPROCESS CONTROL</u>			
2.1	Welding qualification records	WPS, PQR, WPQ	100%	C
2.2	Hard faced areas:			
2.2.1	NDT	PT	10%	C
2.2.2	Surface	Hardness	Random	C
3.0	<u>FINAL INSPECTION</u>			
3.1	Welding quality & dimensions	Visual inspection	100%	A
3.2	Operating Test – Burner/Nozzle tip cyclic Tilting test	-Easy movement of link mechanism, Smooth operation, -Tilting angle	100%	A
3.3	Paint Check	Appearance & DFT	100%	C
3.4	Documentation review	As per stage inspection records.	100%	C
4.0	<u>STANDARDS:</u>			
	Materials	As per applicable Material specifications, Approved Datasheets and Drawings		
	Welding	As per ASME Section-IX		
	Non-Destructive Testing	As per ASME BPVC		
5.0	<u>INSPECTION CATEGORY:</u>			
	A - Witness by TCE & Purchaser			
	B - Witness by TCE at the discretion of Purchaser			
	C - Certificates review by TCE / Purchaser			

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ISSUE R06

SPEC. NO. TCE.M4-185-09	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR WINDBOX AND COAL BURNERS	SHEET 2 OF 2

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ISSUE
R 06

SPEC. NO. TCE.M4-185-54	TATA CONSULTING ENGINEERS LIMITED	SECTION: WRITE-UP
	MINIMUM INSPECTION REQUIREMENTS FOR RUBBER EXPANSION JOINTS	SHEET 1 OF 2

1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	Plates	Chemical composition & Mechanical properties	per heat	C
1.2	Rubber	Mechanical properties	per lot	C
		Permanent set test & Adhesion test (rubber to fabric /Rubber to metal)		
1.3	Tie rods	Chemical composition & Mechanical properties	per heat	C
		UT if dia > 50 mm	100%	C
		Galvanising thickness	random	C
2.0	<u>INPROCESS CONTROL</u>			
2.1	Retainer rings	Welding procedure & Welder's performance qualification	100%	C
		Butt Welds - PT	100%	C
2.2	Flange	Welding procedure & Welder's performance qualification	100%	C
		Butt Welds - RT (if thk. > 32 mm)	100%	C
		Butt Welds - PT (if thk. <= 32 mm)	100%	C
		Review of heat treatment records (As applicable)	100%	C
3.0	<u>FINAL INSPECTION :</u>			
3.1	Integrity inspection	Hydro test for body	100%	A
		Axial compression test under pressure	100%	A
		Axial expansion test under pressure	100%	A
		Lateral deflection test under pressure	100%	A
		Vacuum test	100%	A
		Dimensional Inspection after 24 Hrs.	100%	A

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**ISSUE
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SPEC. NO. TCE.M4-185-54	TATA CONSULTING ENGINEERS LIMITED	SECTION: WRITE-UP
	MINIMUM INSPECTION REQUIREMENTS FOR RUBBER EXPANSION JOINTS	SHEET 2 OF 2

		Hardness Test	100%	A
		Deformation after 24 hrs of hydro test(permanent set)	100%	A
		Life cycle test report	One/ design	C
3.2	Paint Check	Appearance & DFT	100%	C
3.3	Documentation review	As per stage inspection records.	100%	C
4.0	<u>STANDARDS:</u>			
	Materials	As per applicable Material specifications, Approved Datasheets and Drawings		
	Welding	As per AWS D 1.1		
	Non-Destructive Testing	As per ASME BPVC / AWS D 1.1		
5.0	<u>INSPECTION CATEGORY:</u>			
	A - Witness by TCE / Inspection agency & Purchaser			
	B - Witness by TCE / Inspection agency at the discretion of Purchaser			
	C - Certificates review by TCE / Inspection agency / Purchaser			
6.0	<u>ABBREVIATIONS:</u>			
	ASME - American Society of Mechanical Engineers			
	AWS - American Welding Society			
	DFT - Dry Film Thickness			
	HT - Heat treatment			
	PQR - Procedure Qualification Record			
	PT - Liquid Penetrant Testing			
	RT - Radiographic Testing			
	UT - Ultrasonic Testing			
	WPQ - Welder Performance Qualification			
	WPS - Welding Procedure Specification			

The codes and standards mentioned in the various specifications and requirements specified in the enquiry document shall be latest as on the day of award of contract of the works unless otherwise specified. Contractor shall be responsible to inform to the Consultant / Owner in case of any revision / re-affirmation / amendment in the relevant codes and standards after the date of award of contract within 30 days of the issue of such revision / re-affirm/amendment of the code / standard. Consultant / Owner may approve use of the earlier code / standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed.

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SPEC. NO. TCE.M4-185-17	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR VALVES ANSI 600 # and ABOVE RATING	SHEET 1 OF 3

1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	<u>CASTINGS</u>			
1.1.1	Properties as per specification	Material test certificates	one /heat	C
1.1.2	NDT for body and bonnet	RT - Film review	100%	C
1.1.3	Heat treatment	HT charts	100%	C
1.1.4	NDT after machining	MT/PT	100%	C
	Ref Notes for Gr 91			
1.2	<u>FORGINGS</u>			
1.2.1	Properties as per specification	Material test certificates	one /heat	C
1.2.2	Heat treatment	HT report	100%	C
1.2.3	NDT for all valves	MT/PT	100%	C
1.2.4	NDT for valves 1500 class and above	UT	100%	C
	Ref Notes for Gr 91			
1.3	<u>STEM</u>			
1.3.1	Properties as per specification	Material test certificates	one /heat	C
1.3.2	Heat treatment	HT report	100%	C
1.3.3	NDT if dia >= 50 mm	UT	100%	C
1.4	<u>BYPASS PIPE</u>			
1.4.1	Properties as per specification	Material test certificates	one /heat	C
1.4.2	NDT / Leak tightness	UT / Hydrostatic test	100%	C
2.0	<u>INPROCESS CONTROL</u>			
2.1	Welding & Hard facing qualification records	WPS, PQR, WPQ	100%	C
2.2	Butt welds	UT / RT - Film review	100%	C
2.3	Fillet welds	MT / PT	100%	C
2.4	PWHT	HT chart	100%	C
2.5	Hardness of welds (see Notes)	Hardness test	Each	C
2.6	Stem and gland sealing area	Visual, dimensional inspection and surface finish	100%	C
2.7	Seat & Backseat	Hardness test	On test coupon	C

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FILE NAME: F-329-Rev-R7.docx

TCE FORM NO. 329 R7

SPEC. NO. TCE.M4-185-17	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR VALVES ANSI 600 # and ABOVE RATING		SHEET 2 OF 3	

2.8	Seat face, Hard faced areas & machined surfaces	PT	100%	C
3.0	<u>FINAL INSPECTION</u>			
3.1	Body Leak tightness	Hydro test	100%	A
3.2	All valves	Hydrostatic seat leak test	100%	A
3.3	Valves with back seat	Hydrostatic back seat leak test	100%	A
3.4	Globe valve/gate valve	Pneumatic seat test	10%	A
3.5	Check valve	Hydro test of seat at 100% and low pressure seat test at 25% of seat test pressure.	100%	A
3.6	Actuator operated valves	Performance test of valve with actuator	100%	A
3.7	Dimensional conformity	As per drawing	100%	A
3.8	Paint Check	Appearance & DFT	100%	C
3.9	Documentation review	As per stage inspection records	100%	C
4.0	<u>STANDARDS:</u>			
	Materials	As per material specification		
	Welding	As per ASME BPVC, IBR		
	Non-Destructive Testing Evaluation	As per Valve Design standard		
	Dimensional Tolerance	As per Valve Design standard		
	Valve Leakage	As per API 598/EN 12266/Data sheet		
5.0	<u>INSPECTION CATEGORY:</u>			
	A - Witness by TCE & Purchaser			
	B - Witness by TCE at the discretion of Purchaser			
	C - Certificates review by TCE / Purchaser			

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SPEC. NO. TCE.M4-185-17	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR VALVES ANSI 600 # and ABOVE RATING	SHEET 3 OF 3

6.0	<u>ABBREVIATIONS:</u>
	ASME - American Society of Mechanical Engineers
	CSEF - Creep strength enhanced Ferritic Steels (defined in ASME Sec IX)
	DFT - Dry Film Thickness
	HT - Heat treatment
	MT - Magnetic Particle Testing
	PQR - Procedure Qualification Record
	PT - Liquid Penetrant Testing
	PWHT - Post Welding Heat Treatment
	RT - Radiographic Testing
	UT - Ultrasonic Testing
	WPQ - Welder Performance Qualification
	WPS - Welding Procedure Specification
7.0	<u>NOTES:</u>
7.1	For Grade 91: Al 0.02% max, No delta ferrite, N/Al weight % ratio ≥ 3 , C+N weight % ≥ 0.14
7.2	Hardness of CSEF welds shall be 200 HB-250 HB
7.3	For all witness points, % specified shall be per size per class rating.
7.4	The codes and standards mentioned in the various specifications and requirements specified in the enquiry document shall be latest as on the day of award of contract of the works unless otherwise specified. Contractor shall be responsible to inform to the Consultant / Owner in case of any revision / re-affirmation / amendment in the relevant codes and standards after the date of award of contract within 30 days of the issue of such revision / re-affirm/amendment of the code / standard. Consultant / Owner may approve use of the earlier code / standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed.

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SPEC. NO. TCE.M4-185-30	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR LP VALVES & SPECIALTIES (ANSI CLASS BELOW 600)	SHEET 1 OF 3

1.0	<u>MATERIALS</u>		Quantum	Inspection category
1.1	<u>CASTINGS</u>			
1.1.1	Properties as per specification	Material test certificates	One / heat	C
1.1.2	NDT, based on casting quality factor	RT - Film review	100%	C
1.1.3	Heat treatment	HT charts	100%	C
1.1.4	NDT	MT/PT	100%	C
1.2	<u>FORGINGS</u>			
1.2.1	Properties as per specification	Material test certificates	One / heat	C
1.2.2	Heat treatment	HT report	100%	C
1.2.3	NDT for all valves	MT/PT	100%	C
1.3	<u>STEM</u>			
1.3.1	Properties as per specification	Material test certificates	One / heat	C
1.3.2	Heat treatment	HT report	100%	C
1.3.3	NDT if dia $\geq$ 50 mm	UT	100%	C
1.4	<u>DIAPHRAGM</u>			
1.4.1	Properties as per specification	Material test certificates	One / heat	C
1.4.2	Hardness test	Test report	per lot	C
1.4.3	Endurance test	Type test report	per size per type	C
2.0	<u>INPROCESS CONTROL</u>			
2.1	Welding & Hard facing qualification records	WPS, PQR, WPQ	100%	C
2.2	Weld joints	MT / PT	100%	C
2.3	Stem and gland sealing area	Visual, dimensional inspection and surface finish	10%	C
2.4	Seat & Backseat	Hardness test	On test coupon	C
2.5	Seat face, Hard-faced areas & machined surfaces	PT	100%	C

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SPEC. NO. TCE.M4-185-30	TATA CONSULTING ENGINEERS LIMITED			SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR LP VALVES & SPECIALTIES (ANSI CLASS BELOW 600)			SHEET 2 OF 3

3.0	<u>FINAL INSPECTION</u>			
3.1	Body Leak tightness	Hydro-test	100%	A
3.2	All valves	Hydrostatic seat leak test	100%	A
3.3	Valves with back seat	Hydrostatic back seat leak test	100%	A
3.4	Globe valve, ball valves, plug valves, diaphragm valves	Pneumatic seat test	100%	A
3.5	Gate valve	Pneumatic seat test	10%	A
3.6	Check valve	Hydro test of seat at 100% and 25% of seat test pressure.	100%	A
3.7	Actuator operated valves	Performance test of valve with actuator	100%	A
3.8	Steam Traps	Hydro test, Operation & Performance test	100%	B
3.9	Dimensional conformity	As per drawing	100%	A
3.10	Paint Check	Appearance & DFT	100%	C
3.11	Documentation review	As per stage inspection records	100%	C
4.0	<u>STANDARDS:</u>			
	Materials	As per material specification		
	Welding	As per ASME BPVC, IBR		
	Non-Destructive Testing Evaluation	As per Valve Design standard		
	Dimensional Tolerance	As per Valve Design standard		
	Valve Leakage	As per IS 6157/API 598		
5.0	<u>INSPECTION CATEGORY:</u>			
	A - Witness by TCE & Purchaser			
	B - Witness by TCE at the discretion of Purchaser			
	C - Certificates review by TCE / Purchaser			

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SPEC. NO. TCE.M4-185-13	TATA CONSULTING ENGINEERS LIMITED		SECTION:	
	MINIMUM INSPECTION REQUIREMENTS FOR DUCTS, EXPANSION PIECES, CYCLONES		SHEET 1 OF 2	

1.0	<u>Materials</u>		Quantum	Inspection category
1.1	Plates and Sheets, Rolled Sections, stiffeners	Material test certificates	100%	C
1.2	Plates > 40 mm thickness	UT	100%	C
2.0	<u>In process control</u>			
2.1	Welding qualification records	WPS, PQR, WPQ	100%	C
2.2	Butt Welds:			
2.2.1	Surface defects	PT on Back grinding areas	100%	C
2.2.2	Leak test	Kerosene leak test	100%	A
2.2.3	Alloy steels	RT Film review	100%	C
2.3	Fillet Welds	PT	10%	C
2.4	PWHT for butt welds on Alloy steel support rings in Cyclone Assembly	Alloy steels - HT charts	100%	C
2.5	Lifting lugs	MT/PT	100%	C
3.0	<u>Final inspection</u>			
3.1	Trial assembly	Visual inspection, Dimensions and Weld quality;		
		For Profiles ducts and ducts more than 10 MT	100%	A
		Ducts between 5 MT to 10MT and straight ducts	10%	B
3.2	Paint Check	Appearance & DFT	100%	C
3.3	Documentation review	As per stage inspection records.	100%	C
	<u>Note</u>			
	Suitable stiffeners to be provided on individual pieces for handling and transportation purpose			
4.0	<u>Standards:</u>			
	Materials	As per applicable Material specifications, Approved Datasheets and Drawings		
	Welding	As per AWS D 1.1		
	Non-Destructive Testing	As per ASME BPVC / AWS D 1.1		

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ISSUE
R06

5.0 **Inspection category:**

A - Witness by TCE & Purchaser

B - Witness by TCE at the discretion of Purchaser

C - Certificates review by TCE / Purchaser

6.0 Abbreviations:

ASME - American Society of Mechanical Engineers

.....
AWS - American Welding Society

DFT - Dry Film Thickness

HT - Heat treatment

IBR - Indian Boiler Regulations

MT - Magnetic Particle Testing

PQR - Procedure Qualification Record

PT - Liquid Penetrant Testing

PWHT - Post Welding Heat Treatment

RT - Radiographic Testing

UT - Ultrasonic Testing

WPQ - Welder Performance Qualification

WPS - Welding Procedure Specification

SPEC. NO. TCE.M4-185-32	TATA CONSULTING ENGINEERS LIMITED	SECTION:
	MINIMUM INSPECTION REQUIREMENTS FOR CENTRIFUGAL PUMP	SHEET 1 OF 2

Sr. No.	Stage / component	Inspection / test	Extent of inspection	Inspection category
1.0	<u>RAW MATERIALS</u>			
1.1	<u>Casting</u>			
1.1.1	Impellers			
a)	Properties as per specification	Material test certificates	100%	C
b)	Heat treatment	HT charts	100%	C
c)	Sea water application (Austenitic stainless steel)	IGC test and microstructure as per ASTM A 262 Practice E	One per heat	C
d)	NDT	NDT-RT	100% coverage (as per design standard)	C
1.1.2	Wearing Rings	Material test certificates	100%	C
1.1.3	Sealing Rings	Material test certificates	100%	C
1.1.4	Diffuser and Casing	Material test certificates	100%	C
1.2	<u>Forgings</u>			
1.2.1	Impeller			
a)	Properties as per specification	Material Test Certificates	100%	C
b)	NDT	PT/MT	100%	C
c)	For Sea Water Application (austenitic stainless steel)	IGC test and microstructure as per ASTM A 262 Practice E	Per heat /HT batch	C
1.2.2	Shaft	Material Test Certificates	100%	C
		UT of Shaft (for > 50 mm dia.)	100%	C
2.0	<u>INPROCESS CONTROL</u>			
2.1	Casing	a) PT on Machined Area	100%	C
		b) Hydro Test	100%	B
2.2	Shafts	a) PT after Machining	100%	C
		b) Run-out check	100%	B
2.3	Impellers	a) PT after Machining	100%	C
		b) Dynamic Balancing	100%	B
2.4	<u>Motors</u>			
2.4.1	For motors > 30KW	a) Type test	100%	C
		b) Routine test	100%	C
3.0	<u>FINAL INSPECTION</u>			
3.1	Performance test	a) Performance Test- Q Vs. Head, Q Vs efficiency & Q Vs. Power	100%	A
		b) Noise Level Check	100%	A
		c) Vibrations Check	100%	A
		d) Paint check (DFT)	Random	C
		e) Dimensional Check	100%	C

FILE NAME: M4-185-22-Rev-R7

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**ISSUE
R7**

SPEC. NO. TCE.M4-186-01		TATA CONSULTING ENGINEERS LIMITED										SECTION: D		
		SHOP INSPECTION REQUIREMENTS UNFIRED PRESSURE VESSELS										SHEET 1 OF 1		
DESCRIPTION		1	2	3	4	5	6	7	8	9	10	11	12	NOTES 1 - ALL STAGES SHALL BE CHECKED 100% BY VENDOR AND RECORDS THEREOF SHOWN TO TCE / PURCHASER. 2 - WITNESSING BY TCE / PURCHASER MAY BE 100% OR ON RANDOM SAMPLES. 3 - THIS DOCUMENT SHALL BE READ IN CONJUNCTION WITH INSPECTION REQUIREMENTS MENTIONED IN TCE.M4-904 AND RELEVANT TECHNICAL SPECIFICATIONS. 4 - THE PRESSURE GAUGES AND INSTRUMENTS FOR MEASURING CRITICAL PARAMETERS SHALL HAVE VALID CALIBRATION CERTIFICATE TRACEABLE TO NATIONAL LABORATORY.
MATERIAL FOR PRESSURE PARTS, NOZZLE PIPES, FLANGES, PADS, LUGS		D	D	D	D	D	D	D	A	A	A	A	D	
FORMED SHELLS & HEADS		D	D	D	D	D	D	D	A	A	A	A	D	
BUTT, GROOVE WELDS ON PRESSURE PARTS, FLANGES, PADS, LIFTING TRUNIONS & LUGS		D	D	D	D	D	D	D	A	A	A	A	D	
FILLET WELDS ON ABOVE MATERIALS		D	D	D	D	D	D	D	A	A	A	A	D	
OVERLAY WELDS		D	D	D	D	D	D	D	A	A	A	A	D	
INTERNAL SUPPORTS WELDING, IF ANY		D	D	D	D	D	D	D	A	A	A	A	D	
INTERNAL FITTINGS, IF ANY		D	D	D	D	D	D	D	A	A	A	A	D	
COMPLETED VESSEL		D	D	D	D	D	D	D	A	A	A	A	D	
MOUNTED AGITATORS, IF ANY		D	D	D	D	D	D	D	A	A	A	A	D	
LINING, IF ANY		D	D	D	D	D	D	D	A	A	A	A	D	
COATING, IF ANY		D	D	D	D	D	D	D	A	A	A	A	D	
SURFACE PREPARATION AND PAINTING AT SHOP		D	D	D	D	D	D	D	A	A	A	A	D	
LEGEND		A - WITNESS BY TCE/PURCHASER. B - WITNESS BY TCE / PURCHASER IF REQUIREMENT IS SPECIFIED. C - RECORDS VERIFIED BY TCE / PURCHASER WHEREVER APPLICABLE. D - A OR C, AT TCE' S / PURCHASER' S DISCRETION WHEREVER APPLICABLE.												
SERIAL NO														
FILE NAME: M4-186-01-REV-R7.DOC														
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													ISSUE R7	

TITLE	MINIMUM INSPECTION REQUIREMENTS FOR GENERATOR			
1.0	Component / Operation	Characteristics Checked	Quantum	Inspection category
1.1	Generator Stator / Stator winding			
1.1.1	Stator frame fabrication	1. Visual and Dimensional 2. DP test on cage seating pad	100%	C
1.1.2	Stator core stacking	1. Dimensions 2. Core tightness	100%	C
1.1.3	Copper for stator coils	Verification of chemical , mechanical & electrical properties	100%	C
1.1.4	Stator winding	1. Winding Resistance 2. Insulation Resistance 3. HV test at 2*rated V + 1 kV for 1 min 4. Polarity test 5. Wedges/spacers tightness	100% Random	C -
1.2	Generator main rotor			
1.2.1	Shaft machining	Dimensions	100%	C
1.2.2	Rotor stamping & material	1. Verification of Mechanical/Electrical properties 2. Dimensions	100%	C
1.2.3	Rotor core assly	Dimensions	100%	C
1.2.4	Damper bars	Verification of chemical and mechanical properties	100%	C
1.2.5	Copper for rotor coils	Verification of chemical, mechanical & electrical properties	100%	C
1.2.6	Resiglass tape	Verification of mechanical properties	100%	C
1.2.7	Rotor Coils making	1.Dimensions 2.Resistance	100%	C
1.2.8	Rotor winding	1.High frequency test @ 400hz 2.HV Test 3.Polarity test 4.Resistance 5.Insulation resistance	100%	C
1.2.9	Rotor fans	1.Dimensions 2.DP Test on weld joints	100%	C
1.2.10	Rotor balancing @ reduced speed	1.Unbalance check as per G2.5 of ISO 21940/11 2.Fastening of weights	100%	C

TITLE	MINIMUM INSPECTION REQUIREMENTS FOR GENERATOR			
1.3	Generator Bearings			
1.3.1	Bearing bush	1.Dimensions 2.Chemical & mechanical properties 3.Ultrasonic test	100%	A
1.3.2	Bearing housing	1.Dimensions 2.Leak test	100%	A
1.4	Generator coolers			
1.4.1	Completed cooler	1.Pressure test on coolers 2.Dimensions of cooler with shroud 3.Functional check of leakage detector	100%	A
1.5	Generator final assembly			
1.5.1	Fitment of accessories	1.Position as per outline drg 2.Visual check & resistance of all accessories	100%	C
1.5.2	Exciter assembly	Air gap measurement	100%	C
1.6	Other test			
1.6.1	Functional checks of accessories and bearings & Cooler	1. Check for temperature indicators 2. Oil inlet Pressure and Flow measurements 3. Bearing temperature check during temp. rise test at specified oil inlet temperature & pressure 4. Check for oil leakage 5. Water flow for cooler	100%	B
1.6.2	Generator Accessories	Resistance measurement of winding RTD's, BTD's, ATD's, CTD's, Thermocouples, Main & Exciter space heaters	100%	B
1.6.3	Complete generator	1. PMG voltage & Phase sequence test(If applicable) 2. OCC & SCC 3. Magnetic center position measurement 4. Visual, Dimension check, Paint shade & DFT, BOM verification of instruments	100%	B

TITLE	MINIMUM INSPECTION REQUIREMENTS FOR GENERATOR	
1.7	Generator control of completeness (Pre-dispatch Inspection)	
1.7.1	Complete generator	Fitment of all accessories, finish painting, name plates, tags fixing, terminals marking etc.
		100%
		B
2.0	<u>Standards:</u>	
	Winding	As per Approved drawing / specification.
	Generator main Rotor	As per Approved drawing / specification.
3.0	<u>Inspection category:</u>	
	A - Witness by Inspection agency & Purchaser	
	B - Witness by Inspection agency at the discretion of Purchaser	
	C - Certificates review by Inspection agency / Purchaser	
4.0	<u>Abbreviations:</u>	
	ISO-International Organization for Standardization	
	DP- Dye Penetrant	
	HV-High Voltage	
	RTD- Resistance Temperature Detector	
	BTD- Bearing Temperature Detector	
	ATD-Automatic Temperature Detector	
	CTD- Conductivity, Temperature, and Depth	
	BOM- Bill of Material	



Client – Hindalco Industries Ltd
Project - Aditya Alumina Refinery
TCE.13833A-ME-6002-6001, Rev-P0



TECHNICAL SPECIFICATION FOR MAIN PLANT SYSTEM

Page 1 of 1

ATTACHMENT-11 PRELIMINARY GEOTECHNICAL REPORT



Client – Hindalco Industries Ltd
Project - Aditya Alumina Refinery
TCE.13833A-ME-6002-6001, Rev-P0



TECHNICAL SPECIFICATION FOR MAIN PLANT SYSTEM

Page 1 of 1

LATER



Client – Hindalco Industries Ltd
Project - Aditya Alumina Refinery
TCE.13833A-ME-6002-6001, Rev-P0



TECHNICAL SPECIFICATION FOR MAIN PLANT SYSTEM

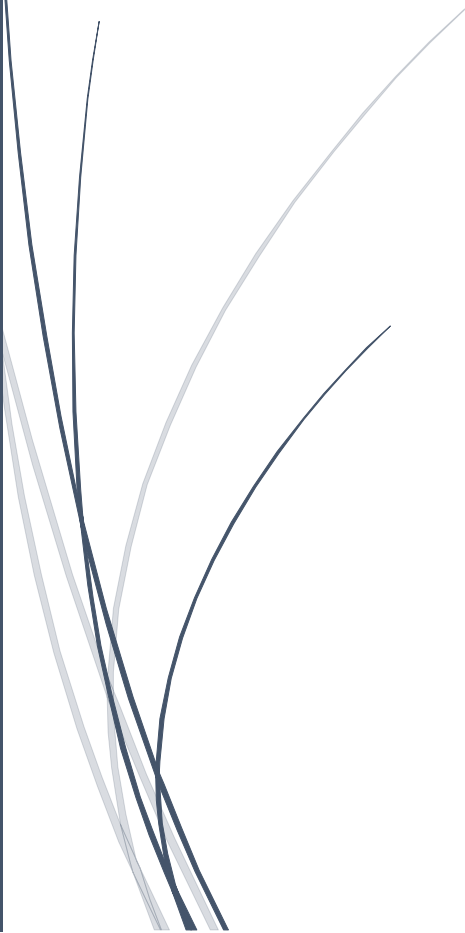
Page 1 of 1

ATTACHMENT-12 GENERAL SAFETY GUIDELINES

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10/8/2021

Health & Safety Guidelines for Contractors

Several thin, curved lines in shades of blue and grey sweep upwards from the bottom left corner of the page.

HINDALCO INDUSTRIE LIMITED

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1. PURPOSE

This manual sets out Hindalco Industries Ltd (HIL) expectations, in areas of Health and Safety (H&S), of all contractors of HIL as defined in the scope and provides guidance in how these expectations can be met.

The contractor shall meet these H&S requirements when conducting work under contract to or on behalf of any entities related to or affiliated with HIL. These requirements do not supersede any other requirements, such as those described in applicable contracts between HIL and the contractor or in the applicable national or state laws and/or regulations but are intended to complement them.

- To align with the HIL H&S Policy, HIL requires that its contractors:
- Comply with all applicable H&S laws, regulations, and industry standards
- Comply with all H&S requirements contained in the contract between the applicable HIL Entity and this manual. In the event of a conflict between the terms and conditions of any such contract and this document, the terms and conditions of such contract shall prevail.

Contractors are responsible for the health and safety of their employees, its subcontractors (where applicable), members of the public and others who may be affected by its activities, and for the safe and environmentally acceptable performance of their work.

HIL believes in “Zero Harm” with respect to health and safety while performing work for HIL. All contractors and their subcontractors are required to strictly observe all health and safety requirements of HIL’s requirements when working in HIL’s Premises or on behalf of HIL or its customers. This requirement extends to all levels of subcontracting done by the contractor. Circumventing safety procedures and not utilizing required safety equipment or personal protective equipment (PPE) will not be tolerated. The consequences for contractors that fail to observe safety requirements will be disciplinary in nature up to and including termination of the contract. A breach of safety requirements will be deemed to be a breach of contract with HIL.

Contractors shall ensure that H&S hazards and risks are properly identified, assessed, controlled, and evaluated prior to any work begins. Only applicably competent / certified persons may perform the specified activities

2. SCOPE:

The requirements outlined in this document apply to all HIL contractors and can be used as a guidance document for other works / services including, but not limited to, construction activities, equipment installation or de-installation, maintenance, or repair activities for or on behalf of HIL.

A. Operations and Safety Regulations

- The Contractor shall be solely responsible for the adequacy, stability, and safety of its operations on the Site. The Contractor shall, prior to the commencement of Works at the Site, prepare and submit a comprehensive set of safety regulations in connection with its operations at the Site. The Contractor shall comply with and shall ensure that all its employees, agents and Sub-Contractors of any tier engaged in work at the Site comply with the provisions of such safety regulations.
- Ensure accident-free working at all sites - No fatality or LTA MTC, RWC and FAC at any site associated with a vision to achieve Zero harm.

- All jobs as defined in the contract within the company premises or associated with company related work is made/carried out in a manner that the risk to Health, Safety and Environment is adequately addressed.
- Compliance of all the local regulations (Acts, Rules & IS specifications) pertaining to Health- Safety & Environment including employment & conditions of services. Compliance of Health Safety Environment standards & practices of HIL.

B. Safety Code of Conduct

Contractors have to follow 100% safety norms during the course of contract as per “Safety Code of Conduct” in HIL premises. Brief guidelines on safety code of conduct are appended below-

- Contractor shall deploy qualified (with qualification indicated) safety officer / supervisor as mandated in safety plan
- Contractor shall provide/ensure site orientation / safety induction Job specific training to its each workman prior to deploying them on the job
- Contractor shall conduct weekly safety meeting, daily toolbox meetings, and monthly gate meetings as per requirement of the safety plan and submit the proof there of on regular basis
- Contractor shall ensure proper housekeeping at the work sites, segregation of waste and disposing them at prior identified location(s)
- Contractor shall thoroughly assess the work scope, properly understand the hazards and risks associated with the job and identify risk mitigation measures, submit information about the measures and employ them while executing the job(s)
- Contractor shall devise safety plan for work scope involved which includes but not limited to proper access, proper exits. Assembly point, storage areas, waste disposal, movement of manpower & equipment, inspection schedules of plant & machineries, rigging plans etc
- Contractor shall ensure deployment of qualified, skilled & competent persons.
- Contractor shall provide / submit work method statement before start of the Job
- Contractor shall ensure that his work force engaged in critical activities like confined space entry, work at height, hot work / welding, rigging etc are medically / physically fit to carry out the job, certified to that effect by medical practitioner and are specially trained to carry out these jobs safely.
- Contractor shall ensure that his workforce will use proper scaffold or other suitable work place access & egress devices and will not employ any unsafe means like temporary work plat forms, damage tools & equipment's, cable trays etc.
- Contractor shall ensure that his entire workforce will be provided with work required PPE of good quality (approved by/as per specifications provided by Hindalco) and ensure their strict uses by entire workforce.
- Contractor shall comply with all safety requirements communicated to him / his representatives & workforce in safety induction / training, contract agreement, in safety plan, safety manual etc.
- Contractor shall provide detailed breakup of his estimate for compliance with safety requirements.
- The contractor shall comply requirement of safety work permits of HIL as applicable, and no work shall be carried out without safety work permit failing which penalty will be imposed.
- The Contractor shall compensate the Company for loss or liability suffered or incurred on account of defaults or non-compliance to safety guidelines by the Contractor.

- Only those persons who are medically fit and have no phobia for working at height should be engaged by the Contractor/Sub-contractors for such jobs.
- The contractor shall conduct toolbox talk every day to all the workers and records should be maintained and kept the document ready during the time of checking/Audit.
- The contractor shall ensure that their workers only perform designated work in designated location.
- The contractor shall not appoint sub-contractor without the written permission from HIL. Safety code of conduct of HIL will also be applicable to the sub-contractor.
- The Contractor shall be solely and exclusively liable and responsible for compliance with all existing applicable safety laws, rules and regulations, the safety of workmen, Sub-contractors, nominated contractors, employees, including those of its Sub-contractors or others whom they may engage or employ for the purpose of this Contract after written permission from HIL
- The Contractor shall ensure that its Sub-contractors/nominated Contractors do abide by the safety rules and practices strictly including use of proper personal protective equipment by their employee as well as his employees working at Site at their own cost.
- The contractor shall appoint only qualified supervisors having relevant experience for deploying in each location for effective supervision at work.
- The contractor must ensure the pre & periodic medical check-up of their workers as per the factories Act 1948 and submit the report in the prescribed format.
- The contractor shall ensure the use of safety appliances/Personal Protective Equipment (PPE) as per the requirement related to the job (example - Rubber hand gloves for handling chemicals. Cut resistance-5 Hand Gloves for handling sharp edges, wire rope, MS angle, channels etc. including rigger's work. Leather/ heat resistance Hand Gloves for handling hot surfaces/materials including welder's work. Job specific gloves to be used as per the guidelines of the HIL
- All lifting tools (Chain Pulley block, Lift, Winch, Crane, Hydra, slings, hooks, D- Shackles etc.) must be tested and certified by a competent person once in a year duly approved by Competent Authorities (Director of Factories & Boilers, of State). A copy of the test certificate should be submitted to Safety cell before starting the work.
- No mobile lifting appliances shall be used on a sloping surface unless adequate precautions are taken to ensure stability.
- Daily check of Safety belts, Scaffolding, Electrical Tools etc. as per the HIL guidelines.
- Adequate nos of Fire extinguishers near Gas cylinders, DG sets etc. First Aid box at site office
- Competent and qualified Safety officer(s) from day one at site as per the HIL guidelines.
- The Contractor shall take all preventive steps to keep working place, office free from fire hazard materials to the fullest extent. In case any fire hazard material is kept near site or work place as a consumable for the day's use, adequate fire protection measures shall be taken, making temporary barricade and Visuals for no smoking, no welding and gas cutting zones shall be displayed and appropriate fire extinguishers shall be installed (Use of cartridge type portable fire extinguisher is not allowed in HIL).
- No smoking, No intake of alcohol, guthka inside the HIL Premises.
- Emergency vehicle with driver during all the time when any workmen at site.

- Good housekeeping must be practiced at all times while within the plant. During and after completion of the work they shall ensure that their work area is kept clean and tidy.
- Contractor shall ensure that he will observe all safety precautions while carrying out the job.
- Contractor shall be solely responsible for any accident to men and machines which occurs due to noncompliance of any safety measures. If a reportable accident occurs due to your negligence, action will be taken against you and penalty will be imposed. If two reportable accidents occur during a year to a contract agency, the contract will be terminated.
- The contractor shall have insurance policy/ESI for his workmen under workmen compensation act before commencement of work as per the statutory requirement.
- Contractor will issue gate pass for their employees in line with our HR policy for easy identification of their employees at site of work.
- Contractor engaged in the transportation of materials or vehicle engaged inside the HIL Premises comply with all Motor Vehicle act and Motor Vehicle Rules- basic PPE, speed limit, roadworthiness, insurance, PUC etc. No person to be allowed to board the running vehicle. Helper/Cleaner is not allowed in HIL Premises.
- The contractor must have a first aid box with all required medicines (as per HIL Medicine Content list) covering his workmen at workplaces, at the contractor's cost.
- In case of any accident the person should be immediately sent to plant occupational health centre with injury slip and accident report should be submitted to HIL Safety officer.
- In case of any accident of the contractor employees, the contractor will have to take care for the medical treatment/ compensation.
- Contract workman engaged for Working at or construction site or in confined space or near high temperature or very low temperature or work with any gas or chemicals which has effects on respiratory or cardiac system, must not be suffering from uncontrolled Hypertension, Diabetes, Cardiac pathology, Vision defect, hearing defect, Asthma, Vertigo, Claustrophobia & Epilepsy.
- Contractor working inside the plant is not allowed to store combustible material in his any of the go-downs /storeroom. In case of storage of the same as per job requirement, prior written permission from execution department, Safety & security must be taken. The contractor in this regard shall ensure compliance of legal rules & regulations. No explosive material should be entered in plant premises if required then approval should be taken from regulatory authorities as well as concern plant, security & safety department.
- Contractors must provide the safe work arrangements for all jobs.
- Adequate housekeeping at working site(s) to be maintained during & after closing of the job. All materials including waste must be put at defined end location(s).
- PPE availability shall be submitted before gate pass & name of the person along with blood group to be mentioned on the helmet.
- Colour coding of all lifting tools and tackles for the periodic third-party test by competent authority to be maintained as provided by client.
- Proper drinking water and other welfare facilities to be provided by the contractor.
- Safety of man machine and material is the essence of this safety code of conduct. In the event of non- compliance of clauses of safety code by workmen engaged by the contractor HIL will undertake specific training to workman or group of workmen so that the non-compliances of

clauses of safety code does not happens. However, in spite of training and counselling workmen a group of workmen of the contractor continues to non-comply clauses of safety code of conduct, HIL will impose penalties to the contractor as mentioned in this document.

C. Safety Non-Compliance:

- If the Contractor fails to take all due precautions to ensure the safety of its staff and labor and implementation at site, HIL will withheld 10% of its payment until such time the same gets implemented. In case of continual noncompliance over a period, Company will be forced to suspend the work and the cost of such suspension will be at Contractors account. The regular audit of safety compliance at site will be carried out by HIL safety officers/FCA at site and the report in this matter will be binding on the Contractor.
- Safety: The contractor shall be responsible to take all precautions to ensure safety of the labours / workers at work. The contractor will supply his labours / worker's safety equipment as per rules.
- In case of any incident like Near miss/ First aid/ Medical treatment injury/ LTI/ Fatal etc., must be reported immediately verbally over telephone or in the format available with the safety dept.
- In addition to the above, the contractor must submit the consolidated information in the format prescribed by the Safety Department of HIL or FCA on monthly basis.

D. Discipline at Work Area:

Contractor must maintain discipline at work area. He must keep the area neat and clean during and after work is over.

- Contractor must ensure the equipment such as Crane / mobile crane, Hoists, Wire rope, Chain slings, Chain pulley block, lifting tackles, and Forklift & Safety belt etc. are to be tested and certified by the relevant authority and approved by the Director of Factories.
- Wooden scaffolding is strictly banned inside the HIL plant.
- Special risk jobs involving height job, confined space work, electrical job, Hot work at flammable/chemical area, excavation job must be carried out with PTW. Clearance must be obtained from a SME of concerned Task Force.
- Contractor must submit the valid copy of approvals from relevant authority/Director of Factories to the concerned Engineer In-charge of HIL
- Contractor must ensure that the electrical equipment's (welding m/c, hand-drilling m/c, cutting m/c, circuit breaker and grinding m/c etc.) are certified by the relevant authorities for their smooth working.
- Contractors must start the work after obtaining the necessary work permit from the concerned Engineer In-charge of HIL.
- Contractors must ensure that the entire job carried out at site should be as per the compliance with Safety, Health & Environment procedures.
- Contractors must follow the control measures to ensure that the risks are eliminated / mitigated.
- After completion of work, contractors shall move the scrap to the specified location of the scrap yard.

3. DEFINITION AND ACRONYMS:

The following definitions apply to this document:

Authorized – Those persons permitted in a work area by HIL or the contractor because they are aware of the potential hazards, the precautions to be taken and they possess the required certifications and licenses as per regulatory requirements (e.g., electricians, tower climbers, crane operators, aerial lift operators).

Competent Person – An individual who, by way of training, education, and experience, is knowledgeable of applicable standards, capable of identifying workplace hazards or environmental aspects relating to the specific operation, is designated by the employer and has the authority to take appropriate corrective actions.

Critical Lift - Any lift: utilizing multiple cranes; exceeding 85% *1 of total capacity of the crane at lift radius; over an occupied structure or public street; of lifting an item of high value or long replacement time.

Dynamic Risk Assessment - The continuous process of identifying hazards, assessing risk, taking action to eliminate or reduce risk, monitoring and reviewing, in the rapidly changing circumstances of an operational incident.

Hot work - Any work involving burning, welding, torch cutting, grinding where sparks are produced, soldering, or brazing in construction, maintenance, and fabrication.

High risk - Refers to a risk level that is not acceptable, after evaluating the risk of a work activity, and must be mitigated to at least a medium level before the work begins. Risk control measures should not be overly dependent on PPE and management review is required prior to work beginning.

Inclement weather - The existence of rain, such as typhoons and rainstorms or abnormal climatic conditions (whether they be those of hail, snow, cold, high wind, severe dust storm, lightening, extreme high temperature or the like or any combination thereof) by virtue of which it is either not reasonable or not safe for workers exposed thereto to continue working whilst the same prevail.

Lost Time Injury (LTI) - An occupational injury or illness resulting in lost productive worktime. An injury is considered an LTI only when the employee is not resumed his regular work duty within 48 Hrs.

Medium risk - Refers to a risk level that is tolerable but careful evaluation of hazards associated with the work activity must be carried out to ensure the risk is reduced to as low as reasonably practicable. Interim control measures like administrative controls and PPE may be used while long term control measures are being established.

Method Statement – Sometimes referred to as a Safe System of Work” (SSOW), describing the way a work task or process is to be completed. As a minimum, details site location, landlord’s details, known hazards on site and details of nearest hospital or medical centre. The method statement should outline the hazards involved and include a step-by-step guide on how to do the job safely. The method statement must also include which control measures have been introduced to ensure the safety of anyone who is affected by the task or process.

Safety Data Sheets (SDSs) – An important component of product stewardship and occupational safety and health. It is intended to provide workers and emergency personnel with procedures for handling

or working with chemical substances in a safe manner and includes information such as physical data (melting point, boiling point, flash point, etc.), toxicity, health effects, first aid, reactivity, storage, disposal, protective equipment, and spill-handling procedures.

Supplier Personnel – Includes, but is not limited to, supplier's direct, full time, part-time, temporary, and contracted employees, consultants, contractors and any other third parties hired or used by the supplier to provide the services or perform the work at the HIL assigned work sites.

4 GUIDELINES

4.1 Requirements:

- As noted above, the requirements set forth in this document are the minimum expectations of HIL. No HIL entity may make representations, guarantees, or warranties that these requirements, by themselves, represent appropriate safety practices as may be reasonable and customary in the industry, nor shall any statements by any HIL employees be interpreted as making any such representation, guarantee, or warranty. The Contractor remains liable for the safe performance of the work and HIL reserves all rights and does not waive any claims regarding the safe performance of the work.
- The contractor shall take all reasonable actions to prevent personal injuries and environmental incidents associated with the work to be performed.
- The contractor shall designate an H&S representative who will be responsible for ensuring all H&S requirements are followed at all work sites including monitoring, inspection, and supervision of next tier contractors. The contractor may designate one of its contractors' employees as H&S representative, but the contractor will remain directly responsible for the H&S performance and compliance with this manual and all applicable laws and regulations. Contractors shall hold a safety briefing (daily toolbox safety meeting) covering the precautions to be taken, before start of the job.
- Safe access and egress to the work site to be always maintained.
- All H&S documentation related to the work to be maintained by contractor and the same must be provided to HIL or affiliates upon request.

4.2 Training and Qualifications

To improve each worker's awareness and knowledge of safe work and the prevention of accidents and incidents, HIL requires that all persons working for and / or on behalf of the Contractor have appropriate training. For example, measures to protect workers from hazard in the workplace, requirements to handle machines and /or dangerous substances and have the appropriate qualifications require to perform the work where required.

1. The contractor shall ensure that their employees and the employees of their subcontractors, if any, receive appropriate training and instructions and are both competent and able to perform the work in a healthy, safe, and environmentally acceptable manner.
2. The contractor shall provide acceptable proof of qualifications, safety training or certifications, for all such employees to the applicable HIL entity upon request. For example – certifications / licenses as locally required for electricians, tower climbers, aerial lifts, crane and powered industrial lift truck operators etc.

4.3 Emergency Response

To eliminate risks as much as possible, HIL requires the Contractor to take appropriate actions and create a plan for emergency response.

- The contractor shall immediately respond to emergency situations involving their employees and those activities directly under their control (including the control of any of their subcontractors) commensurate to the event.
- In HIL premises, the contractor shall become familiar with and follow the appropriate local emergency response plan and notification procedures.
- In the absence of a customer emergency response plan, the contractor shall develop and follow its own Emergency Response Plan, which shall include the appropriate on-site response to emergencies and the notification of the appropriate external authorities and emergency response personnel in a timely manner.
- The Emergency Response Plan shall address the actions to be taken by the contractor's employees or their subcontractors in response to fire, evacuations, accidents, injuries, work-induced illnesses, environmental incidents, and any other event that creates or could reasonably create an emergency.

4.4 Notification

It is HIL's goal to prevent all accidents and incidents in the workplace. However, in the event of such accidents and incidents, the contractor shall, in order of priority, ensure the proper rescue and aid of victims, notify the appropriate authorities of HIL.

- The contractor shall make all legally required accident / incidents notifications including "Lost Time Injury" and "Near Miss" accidents to the appropriate authorities and HIL representatives within the time limits prescribed by such authorities.
- The contractor shall notify the applicable HIL representative as soon as is reasonably possible (preferably within 12 hours) after personal injuries, fatalities, environmental incidents, property damage or regulatory inspection so that such notification does not, in any way, delay the handling of the emergency or affects the response time.
- The contractor shall work with HIL Investigation teams as required to ensure a complete investigation including root cause analysis with appropriate corresponding corrective and preventive actions and report it to the HIL representative.

4.5 Risk Assessment

To identify, evaluate and decide on precautions required for the mitigation of hazards and risks in the workplace, HIL requires the Contractor to conduct risk assessments.

- During the Work planning phase, the contractor shall conduct and document a generic or Job specific risk assessment of the operations, facilities, and equipment applicable to the work to be performed. All work activities identified with "High" risk must be controlled and the elimination of such activities is to be considered. If elimination is not possible, at least mitigation of "Medium" risk before work begins.
- Method Statement is to be prepared and documented for each installation. It shall outline the hazards involved and include a step-by-step guide on how to do the job safely. It shall also detail which control measures have been specified to ensure the safety of anyone who is

affected by the task or process and be used to communicate the risk and precautions required to all those involved in the work. It should be clear and illustrated by simple sketches where necessary. Equipment needed for safe working shall be clearly identified and available before work starts. Workers should know what to do if the work method needs to be changed. Emergency arrangements shall be included in the method statement.

- On arrival at the Job site, and before any work is undertaken, the contractor shall conduct an on-site risk assessment, often referred to as a “dynamic” risk assessment, evaluating site-specific hazards including the ones affected by inclement weather, how they could affect the Job and the means of mitigation. This “dynamic” risk assessment shall be recorded and signed off by all persons involved in the Job. Sign-off shall demonstrate agreement and understanding of the “dynamic” risk assessment. When visitors arrive on site during the works, an H&S induction to be completed. The “dynamic” risk assessment to be used as part of this induction process.
- The contractor shall promptly notify the applicable HIL representative of any defect, unsafe, unhealthy, or environmentally unsound condition identified during the “dynamic” risk assessment that prevents or may prevent a safe and proper installation from being completed. When a risk or hazard cannot be mitigated, work is to be stopped until it is safe to proceed

4.6 Site Inspections / Corrective Actions / Post Job Evaluations

HIL requires the Contractor to take corrective actions on observed hazards or potentially hazardous conditions when such hazards are identified through site inspections.

- The contractor shall conduct and document periodic site inspections to identify and correct any observed or potentially unsafe or environmentally unacceptable conditions.
- Documented periodic site inspections to be made available to the applicable HIL representative or any of their representatives upon request. The contractor shall promptly correct any observed or potentially hazardous conditions at the contractor’s expense if the condition is of their making and notify HIL if the condition was not caused by the contractor.
- The contractor shall collaborate with and contribute to post Job Evaluations as required.

4.7 Work in Inclement Weather

Serious and fatal accidents may occur at workplaces in inclement weather conditions, such as the loss of body balance resulting in falls, electric shock, or electrocution due to leakage of current from wet electrical equipment and the slipping of tools or equipment. The contractor should not underestimate the danger of inclement weather and should adopt a flexible approach and consider employees’ safety both in the workplace and during their journeys to and from work. Before start the job contractor’s supervisor will check the weather condition and mention in daily tool box register and also describe with his working crew. HIL requires the Contractor to –

- Stop work at places with risks of falling objects or fall of persons and avoid operating cranes Such as tower cranes, Hydra etc.
- Remove or secure loose materials.
- Secure plant and scaffolds.
- Stay inside a safe shelter away from metal pipes, cable, structure, fences or window glasses.
- Not perform work at height that cannot be safely performed.
- Not use an umbrella which can cause loss of body balance due to strong wind.

- Use suitable PPE e.g. safety helmets.
- Use safe means of transport and have a route for evacuation.
- Always remain alert on changes to the working environment.
- Prepare for evacuation at any moment.
- Be familiar with the escape route in case of emergency.
- Follow established HIL safety procedures. No use of Mobile Phone.
- Resume work only when conditions improve.

During a lightning thunderstorm the contractors shall

- Keep away from antennas, masts, guy wires and all grounding and lightning protection equipment, including ground rods and don't take shelter under trees.
- Not work on conductive materials such as electrical lines, tower structures or pipelines and not wear highly conductive equipment, e.g. a headset.
- If in a vehicle, stay in the vehicle until the lightning ends. Avoid touching metal or other surfaces in or outside the vehicle that conduct electricity.
- Not lie down on a concrete floor or lean against a wall.

4.8 Chemical Management

Chemical substances have the potential risk to cause considerable health and environmental problems if they are not appropriately managed. To eliminate these problems and hazards, HIL requires the Contractor to manage and handle such substances in a proper manner. ·

- All chemicals used in the course of the work shall be included in the risk assessment.
- The contractor is responsible for ensuring that all users are properly trained in the safe use and disposal of any hazardous material or chemical involved in or related to the project.
- Chemicals and other hazardous materials must be properly labelled with the name of the chemical or material and its environmental, safety, and / or health hazards.
- Appropriate PPE shall be used when handling chemicals as prescribed in MSDS.
- Chemicals and other hazardous materials shall be properly stored according to the manufacturer's recommendations and any applicable laws or regulations.
- Except for materials intended to be left as part of a project deliverable, chemicals and other hazardous materials shall be removed from HIL premises upon completion of the work activities.
- MSDS's shall be readily available to the HIL and the individuals working on the site for any hazardous materials and chemicals as applicable and provided upon request.
- Secondary containment facility should be available near the chemical storage area.
- All chemicals should store according to compatibility chart

4.9 Barricades, Signs & Perimeter Guarding

When the work is performed, taking precautions to prevent any incident is mandatory. HIL requires the Contractor to display visible warning signs so that all workers and the public are aware of the dangers in the workplace.

- Signs and temporary guarding, such as cones, tape, and posting guards, shall be used to warn individuals of potentially hazardous situations caused by or relating to the work being

performed. Such work shall include, but not be limited to, excavation, trenching, electrical, construction, tower erection or climbing, antenna installation, and cable work. All barricades shall be appropriate for the application, visible, legible, and able to withstand any adverse conditions present at the work site and comply with all applicable laws and regulations.

- If the work restricts traffic on a roadway, warnings such as signs, cones, flags, sign / traffic worker(s), traffic lights, or other means of communication as appropriate and in accordance with local requirements shall be provided. Proper precautions shall be taken to communicate the restrictions and re-direct the traffic accordingly. The initial warning sign shall be located and maintained at least 300 meters ahead of the work site
- If the work is being conducted at a tower or other elevated structure, signs and temporary guarding shall be placed at the perimeter of the work area. This is defined as the “drop zone” and it shall be a minimum of 1/2 of the working height. If a minimum of 1/2 cannot be achieved, a third man (spotter) shall be deployed at the edge of the “drop zone” whilst persons are working at height.
- Personnel, having to work in an area where guards, warning signs and / or controlled access are being established by another contractor, shall be aware of the hazard, take necessary precautions and follow all necessary steps to get access to and work on the subject site if granted permission and if safe to do so

4.10 Confined Space Entry & Rescue

A confined space can be more hazardous than regular workspaces as it is an enclosed or partially enclosed space that is not primarily designed or intended for human occupancy with several hazards, such as poor air quality, chemical exposures, fire hazard and temperature extremes.

HIL requires the Contractor to identify the hazards and create a rescue program.

- The contractor shall establish and maintain a Confined Space Entry & Rescue Program to enter confined spaces.
- All confined spaces encountered during the course of the work shall be evaluated for hazards before entry is allowed. Classification of the space shall be documented (e.g., entry permit required) and safe work practices applicable to the type of confined space shall be enforced.
- Atmospheric monitoring shall be performed to detect hazardous atmospheric conditions in confined spaces (such as manholes and vaults) prior to entry and such monitoring shall be documented and be made available upon request. These spaces shall be properly ventilated prior to and during entry in accordance with applicable H&S laws and regulations. One person shall stand guard, when required by local laws and regulations outside the confined space whenever another person enters it and shall be appropriately trained and ready to implement emergency procedures without putting themselves at risk in order to help that person if necessary. During a confined space entry, a mechanical means to rescue a worker from the space must be available and in use in the event an emergency situation arises.
- The person(s) entering the confined space shall be provided with a means of communicating to person(s) outside the confined space. A mobile phone or walkie-talkie is recommended.
- No entry shall be allowed into a confined space that has an atmosphere that is immediately dangerous to life or health.
- Entry and exit register should maintain during working in confined space

4.11 Personal Protective Equipment (PPE)

On-site work requiring contractors to wear PPE always involves high risk and performing regular maintenance and inspections of PPE is very important. HIL requires the Contractor to ensure proper maintenance of and to wear the appropriate PPE for the work.

Indian Standard quality PPEs in line with HIL guideline must be used with uniformity by all associate partners within HIL works premises.

- Safety helmet with chin strap IS 2925:1984
- Safety shoes (For electricians/engineers shall be tested electrical shock proof) IS 15298:
- Hand gloves (For electrical works shall be tested – with certificate) IS 6994 (part1): 1973
- Nose mask (specific mask suitable for welding fumes shall be used by welders/helpers) IS 9473/ NIOSH N 95
- Ear plug IS 8520: 1977
- Safety goggles for dust protection IS 5983: 1980 TYPE -1, EN 166 (2001)
- Safety mono goggles for protection from chemicals IS 5983B TYPE -2, IS 8520: 1977, EN 166 (2001)
- Full body safety harness IS 3521: 1999
- Leg guards (leather) IS10667
- Aprons (leather/fire retardant cloth)
- Welding goggles / shields suitable for use with helmets IS 8520:1977/ IS 8521 (Part-2): 1994
- Cutting goggles IS 8520: 1977
- Fire suit and Chemical Suit as per HIL guidelines
- Respirator area specific as HIL guidelines
- Any other item not mentioned above and required for safety as per the HIL standard.
- Prior to its use, the contractor shall
 - Perform inspection to determine if PPE is fit for purpose and whether they have no cracks, damages, wear, or any other functional defects.
 - Perform further inspection of PPE items following large damages or a big shock to ensure that their function is maintained.
 - Perform further inspection by a qualified person at a frequency no greater than that stipulated by the manufacturer (more frequently if specified locally).
 - Comply with the requirements of applicable laws / regulations of HIL.
- The Contractor is responsible for ensuring that PPE identified during the generic risk assessment is available to and worn by employees who will perform the work. Employees shall be appropriately trained in the proper use, maintenance, and storage of PPE.
- Contractor's employees shall dress appropriately for the work being performed and for the prevailing weather conditions.
- Adequate eye protection (e.g., safety glasses with attached side shields; chemical goggles, welding glasses) shall be worn whenever the potential for eye injury exists (e.g., flying objects, use of power tools, potential for chemical splashing, working on or near exposed energized components) or when specified as a requirement at the.
- Appropriate footwear shall consist of, at a minimum, sturdy work boots or Safety shoes.
- Hard hats shall be worn whenever there is a danger of being struck by falling objects, striking the head on a hard or sharp surface, working on or near exposed energized components, or whenever it is an onsite customer requirement. Non-conductive hard hats shall be utilized when performing electrical work.

- Neckties, loose clothing, long hair, and any kind of accessories, such as chains, watchbands, rings, and earrings shall not be worn when working near equipment with moving or rotating parts.
- Metal jewellery shall not be worn while working on live exposed electrical components.
- Reflective vests shall be worn at work site
- T- Shirt and half sleeve shirt shall not be worn.

4.12 Electrical Safety

HIL requires the Contractor to maintain proper handling and operation of electrical equipment.

- The Contractor shall develop and follow its own Electrical Safety procedures for ensuring that any requirements applicable to the type of job being done are addressed in accordance with applicable H&S laws and regulations (e.g., training, certificates / licenses / permits, etc.)
- The Contractor's procedures shall include steps for ensuring that equipment with hazardous energy is not inadvertently released while someone is working on it.
- General and equipment clearance permit & Electrical work permit to be taken from the concerned authority before execution of the job.
- Before commencing work, when possible, systems should be de-energized and appropriate lock-out/tag-out/Try out (LOTOTO) procedures followed.
- The contractor shall provide evidence of the certification, either academic or issued by government or duly recognized institution as related to its electricians.
- Earth leakage circuit breaker (ELCB) [also known by the term, residual current circuit breaker] shall be used on all portable tools and equipment utilized on outdoor construction/installation sites or when requested by the customer. Low voltage tools or isolating transformers shall be used if required by local regulations.
- The contractor shall not use electrical equipment or tools in wet areas. If the skin of a worker is wet for any reason (rain, sweat, standing in a puddle of water), the works should be stopped.
- Portable electrical hand tools shall be double-insulated or grounded.
- Extension cords shall not be damaged, taped, or repaired.
- The contractor shall not place any materials such that they create obstruction and limit access to electrical equipment and panels
- Electrically insulated tools, fire retardant clothing, or insulating matting may be required, depending on the job requirements.
- The contractor and subcontractors' employees shall exercise extreme caution when working with aerial lift devices, cranes, and other equipment that is operating near overhead electrical lines.
- The contractor's H&S Representative shall be made aware of any site-specific hazards such as voltage of electrical utility overhead power lines, adverse weather conditions, vehicle, and pedestrian traffic, etc.
- A minimum safe distance from electrical utility overhead power lines and un-insulated, exposed, and energized parts (e.g., transformers and capacitors) shall be maintained at all times
- Contractor shall comply with all electrical safety provisions made in Central Electricity Authority (Safety Requirements for Construction, Operation and Maintenance of Electrical Plants and Electric Lines) Regulations, 2011 and Central Electricity Authority (Measures

relating to Safety & Electric Supply) Regulations, 2010 [11]. In case of failure to meet safety standards, they will be issued with warning letter. On issue of three warnings, Hindalco has right to terminate the contract without any commercial impact.

- For carrying out Electrical job, contractor will make Hindalco gate pass for state Govt authorized one number Diploma Holder supervisor and two number ITI technician, failing to comply will result in cancellation of contract”.

4.13 Safe Operation of Mechanical & Electrical Equipment

Operating mechanical and electrical equipment in a safe way is necessary in the workplace. HIL requires the Contractor to manage the risks associated with its use by identifying machinery and equipment hazards in the workplace and eliminating or reducing the risk of those hazards than can cause harm.

- The contractor shall instruct and train its employees in the safe operating procedures and hazards of all mechanical and electrical equipment. Training shall be documented and conducted in accordance with applicable H&S laws and regulations of HIL.
- The contractor shall provide evidence of the certification, either academic or issued by government or duly recognized institution as related to its Powered Industrial Lift Truck, forklift, and Mobile Elevated Work Platform (MEWP) or any other mechanical and electrical equipment.
- All mechanical and electrical equipment shall be operated and maintained according to the manufacturer’s recommendations.
- All mechanical and electrical equipment shall have a calibration / inspection test date & due date which is visible to the user. Documentation shall be available that demonstrates that mechanical and electrical equipment has been calibrated / inspected through competent person. All mechanical and electrical equipment shall be inspected before each use. The equipment shall not be used unless it is found to be free of defects that would affect its safe use.

4.14 Rigging Operations

Improper rigging of a load or a rigging failure can expose riggers and other workers nearby to a variety of potential hazards, including riggers’ being injured or killed when loads have slipped from the rigging, or the rigging has failed. HIL requires the Contractor for the measures to eliminate these dangers.

- Rigging equipment shall be adequate for the type of lift.
- Manufacturer’s operating manuals shall be kept at the worksite for cranes, hoists and gin poles.
- Rigging equipment shall have a unique identification number that is traceable to the manufacturer and an inspection due date, both of which are traceable via a lifting register. Documentation shall be available that demonstrates that rigging equipment has been inspected. Rigging equipment shall be inspected at a frequency stipulated by the manufacturer (more frequently if specified locally) and prior to each use.
- Employees shall be trained in the proper use of rigging equipment.

4.15 Crane/Hydra Operation

Cranes need particular attention paid to their operation, HIL requires the Contractor to properly plan and operate cranes.

- Crane operators shall be trained and also licensed / certified and medically fit as per HIL requirements. Documentation of training and licensing/certification shall be made available.
- The crane operator shall inspect the crane, rigging and the area of the lift before commencing operation. Both daily and all other applicable frequencies of crane inspection documentation shall be made available.
- The crane operator shall identify the work zone by marking boundaries (such as with flags or a device such as a range limit device or range control warning device) and not operate the equipment past those boundaries.
- Equipment operations within minimum clearance distances of a power line are strictly prohibited except where the mobile crane supplier demonstrates that all country, state and local regulations are met.
- A pre-lift meeting shall be held so that all parties involved in the lifting operation, including crane operator(s), riggers, signal persons, employees on personnel lift platforms and supervisors have a thorough understanding of how communication will take place.
- A single person should be designated to direct all operations during the lift. Signal persons shall be trained, and documentation of that training shall be made available upon request.
- A lifting plan shall be prepared and made available for all lifts. The lifting plan shall include items necessary to address the special conditions of each lift. These items shall include but not be limited to, the total load weight to be lifted, crane placement location, required crane configuration, sling and rigging selection, and diagrams of lifting area dimensions.
- Personnel Lifting Systems utilizing either suspended or boom-attached personnel platforms shall comply with all the legal requirements.
- A trial lift with the unoccupied personnel lift platform loaded at least to the anticipated lift weight shall be made from ground level, or any other location where employees will enter the platform, to each location at which the platform is to be hoisted and positioned.
- Both daily and all other applicable frequencies of inspections of personnel lift platforms shall be made available upon request.
- Prepare and document a Personnel Lift Plan as required by country, state, and local requirements.
- The crane's load chart shall be available. The load chart specifies the rated (maximum) capacity of that machine for every permissible configuration as well as the machine's operational limitations and conditions necessary for safe operation.
- Loads are never to be hoisted or moved over workers within the crane's swing radius.
- All personnel shall be kept clear of loads about to be lifted and of suspended loads.
- The area within the swing radius of the crane's superstructure shall be barricaded.
- New Generation hydra (K-10 series) should be used in HIL premises.
- Mobile phone should be prohibited during working with crane and hydra.
- Regular toolbox talks and on the job training on safe material handling related training to be conducted by the supervisor for work crew before starting of the job.

4.16 Excavation and Trenching

Trenching and excavation work presents serious hazards to all workers involved. Cave-ins pose the greatest risk and are more likely than some other excavation-related incidents to result in worker fatalities. HIL requires the Contractor to have adequate protections in place by identifying excavation and trenching hazards.

- The contractor shall identify any potential hazards, including, but not limited to, the location of existing underground utilities, and obtain all required approvals before beginning any excavation, trenching, or other digging operations.
- The contractor should be taken General & equipment clearance work permit and excavation work permit from the concerned authority before execution of the job.
- The trench or excavation must be shored, sloped, braced, or otherwise supported to prevent cave-ins, unless the excavation is in stable rock.
- Ladders must be placed no more than 8 meters apart, for immediate egress.
- Tools, machines, or excavated material must be placed no closer than 60 centimetres from the edge of a trench excavation and 1.2m from any other excavation.
- Adequate ventilation must be ensured when operating equipment with internal combustion engines.
- For mechanical trenching, specific documented safety controls shall be developed and implemented to protect the ground employees working in close proximity to the Chain or Rock Wheel of the Trenching Equipment.
- Workers must understand and have knowledge of the locations of underground utilities.
- A clear communication between the Supervisor and Drilling Operators shall be established to avoid impacting existing utilities infrastructure.
- The crew shall adopt an electromagnetic tracking device to avoid disrupting existing utilities.
- Additionally, particular attention to pipe coupling and decoupling shall be implemented.
- Compressed air is frequently used when dropping cable inside the piping. HIL Safety procedures on working with compressed air shall be documented and adopted by the contractors' employees performing this task.
- Appropriate warning signs, barricades, and other perimeter guarding shall be used to prevent workers and members of the public from falling into the excavation.
- If, during the excavation, unknown materials are unearthed, the contractor must stop the work immediately, notify their H&S representative, determine the nature of the materials, and take the appropriate measures to protect human health and the environment before proceeding. Measures taken must be in accordance with applicable H&S laws and regulations of HIL.

4.17 Concreting

Shuttering and supporting structures shall be of adequate strength and approved by Engineer-in-Charge. This shall be ensured before concrete is poured. The procedure approved by Engineer-in-Charge shall be followed for mixing, transporting, and pouring of concrete. You have to ensure safe operation and maintenance of Batch mixing equipment's. The SOP for operation of Batch mixing equipment's approved by HIL has to be displayed at work site.

4.18 Demolition

Before any demolition work is commenced and also during the progress of the work:

- All roads and open area adjacent to the work site shall either be closed or suitably protected. Appropriate warning signs shall be displayed for cautioning approaching persons.
- Before demolition operations begin, the Contractor shall ensure that the power on all electric service lines/Cables is shut off and the lines cut or disconnected at or outside the demolition site. If it is necessary to maintain electric power during demolition operation, the required service lines shall be adequately protected against damage. Persons handling heavy materials/equipment's shall wear safety shoes.
- No floor, roof or other part of the building shall be overloaded with debris or materials as to render it unsafe.
- Entries to the demolition area shall be restricted to authorized persons only

4.19 Reinforcement

- Bar bending and cutting yard shall be properly cordoned / barricaded and entry shall be restricted.
- Re-bar bending and cutting machines shall be handled by trained operator / skilled workers.
- Shifting of cut re-bars shall be done by mechanical means as far as possible. When re- bars are shifted manually, it shall be done with proper care and proper balance shall be maintained. Clear access shall be provided for shifting of re-bars.
- Proper support shall be given to the column bars by means of rings / props against undesirable sway.
- Free ends of the binding wires shall be bent inside to avoid injuries.
- Proper PPE viz. leather / cotton hand gloves, goggles, etc., for the people handling / shifting and cutting / tying of re-bar, shall be used.

4.20 Formwork for concreting

- Shuttering and supporting members viz. props, tie rods, etc. shall be of adequate strength to support the load / pressure of concrete and the formwork scheme shall be approved by Engineer-In-Charge in advance. The procedure approved by Engineer-In- Charge shall be followed for mixing, transporting and pouring of concrete.
- The process of stripping of formwork shall be planned in advance and approved by Engineer-in-charge. Stripping shall enable the structural member to behave in desired manner. The area shall be suitably cordoned / barricaded and unauthorized entry shall be restricted by displaying signboards, etc.
- While removing formwork from vertical surfaces, the shuttering board shall be adequately supported by props, in order to prevent the same from toppling / slipping, until it is lowered on ground safely. Same support with props shall be provided during erection of formwork too until the plywood is secured in desired place with tie rods

4.21 Ladder Safety

When using ladders, the following practices shall be followed:

- All ladders shall be inspected and shall be in good condition prior to each use. There should be anti skid rubber shoe with leg of the ladder

- Ladders must be made of nonconductive material (i.e., wood, or fiberglass with a plastic top) if being used where the person on the ladder or the ladder could come in contact with energized equipment parts/components, fixtures or circuit conductors.
- Stepladders shall be used only in the fully opened, locked position.
- All ladder feet shall be positioned on secure, even surfaces; and All employees that use ladders shall be instructed in the proper use of ladders.
- Use of personal fall protection equipment while use of ladder
- Ladder should be use in 1:4 ration.
- During working on ladder it should be tied with permanent structure and one crew member also hold the ladder.

4.22 Work at Height

The Contractor shall engage only properly trained and certified climbers who are fully aware of and knowledgeable about the inherent dangers of climbing or working above ground level. The climber's training and knowledge shall include:

- The nature of fall hazards in the work area.
- The correct procedures for erecting, maintaining, disassembling, and inspecting the fall protection systems to be used.
- The correct procedures for inspecting personal fall protection equipment for wear, damage, defect or deterioration.
- Climbing safety procedures
- The use and operation of the fall protection systems utilized by the contractor/sub-contractor.
- The role of each employee in the safety monitoring system used
- The correct procedures for handling and storing equipment and materials
- The compatibility of fall protection equipment and fall protection systems
- Hands-on field exercise that will cover climbing, repositioning, and rescue on the type of elevated structures tower climbers will encounter in the field.

The Contractor must ensure:

- The person having valid Height passes to be engaged for working at height activities.
- Regular toolbox and on the Job training to be conducted before and during execution of the job on regular basis.
- Working at height Job to be planned and supervised properly for safe execution of the job.
- Prior to execution of the job, Safe working method/HIRA to be made, communicated among the work force.
- Always appoint a competent supervisor for Working at height job.
- Working at height permit to be taken from the concerned authority at shop floor before execution of the job.
- Always use safe means of access, platforms, staircases etc.
- Use of fully body harness (safety belt), life arrangements, fall arrestors to be ensured during execution of the job.
- Always fix the anchor point of full body harness to a rigid point/structure of the platform during ascending and descending time.

- Use of Mobile phone is strictly prohibited during height or any job.
- Use of toxic drugs (cigarettes, Guthka's, Bhang's) is strictly prohibited during such jobs.
- Do not keep loose materials on the working platform.
- Do not throw welding stub from the height, use stub bins to collect it.
- Do not block the walkway at higher elevation this could lead to tripping hazard.
- Hand tools such as spanner, hammer should be securely kept While working at height.
- Inspection of PPE's, tools & tackles, equipment's to be done and ensured before execution of the job.
- Do not work during adverse weather condition (foggy climate, rainy condition, and heavy wind)
- Rest ladder at must be rested at the appropriate angle (60-75 degree).
- Work platforms must have top and intermediate handrails and toe boards.
- Do not disengaged both safety harness hook while moving on work at height activity.

4.23 Welding Activities:

- Zero joint policy should be followed power supply cables with many welding machines should not have several joints. All welding cables (power and earthing) should be jointless upto a min. length of 50/75/100 mtr
- Fully insulated electrode holders to be used. Torsion bars and structures not to be used in place of welding return cables to job directly as per the guidelines of the HIL.
- Use of job specific PPE' for welders as per IS standards such as Safety helmets, safety shoes of nonconductive sole / Leather apron/non- flammable, face shield attached with Safety helmets, leather hand gloves to be ensured.
- Use of two-phase welding machines to be restricted in the workplace locations.
- Only Trained, qualified / experienced, Medically Fit person/ welders to be employed and used. Regular toolbox talks and on the job training on safe execution of welding activities to be conducted by the supervisor for work crew before starting of the job.
- The output circuit should be de-energized while electrode is being changed. The helper should have a switch, adjacent to work, so that he can cut off the current supply. For this following setup shall be ensured and welding machine shall be positioned in such way that helper can switch it off immediately.
- Return earthing cable with clamp to be fixed with work piece. Welding current return clamp should only be connected at another place when it is practically impossible to attach it to work piece. However, in such cases it should be as near as possible to work piece and electric current path should be firm. Welding current return cable clamp shall form firm joint.
- Electrical distribution board/panel to be fixed with Earth Leakage Circuit Breaker (ELCB)/ Residual. Current Circuit Breaker (RCCB) connections.
- Welding Machine should be fitted with VRD
- Work permit to be taken by the Respective contractor, concern mechanical person, area engineer from the process department and area owner before starting of the job at workplace locations.
- Proper double body earthing from and with the machine to be ensured during welding activity.
- The lugs fitted with welding machines to be properly insulated. Proper clamping to be

ensured.

- Conditions of welding machines wheels to be always in good and working conditions.
- Provision of "MAIN POWER CUT OFF SWITCH" and "SECONDARY CIRCUIT POWER CUT OFF SWITCH" to be ensured at Job site.
- Use of Single-Phase Supply Welding Machines is restricted at job site.
- Hot Work Permit to be obtained by respective Contractor before execution of any Hot Work Job. Inspection of Welding machines to be done and ensured by your supervisor as per the checklist of Hindalco on daily basis.
- Inspection of welding machine to be done and ensured by your supervisor as per the checklist of HIL on daily basis.

4.24 Gas Cutting Activities

The gas cylinders used in our premises/workplace to be complied as per statutory requirement under rule 20 of "The gas cylinder rules (Schedule VI clause 4)" and as per HIL safety guidelines which are mentioned below:

- All the cylinders should be received with valve protection caps.
- All cylinder valves while in use and in transportation shall be protected with valve protection cap. Also, once this cap is fitted properly on cylinder, it is not required to be removed for filling or withdrawing material from cylinder. All connections can be made without removing these caps.
- Each cylinder must be subjected to inspection before accepting them at store /contractors /vendors and should have copy of Hydrostatic pressure testing certificate of each and every cylinder by the user department.
- Both oxygen and acetylene hoses at torch end and cylinder end shall be provided with Flashback arrestors.
- The cylinders to be only transported after kept in a trolley having canopy arrangements tied with adequate chain system with vertical upright position for its protection as per the HIL guidelines.
- Regulators and pressure gauges should not be broken, ruptured and not in working conditions. Proper indications of pointer to be ensured in pressure gauges of all the cylinders.
- Hose joints to be secured with proper and adequate clamp system.
- Periodic cleaning of nozzle to be done and ensured by the concern department.
- Torch handle and adjusting Knobs should be always free from any damage.
- Provision of fire extinguisher on the cylinder trolley.
- Gas cylinders should not be exposed to direct sun rays.
- Hot Work Permit to be obtained by concern department before using them into work.
- Trained, experienced and medically fit work men to be ONLY engaged for gas cutting activities.
- Inspection of Gas cuttings sets to be done and ensured by your supervisor as per the checklist of HIL on daily basis.

4.25 Road Safety

- All vehicles shall have valid registration; insurance & road permit in compliance with regulations & always keep copies of valid travelling documents in the vehicle (Driving license, registration, insurance, identity card & contact details).
- All vehicles shall be equipped with seat belts, first aid box, handy fire extinguisher, standard stopper, etc. The drivers should be trained to use fire extinguishers.
- All vehicles shall be well maintained & kept in perfect working order and fully equipped with the proper safety gear. Conduct regular checks of the vehicle's condition and report defects immediately. Any defect is removed as soon as practicable, before the vehicle is put in use.
- Pick-ups and similar vehicles shall be equipped with cargo barriers to sufficiently stop projectiles and sharp objects from striking the driver and the passengers.
- Comply with HIL defined Health & Safety procedures for the contract vehicles & drivers as per Contract Management system.
- All drivers shall have an experience of minimum 5 years and age should be between 23 & 58 years.
- All contractors shall wear ISI Mark crash helmet and shoes while driving motorbike. Safety helmets worn in plants will not qualify as crash helmets, as they are not adequate to withstand the impact caused during accident.
- Any new driver before starting driving shall attend safety training program for safe driving.
- Drivers shall have his journey schedule showing expected date & time to complete the journey.
- Drivers shall not drive more than 08 hrs. in a day.
- Drivers shall operate only those vehicles for which they are trained, authorized, and licensed.
- Without proper authorization by their respective supervisors, drivers shall not operate any vehicle other than they are authorized to operate, even if they are capable of such operation.
- The person in the driver's seat shall keep seat belts fastened, while the vehicle is in motion.
- Specified and safe speed limits shall be observed and always maintained.
- Specified vehicle operating instructions shall be observed.
- Driving during bad weather conditions shall be done with utmost care.
- Mobile phones are not to be used whilst driving or operating a vehicle.
- Driving under the influence of alcohol or any sedative drug (including prescribed medication) is strictly prohibited.
- Eating, drinking (even non-alcoholic beverages), etc. during driving shall be avoided. Such activities increase the risk of accident due to distraction and lack of concentration.
- When loading and unloading, the driver shall observe relevant guidelines and requirements in a way to avoid danger to any person or damage to any property.

- Drivers shall have their medical fitness report before resuming their job at site as per regulation; and once a year thereafter & copy of medical report shall be available with the driver.
- Should be trained in First Aid and CPR and Transport safety before start of work and should possess a valid certificate.
- Should undergo refresher training at least once a year at the cost of the contractor.
- Violation of the guidelines may result to accidents. In any case HIL reserves the right of taking appropriate action (including termination of services or contracts) against violators of the guidelines.
- In case of an ACCIDENT, Near Miss and Major Vehicle break down, Driver / Travel person shall Immediately report the incident to the concerned responsible person, follow the defined procedures of Indian Motor Vehicle.
- TREM Card must be available with the driver during transportation and Haz-Chem code must be displayed on the chemical transportation vehicles.
- All the vehicles should be parked in designated parking area and should follow the designated route while going to coming from their respective work site.
- Should be well versed in vehicle safety/ transport safety and chemical safety checklists as per the work assigned.

4.26 Material Handling

- A suitable lifting safety program/ safe system of work is developed consisting of planning and execution of lifting operations.
- Risk assessments and permit to work are required for all lifting operation.
- The worksite is physically safe for the lifting operation e.g., there is no physical obstruction in the path of the load.
- The lifting equipment is correctly selected, tested and certified in accordance with legislative requirements and technical standards.
- The personnel deployed as part of the lifting team are suitably trained, competent, and certified.
- All lifting equipment and accessories are tested prior to commissioning and periodically by competent persons for rated capacity and records are maintained.
- Lifting devices and equipment have been certified for use within the last 12 months (at a minimum);
- Load does not exceed dynamic and/or static capacities of the lifting equipment.
- Any safety devices installed on lifting equipment are operational; and
- All lifting devices and equipment have been visually examined before each lift by competent person.
- Every lifting equipment and its component parts shall be identified with a visible marking including the
 - Safe Working Load (SWL).
 - Date of Last Test
 - Next due date

- While crane marching & placement experienced flagman shall navigate the crane movements and provide the directions to crane operator while marching on road.
- Wherever needed soil compaction shall be undertaken and steel plates shall be used to provide a firm base to lifting equipment/crane.
- Barricading/ warnings signs shall be provided to prevent moving below suspended load or the boom areas of potential impact.
- Cranes shall not be operated between sunset and sunrise without adequate lighting provision.
- Test Certificates: All current test certificates for cranes and lifting gear shall be kept readily available. Lifting equipment and accessories shall not be used unless the appropriate current test certificates are available.

Any Deviations must be informed to concerned authority and proper approval shall be taken before proceeding with restricted deviations. All working crew must be aware of the specific deviations including risks & hazards which may occur during execution with deviations. Deviations must be documented, and documentation must indicate causes of deviation with safety plan. Deviation authorization must be renewed periodically.

4.27 Fire Protection

The Contractor shall take all preventive steps to keep working place, office free from fire hazard materials to the fullest extent. Packing materials like polythene, cardboard, wood etc. shall be immediately removed after unpacking to the scrap storage areas earmarked by the Company. Every day, any combustible debris, wastage and other inflammable articles shall be removed to dumping area. Flammable gas, chemicals, fuels; oils shall be stored away from working site, office and living places and precautions taken to keep in fire preventive/proof area where smoking, naked fire, loose electrical connection, sparking etc. should be avoided. In case any fire hazard material is kept near site or work place as a consumable for the day's use, adequate fire protection measures, making temporary barricade and marking no smoking, no welding and gas cutting zones shall be carried out and displayed and appropriate fire extinguishers installed. Fire extinguisher at different places of work, offices, living places shall be installed at adequate nos. and type suitable for fire of supervisors, engineers and workmen should be trained to use fire extinguishers and fire hydrants so that every time and every place trained persons are available to operate appliances and fire hydrants. Besides telephone nos. of the Company's fire brigade as well as nearest fire brigades of the neighbouring organizations and Govt. shall be displayed at work site, office, living places. All fire arrangements as stated above, adequacy certified by the Company's Fire Officer or appropriate Fire authority shall be done by the Contractor at appropriate time at his cost and periodical check shall be carried out to ensure that they are in order in addition to installation of the Contractor's own fire fighting arrangement including Fire Tender, if required. The Fire Tender operator shall have undergone training course in statutory organization of Govt./approved by Govt. and competency certificate in this respect shall be furnished to the Engineer

4.28 Painting

- The following precautions shall be taken during the Painting work.
- Air respirators shall be provided for use by the workers when paint is applied in the form of spray, or a surface having lead paint is dry rubbed or scraped.
- Adequate facilities shall be provided to enable the painters to wash at the cessation of work.

- All painting jobs, especially those in which lead paints are used shall be kept under industrial hygiene surveillance.
- Smoking, open flames or sources of ignition shall not be allowed in places where paints and other flammable substances are stored, mixed or used. A caution board, with the instructions written in national/regional language, "SMOKING IS STRICTLY PROHIBITED" shall be displayed in the vicinity where painting is in progress or where paints are stored. Symbols shall also be used for caution boards.
- Suitable fire extinguishers shall be kept available at places where flammable paints are stored, handled or used.
- When painting work is done in a closed room or in a confined space, adequate ventilation shall be provided. If adequate ventilation cannot be provided, workers shall wear suitable respirators.
- Epoxy resins and their formulations used for painting shall not be allowed to come in contact with the skin. The workers shall use plastic gloves and/or suitable barrier creams.
- Adequate ventilation shall be provided especially when working with hot resin mixes.
- Increased personal hygiene shall be practiced to control inadvertent contact with the resin and eliminate its effects.
- Workers shall thoroughly wash hands and feet before leaving the work. Work clothes be changed and laundered frequently.

5. OCCUPATIONAL HEALTH, SAFETY & ENVIRONMENTO (OHS&E):

The contractor shall be responsible to take all precautions to ensure safety of the labours / workers at work. The contractor will supply his labours / worker's safety equipment/PPEs as per rules. If you're bringing your own equipment to carryout of job inside the plant such equipment should be subjected to hazard identifications and risk assessment prior to commencing of work. The persons engaged by you shall be given appropriate awareness on OH&S. Those personnel who will carry out jobs affecting OH&S shall be properly trained and made competent for the job to be performed by them. During emergency which may be faced in the plant your personnel should move to the designated emergency assembly points. They should not spread any rumour.

- It is preferable to have Occupational health and safety standard implemented by contractor at his site.
- Contractor shall follow all Safety, Health, Environment, and other operational policies as published by Hindalco time to time with latest amendments.
- Contractor shall follow all Safety, Health, Environment, and other operational policies.
- Suppression of Fugitive dust emissions due to vehicle movement of contractor's vehicle will be responsibility of the contractor.
- Contractors shall have to avoid spillage for all kind of materials. In case any spillage happens, it must be cleaned by the contractor at his own cost.
- Ash must be transported in covered condition.
- Contractors shall have to follow the respective control measures while carrying out a particular activity to ensure compliance with environmental standards.

- Contractors need to ensure Pollution under Control (PUC) Certificate and fitness certificate obtained for the vehicle used for transportation. Drivers have to show these certificates as and when required along with their Driving License.
- Contractors shall have to ensure that there are no air horns fitted to their vehicles and the noise from vehicles do not increase the overall ambient noise levels.
- Contractors shall educate their vehicle drivers regarding the use of correct fuel and to explain them ill effects of using adulterated fuel.
- Contractors should avoid over loading of trucks.
- Contractors and their employees should follow SOP for handling of all types of wastes.
- Contractors and their employees should not wash or carry out any maintenance to the vehicle inside the Plant.
- Contractors must ensure that none of the resources (water, energy, steam, compressed air, etc.) are misused.
- Contractors must ensure good housekeeping in their workplace.
- Contractors / transporters must ensure that trucks carrying hazardous chemical like Caustic Soda Lye, Sulphuric Acid, Hydrochloric Acid etc has to display the Transport Emergency Card (TREM card) and their drivers should be trained to handle the material during emergency
- Transporters carrying hazardous waste should have necessary authorization from SPCB and should carry manifest while carrying waste from HIL.

Contractors must ensure that none of their work will result in pollution of air, water, soil & noise

6. SAFETY OFFICER:

- The contractor shall have competent & dedicated safety officer / supervisor to ensure Compliance to safety measures / rules and regulations. The guidelines for deciding number of safety officer / supervisor:
- If average manpower deployment on daily basis per contractor for the specific contract falls in between **1 – 100 persons, one Safety Officer** will be required. If deployment exceeds 50 nos. additional Safety officers will be required in the scale of 1 safety officer for every 50 men deployed.
- Irrespective of the no. of manpower deployment, dedicated Safety Officer will be required per shift for the following job contract (at each location):
 - De-scaling/ working in confined space.
 - Working at height
 - Lifting & handling of heavy items
 - Scaffolding & similar activities
 - Major electrical jobs like Switchgear maintenance
 - Work with chemicals / gases
 - Any construction job.
 - Loading, unloading job.
 - Heavy vehicle use
 - Persons involved in transport whether road or railways.
- Minimum qualification for the Safety Officer/Supervisor will be Engineering (Mech./Elect/Civil) or Diploma in Engineering (Mech./Elect/Civil) and Graduate in Science with Post Diploma in industrial Safety from a recognized institute approved by SCVT/AICTE. The assessment of competency and verification of employability under contractor will be done at site.

SAFETY PENALTY MATRIX

Details of penalties to be imposed on Contractor for non-compliance to safety standards and Safety violations by them or their employees are given below:

#	Description of lapses of procedure/ Safety Systems	Penalty Amount per violation
1	Entry without Gate Pass	Rs. 500
2	Non-Compliances of PPEs (Per Non Compliance)	Rs. 500
3	Unavailability of test certificate of Lifting Tools, Tackles & machines including records / Use of non-standard lifting tools	Rs. 5000
4	Unlicensed electricians/ Sub-standard Electrical equipment's	Rs. 5000
5	Non-standard Ladders or improper use of ladder for working at height/ Unavailability of Railing/ Walkways/ Platforms/ ramps.	Rs. 5000
6	Working at height without use of double lanyard full-body harness/ anchoring to lifeline /Safety Net/ Non-availability of secured lifeline.	Rs. 10000
7	Overtaking/ Overloading/Over Speeding/ Not using safety belt in 4 wheelers / talking on mobile while driving/ Driving without license/Rash driving/ leaving vehicles unattended/ parking on road creating hindrance to other road. (With in Plant Premises)	Rs.1000
8	Working without SWP /Permit/ Clearance	Rs. 5000
9	Non display of name board, Barrication etc. at site	Rs. 5000
10	Absence of contractor representative in HIL safety Meeting whenever called	Rs.2000
11	Non deployment of safety supervisor/ supervisor/ responsible for safety at worksite required as per Contract Conditions	Rs. 2000 per day
12	Non-reporting of injury cases including first Aid Cases	Rs. 5000
13	Non-compliance to hydra driving guideline /heavy vehicle driving	Rs. 10000
14	Sleeping of drivers / helper under parked vehicle/ Driving vehicle without valid driving certificate / Damaged dallah of truck/ Truck causing spillage on the road /Non-availability of parking light/ reverse horn/ head light/ 3 way mirror	Rs. 5000
15	Violations other than above like employment of Unsafe Condition, Unsafe Act, Near miss, Accident	Assessed by concerned deptt.
16	Any equipment damage or property damage due to contractor's negligence or unsafe practice or failure, penalty assessed by concerned department shall be imposed.	Assessed by concerned deptt.
17	Non- Reportable accident (absenteeism <48 hrs)	Up to Rs 20,000
18	Reportable accident (Absenteeism >48 hrs)	Up to Rs 100000

Note : The above are the Indicative Penalty terms. The HIL reserve the rights to deviate the above penalty amount based on the severity of Incident and nature of Job.



Client – Hindalco Industries Ltd
Project - Aditya Alumina Refinery
TCE.13833A-ME-6002-6001, Rev-P0



TECHNICAL SPECIFICATION FOR MAIN PLANT SYSTEM

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ATTACHMENT-13 ELECTRICAL SAFTEY GUIDELINES

HINDALCO

ELECTRICAL SAFETY STANDARD

HINDALCO INDUSTRIES LIMITED



Hindalco Industries Limited



Electrical Safety Standard

Document No. HIL/OHS/STD/ES/01

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	Annexure 5	Audit of Electrical Installations as per CE-2010
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1. General

Electricity is as dangerous as it is useful. Unlike other products we use every day, we can't see, hear or smell electricity. So we may not always think about using it safely. A moment of carelessness, or a piece of faulty equipment, can cause an electrical accident. Minor electrical shocks could be fatal and minor errors while handling electrical equipment could hurt you. The more we learn about the safe use of electricity, the less our chance of injury. Electricity gives us light but do not take electricity lightly! Power systems often have one side of the voltage supply connected to earth ground to ensure safety at that side, by keeping zero potential in between. The "grounded" conductor is called the neutral conductor, while the ungrounded conductor is called the phase or the live wire. Electric shock can only occur when contact is made between two points of a circuit; when voltage is applied across a victim's body. Electric burns, fires, arcing and explosion are other versions of electrical accidents. Effective implementation of Electrical Safety precautions can save lives and to prevent hazards.

2. Purpose

Working on or near energized electrical installations/ equipment's can cause serious risks if installations if not adequately engineered, maintained and operated. Exposure to live electrical installations / cable is major source of electrical injuries besides exposure to electrical arc flash and fire due to electrical short circuit. The purpose of this standard is to provide adequate guidance to work with minimum safety requirements & precautions to be taken during commissioning / installations and provide information and knowledge to the working group so that they can develop procedure for safe operation and maintenance of electrical installations / equipment's.

3. Scope

The purpose of this standard is to provide a practical safe working area for employees relative to the hazards arising from the use of electricity.

4. Reference

- ✓ Indian Electricity Rules 1956
- ✓ Indian Electricity Act 1910
- ✓ Electricity Act 2003
- ✓ CEA Regulation 2010

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- ✓ Battery Management & handling Rules-2001
- ✓ E-waste (Management) Rules-2016
- ✓ OSHA, Electrical Safety Related Work Practices, 29 CFR Part 1910
- ✓ NFPA® 70E, "Electrical Safety Requirements for Employee Workplaces"
- ✓ Requirement under Hindalco- Electrical Task Force Safety committee
- ✓ Safety Policy: ABG/SUST/POL/06
- ✓ Machine Guarding: ABG/SUST/TS/33
- ✓ Electrical Safety: ABG/SUST/GN/31
- ✓ Personal Protective Equipment: ABG/SUST/GN/32
- ✓ Portable Hand and Power Tools: ABG/SUST/GN/35
- ✓ Documented Information Management: ABG/SUST/MS/06.
- ✓ SAFETY MANAGEMENT SYSTEM: ABG/SUST/TS/14
- ✓ ELECTRICAL SAFETY: ABG/SUST/GN/31
- ✓ PERSONAL PROTECTIVE EQUIPMENT: ABG/SUST/GN/32

5. Definition

These definitions are provided to describe the intent of this standard; the terms may be defined differently in other contexts.

Electrical Safety Officer: A person being determined by management, he possesses a certificate of competency on electrical work issued by the Appropriate Government for ensuring observance of safety measures specified under CEA Regulation 2010.

Designating & Authorized Person —a person being determined by management he possesses a certificate of competency on electrical work issued by the Appropriate /Competent authority /Government and given permission and support to perform and/or direct specific tasks or functions.

Qualified Person:

1. Trained and knowledgeable in the construction and operation of equipment or specific work method.
2. Able to recognize and avoid electrical hazards.
3. May be qualified with respect to certain equipment and methods but unqualified for others.



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4. Must be authorized by unit to work & only qualified persons shall be allowed to work on energized parts or equipment.

Electrical Work: Any job or task requiring a Qualified Electrical Worker. It includes any work that involves a shock or arc flash hazard or creates potential a shock or arc flash hazards, energized or DE energized condition.

Electrical event—an unusual occurrence that did not, but had the potential to, lead to an electrical incident.

Electrical incident—an incident that involves, or has the potential to cause, damage to equipment or property or an electrical injury as defined in this standard or other injury that may result from direct exposure to electrical energy (e.g., a fall injury that might result from reaction to electric shock).

Electrical injury—an injury that results from electrical, thermal, acoustic, or radiation energy released at the moment of an electrical incident.

Electrical Resource - A person who is familiar with site safety rules concerning electrical work and understands the hazards, operation and design of the equipment involved. This person need not work in the same area as the involved equipment is located.

Energy-Isolating Device: A mechanical device that prevents the transmission or release of energy. Examples include the circuit breakers and load dis-connector isolator switches, Energy- isolating devices should be lockable by some means or other type of attachment.

Energized Work - Work where exposed and unguarded circuits or parts energized at potentials greater than 50 volts must be contacted or approached closer than the "Prohibited Approach Boundary"

Flash Rating: Maximum energy (from an arc flash) for which the PPE will provide satisfactory protection.

High Voltage (Voltage Level): The term high voltage applies to electrical equipment that operates at more than 650 Volts (for Phase to Phase operation) or more than 300 Volts (for Phase to ground operation)



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Insulation Resistance. The insulation resistance measurement test may be conducted on all types of electrical switchgear, transformers, cables, etc. The test is a method of determining the integrity or condition of equipment insulation.

Electrical Grounding (Earthing): - In the Electrical circuit the ground wire is run along with the phase and neutral wire during the installation. This grounding wire is connected to the common grounding of the building / premises. For the safety purpose it is essential to ensure the electrical equipment is two point grounded otherwise it may leads to accident, if there is any leakage current

Earth Leakage Circuit Breaker (ELCB) — Earth Leakage Circuit Breaker detects grounding problems and shuts electricity off to prevent a possible accident.

RCCB: Residual current circuit breaker detects grounding problems and shuts electricity off to prevent a possible accident.

Shock Hazard Exposure – These approach boundaries are referring to the electrical shock hazard and NOT the arc flash hazard. WARNING: The arc flash boundary may be greater or less than the shock boundary.

Arc Flash: Intense heat and light generated by an electric arc.

Arc Flash Boundary: The boundary within which arc flash PPE is required.

Arc Flash Hazards: Hazards associated with the arc flash (e.g. radiant and convective energy, arc blast vapours, molten droplets and projectiles).

Arc Rating

The value attributed to materials that describes their performance to exposure to an electrical arc discharge. The arc rating is expressed in Cal/cm² and is derived from the determined value of the arc thermal performance value (ATPV) or energy of break open threshold (EBT) (should a material system exhibit a break open response below the ATPV value). Arc rating is reported as either ATPV or EBT, whichever is the lower value.

Arc-rated clothing or equipment indicates that it has been tested for exposure to an electric arc. Flame resistant clothing without an arc rating has not been tested for exposure to an electric arc. All arc-rated clothing is also flame-resistant.

Arc Thermal Performance Value (ATPV)

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The incident energy (Cal/cm²) on a material or a multilayer system of materials that results in a 50% probability that sufficient heat transfer through the tested specimen is predicted to cause the onset of a second degree skin burn injury based on the Stoll curve.

Limited Approach Boundary – entered by “Qualified” persons or unqualified persons escorted by qualified person. ARC Flash suit is required to be worn by all entering into Limited approach Boundary.

Restricted Approach Boundary – entered only by qualified persons required to use shock protection techniques and equipment. ARC Flash suit is required to be worn by all entering into Restricted approach Boundary.

Prohibited Approach Boundary – entered only by qualified persons requiring same protection as if in direct contact with live part. ARC Flash suit is required to be worn by all entering into Prohibited approach Boundary.

NOTE: Each boundary is a sphere to be observed in all directions (Three dimensional / 360 degrees)

Arc Flash Suit: A complete arc-rated clothing and equipment system that covers the entire body, except for the hands and feet. An arc flash suit may include pants or overalls, a jacket or a coverall, and a beekeeper-type hood fitted with a face shield.

Barrier: An insulating physical obstruction, such as insulating sheeting, an insulating blanket, or a Lexan cover, that is intended to prevent contact with energized electrical conductors and circuit parts. Barriers may be permanently installed in the equipment, or placed temporarily during performance of energized work.

Barricade: A physical obstruction such as tapes, cones, or A-frame-type wood or metal structures intended to provide a warning and to prevent unauthorized access to a work area.

6. Procedure and Best Practices :

This standard addresses electrical safety related work practices, safety-related maintenance requirements, and other administrative controls for employee workplaces that are necessary for the practical safeguarding of employees relative to the hazards associated with electrical energy during activities such as the installation, inspection, operation, maintenance, and demolition of electric



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conductors, electric equipment, signalling and communications conductors and equipment. This standard also includes safe work practices for employees performing other work activities that can expose them to electrical hazards.

6.1 Formation of Taskforce

6.2 Identification of Electrical safety compliance/procedures

6.2.1 Safety certification of Electrical operated Hand tools:

Annexure-1 used for carrying out audit of equipment used in the entire plant.

Key Principle for safe operation:

1. No hand tool (company owned & contractor) should be allowed to operate in plant premises without safety clearance given by electrical workshop.
2. A specific tag no. is issued by electrical workshop & identified by any one after looking the tag.
3. Each hand tools machine must be connected to input power circuit designed for work only, which is protected by ELCB/RCCB.
1. Hand tools in defective condition must not be used for maintenance activity.
2. Hand tools that are broken or require repair should be kept separately and labelled with a warning notice "DANGER! DO NOT USE FOR WORK!"
3. Hand tools should not be used for purposes other than they are designed for.
4. When power operated tools are designed to accommodate guards, they shall be equipped with such guards when in use. Tools shall be used with the correct shield, guard, attachments and PPE, as recommended by the manufacturer
5. Only non-sparking tools shall be used in an explosive or flammable atmosphere
6. One should concentrate on the job when using a hand tool.
7. Playing with hand tools should be strictly prohibited.
8. Store it in a careful & safe manner when not in use & never leave power tools in work area.
9. Never pull out the plug top from the socket in energized condition.



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10. More than one wire in a plug top is not allowed to operate.
11. Never pull the top by pulling cable of any hand tools.
12. Never remove the ground wire in any manner.
13. Never touch electrical outlets with your fingers or with objects.
14. Keep the flexible cable away from heat, oil, sharp edges, and moving parts.
15. Replace, don't attempt to fix cables that have been cut or damaged.
16. Avoid making direct contact with any exposed conductor of the cable.
17. Always keep the hands and the body dry.
18. Do not stand in water or on wet surfaces when operating power hand tools or portable electrical appliances.
19. Do not use a power hand tool to cut wet or water-soaked building materials, or to repair pipe leaks
20. Do not use a power hand tool while wearing wet cotton gloves or wet leather gloves
21. Never operate electrical equipment barefooted. Wear rubber-soled or insulated work boots
22. Do not handle or operate electrical tools when your hands are wet or when you are standing on wet floors.
23. Use gloves while working with electrical equipment's.
24. Recheck & confirm that the electrical circuit has been switched off after work.
25. All Single phase electrically operated hand tool should have 3 core cable if it is not double insulated. If the hand tool is double insulated than 2 core cable can be used.
26. No joints in input cable is permitted and maximum length should be 10 Meter.
27. Industrial connectors/plugs and sockets shall be used for both 110v and 240v electrically operated portable power tools; under no circumstances are domestic 3 pin plugs and sockets to be used in an industrial or construction environment

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28. The Purchasing Policy shall include a requirement to purchase equipment with IS, ANSI, CE or equivalent marking as per national standards.
29. Electrically operated portable power tools shall be double insulated.
30. All electrically operated tools shall be used within their design limitations
31. Operators shall be provided with the personal protective equipment necessary to protect them from any specific hazards associated with the use of electrically operated portable power tools, in accordance with the requirements of the Guidance Note on Personal Protective Equipment.
32. When operating any electrically operated hand tools, workman must ensure that socket is protected by 30mAmp ELCB/RCCB.
33. Do Not raise or lower with cable to Electrical hand power tools while working on height also DO Not hang it on cable.

Procedure for certification:

1. It is the responsibility of hand tool owner to shift particular hand tool to the electrical workshop to check the healthiness & refurbishment details.
2. All the hand tools of the plant is to be identified as separate ID (W/s Ref no----) no & numbering to be done.
3. The Hand tool will be pasted with a specific tag no. (As per location defined below)
4. The hand tool will be checked for its healthiness by competent Electrical Engineer. They will list out discrepancies & give refurbishment details.
5. After inspection and testing is successful the hand tool will be released to the respective owner with a certificate, test report.
6. If the hand tool is not found ok in any manner, hand tool will not be released to area till date it was not fit.
7. In case of any abnormalities in the equipment the same need to be confirmed to the to the E & I workshop in specific format (Annexure- B attached below). The hand tool checked at workshop and the damage ascertained, whether it can be repaired at site or need to be sent outside for repairing.

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8. Electrical workshop will repair only Bosch make hand tools. For any other make respective area owner have to make their own arrangement for sending hand tool for repairing. Other units procedures are little different.

9. If the hand tool is completely damaged and can't be repaired as suggested by OEM (original equipment manufacturer) service partner, the information for the same will be given to hand tool owner for purchasing of new hand tool.

10. A centralized record to be maintained at electrical workshop of all the hand tools.

PENALTY CLAUSE:

This penalty clause is implemented to enhance the safety during work, not to intend any commercial loss.

Sl. No.	Particular	Penalty clause	Responsibility
1	1-3 day delay (Company Owned Machine)	Machine received by workshop with approval from HOD	Machine Owner
2	Beyond 3 days delay (Company Owned Machine)	Machine received by workshop with approval from PH	Machine Owner
3	-3 day delay (Contractor Owned Machine) – Use of defective or damaged tools/ machine	Machine received by workshop with approval from EHS-Head. Use of defective or damaged tools/machine	Machine Owner (Contractor)
4	Beyond 3 days delay (Contractor Owned Machine)	Commercial implication as informed by safety department to account.	Safety department

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6.2.2 Safety certification of welding machines:

Annexure-2 used for carrying out audit of equipment used in electrical department.

Key Principle for safe operation:

1. All welding machines used at the site shall be pre-inspected by concerned site supervisor and authorized for their safe use.
2. Use all PPE as per approved by Hot work committee during work.
3. Each welding machine must be connected to input power circuit designed for welding work only, which is protected by ELCB/RCCB.
4. Transport it in a secure manner & Store it in a careful manner when not in use.
5. Earthing Returns:
 - a. Welding current should preferably be returned to the welding m/c by a single cable from the work to the welding m/c.
 - b. Pipelines containing gases or inflammable liquids or conduits carrying E & I conductors shall not be used for a ground return circuit.
 - c. Earth return should be given as close to the job as possible.
6. The return cable to be bolted properly.
7. The frame or case of electric hot work machines shall be grounded. Ground connections shall be mechanically strong and electrically adequate for the required current.
8. Use double insulated insulating Holder.
9. Always keep the hands and the body dry during welding testing job.
10. Recheck & confirm that the Electrical circuit has been switched off /Isolated after check-up.
11. Know the location of safety devices such as fire extinguishers.
12. All transformer type welding machine may be discourage for use in order to eliminating risk of an accidental instantaneous peak of current that may damage the other vulnerable electronic parts, cable etc. and in turn cause life risk to welders.
13. All three phase welding machine incoming power cable should be minimum 4 core cable except for Pot room.

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14. For Pot room, 3 core power cable is ok if the machine is working in non-earthing zone (Room-A, Room-B and basement area), A specific Tag (For Pot room only) on such machine is to be painted.
15. All three phase Welding M/c incoming power cable should be maximum 15 m without any joints.

Procedure for certification:

1. Machine to be send to the E & I workshop as per scheduled (on next due date written on machine). Information of schedule will also be informed to all individuals through mail.
2. All the machines of the plant is to be identified as separate ID (W/s Ref no----) no & numbering to be done.
3. The Machine will be pasted with a specific tag no. (as per location defined above)
4. After inspection and testing is successful the machine will be released to the respective owner with a certificate/ test report.
5. Daily (Pre – checking) check sheet of welding machine is to be filled before start of job in the format approved hot work committee.
6. In case of any abnormalities in the welding machine, the same need to be informed to the E & I/ Mechanical workshop in specific format (Annexure- B attached below).
7. E&I workshop will repair only Zirkon make welding machine. For any other make respective area owner have to make their own arrangement for sending machine for repairing. Other units shall have little different procedures.(For example: In Renukoot all company owned machine irrespective of any make are being repaired in Electrical repair shop and Contractor's welding machines are their own (Contractors) responsibility hence pint is to made accordingly.)
8. A centralized record to be maintained at E & I workshop of all the machines.

PENALITY CLAUSE:

This penalty clause is implemented to enhance the safety during work, not to intend any commercial loss.

Sl. No.	Particular	Penalty clause	Responsibility
1	1-3 day delay (Company Owned Machine)	Machine received by workshop with approval from HOD	Machine Owner

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2	Beyond 3 days delay (Company Owned Machine)	Machine received by workshop with approval from PH	Machine Owner
3	1-3 day delay (Contractor Owned Machine)	Machine received by workshop with approval from EHS-Head.	Machine Owner
4	Beyond 3 days delay (Contractor Owned Machine)	Commercial implication as informed by safety department to account.	Safety department

6.2.3 Safety certification for portable cabin, metallic container: Annexure-3 used for carrying out audit of equipment used in electrical department.

Procedure for certification:

1. Reports to the concern electrical department for any damages to any electrical outlet for rectification.
2. Ensure healthiness of two point earthing to the container. If it was damaged, report the same to concern electrical maintenance team.
3. Ensure healthiness of ELCB/RCCB and testing being carried out periodically as scheduled. If it was not done, report the same to concern electrical maintenance team.
4. Do not use loose wire for further temporary connection.
5. Do not connect any appliances without plug top.
6. No joint in cable of connecting appliances.
7. Always keep the hands dry when connecting any appliances.
8. Recheck & confirm that the circuit has been switched off, prior to take any connection.
9. No fabrication work is allowed to electrically power portable cabin, metallic container until approved by concerned electrical maintenance team.
10. Do not connect heavy electrical load equipment to the portable cabin, metallic container.
11. Do not provide any permanent extra connection to the portable cabin which may be required by user.

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12. The electric fittings of the cabins are designed for minimal vibration exposure. When higher loads are given, appropriate measures must be taken according to the national technical regulations (and/or checks of the plug or screw contacts).
13. Do not place the material at top of the portable cabin/ container having electrical installation.
14. If water is coming inside, inform electrical maintenance team to cut the power.
15. All conduits used in the container shall be of PVC/HDPE material.

6.2.4 Safety Check-up of Hand tools:

Annexure-4 used for carrying out audit of equipment used in electrical department.

Key Principle for safe operation:

1. Tools in defective condition must not be used for maintenance activity.
2. Hand tools that are broken or require repair should be kept separately and labelled with a warning notice "DANGER! DO NOT USE FOR WORK!"
3. Never carry tools in your pocket.
4. Hand tools should not be used for purposes other than they are designed for. Their material strength is always designed according to the nature of work to be performed. Tools being misused may lead to fracture, causing danger to persons.
5. Never leave power tools in work area.
6. One should concentrate on the job when using a hand tool.
7. Playing with hand tools should be strictly prohibited.
8. Select the right tools for right work.
9. To ensure that tool is in good condition & keep it is in safe condition.
10. When using a tool in overhead place, care should be taken to avoid any slipping or falling of tools. This may cause an injury to the person working below.
11. Hand tools should be inspected every time before use.



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12. Special care should be paid to the cleanliness of tools. Blunt cutting edge or deformed working part should be redressed.
13. Hand tools should be systematically kept or stored at tool-rack or toolbox after use. Those having sharp corners or edges should be protected by sheaths before they are stored.
14. Every hand tool should be kept in an orderly manner at a workroom or toolbox designated for the purpose.
15. Periodic examination, repair and maintenance of hand tools should be carried out only by persons who are experienced and competent.
16. Hand tools should only be carried to work area in a proper toolbox or with the use of a tool-belt.
17. Special care should be taken to prevent other persons gaining access to the work area where long handle tools are being operated. When necessary, the work area should be fenced off to prevent unauthorized entry.
18. Before working, work pieces should be checked for protruding metal parts that may cause damage to hand tools.
19. Precautions should be taken when working on or near electrical conductors.
20. Hand tools should be operated in correct posture and strength.
21. Proper steps and procedures should be followed when operating a hand tool, e.g. the face of the hammer head instead of the peen should be used for hammering nails; the handle of a spanner should not be hammered or extended by tubes for applying greater strength in screwing of bolts or nuts.
22. When hand tools with sharp corners or edges are used, their direction of movement should be away from the body.
23. Suitable personal protective equipment such as helmets, aprons or gloves should be used when necessary.
24. When flying fragments, particles or noise are generated during the operation of hand tools, suitable personal protective equipment, e.g., goggles, masks or ear-muffs that conform to safety standards should be worn.
25. The operator should use clamps to secure a work piece that is liable to move into a stable position.

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26. Maintain all hand tools and similar equipment in top-notch working condition, whether they belong to you or the company.
27. Store tools with sharp edges so that they cannot cause injury or damage.
28. Do not carry tools with sharp edges in your pocket.
29. Do not leave tools lying around where they could create an obstruction or a hazard, such as causing a person to trip.
30. Clean, oil, or adjust machinery only when it is not in motion.
31. Keep tools and accessories clean, sharp, and correctly oiled.
32. Keep impact tools such as drift pins, wedges, and chisels free of mushroom Heads.
33. Select the appropriate hand tool for each specific task, and then properly use it, as it has been designed. For example, never use a wrench as a hammer or a screwdriver for prying.
34. Only operate tools within the rate limits.
35. Never try to increase a tool's capacity with bypasses or other modifications.
36. Never attempt to bypass the manufacturers installed safety devices.
37. For following specific jobs, the person should wear requisite PPE as per the unit safe practices
 - Energy meter/Other meter readings
 - Protection relay settings
 - Battery bank electrolyte checking & filling
 - Lift Testing
 - Testing of zero speed switch

6.2.5 Audit of electrical installations: Audit of electrical installation is being carried out as per CEA rule 2010. Attachment of checklist is attached in annexure-5.

6.2.6 Earthing standard: Minimum conductor size for earthing is mentioned in annexure-6.

General notes:

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- Earthing shall be done in accordance with the requirements laid down in specification for Earthing Installation IS: 3043.
- The distance between the two electrodes shall not be less than 2 times the length of electrode.
- Overall earth grid shall be made with 75 x 10 mm GI strip. (The design of earth grid depend upon the System Fault current & operating time)
-
- GI earth plates wherever provided shall be connected to the grid with two runs of 40 x 5 mm GI strips.
- All the electrical trays shall be earthed suitably at an interval of 30m (Approx.) by tapping 40 x 5 mm GI strip from main grid and connected to the tray support/base plate.
- Joints and tapping in the main earth strip shall be made by welding only. Exposed welded joint shall be given two coats of metallic primer and then a coat of zinc based paint.
- Underground joints shall be given two coats of bitumen compound and shall be wrapped with bitumen impregnated hessian tape.
- Cable armour in case of armoured cables shall be earthed through the cable glands.
- 50 x 6 mm GI strip shall be used for making the underground earth grid for street lighting poles and flood lighting masts
- Earth resistance should be checked at least once in a year, preferably in dry seasons.

1. HT Motors - 11KV, 6.6 KV and 690V

Frame of All HT Motors shall be earthed at two visible points. Motor phase side Power Terminal Box (PSTB) shall also be earthed at two points.

2. Transformer:

Transformer body shall be earthed by two separate and distinct connections with the grid.

- The neutral of every transformer/generator shall be earthed by connecting it to not less than two separate and distinct connections to the separate earthed pits, which may be further connected to the earthed grid.
- The Neutral of the transformer must be insulated.
- Jumper sizes for earthing transformer accessories as mentioned in Annexure-7.

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3. 415V Motors

Frame of All 415V Motors of any size shall be earthed at two visible points. However, Power terminal box is not required to be earthed for any size of 415v Motor. Frame of Actuator motors and Soot Blower motors shall also be earthed at two points. Earthing should be done at designated place.

4. Power Junction Boxes

All Power Junction Boxes shall be earthed at two visible points. Earthing should be done at designated place.

5. Three Phase Receptacle Box

All three phase receptacle boxes shall be earthed at two visible points. Earthing should be done at designated place.

6. Single Phase Receptacle Box

All three phase receptacle boxes shall be earthed at two visible points. Earthing should be done at designated place.

7. Single Phase Extension Board

Mobile single phase extension Boards shall be earthed inside the Box through incoming power cable. One spare core shall be provided for this purpose. This will be earthed at one point only. Alternatively, local earthing can also be done at one point only. Earthing should be done at designated place.

8. Mobile three phase extension Board

Mobile single phase extension Boards shall be earthed inside the Box through incoming power cable. One spare core shall be provided for this purpose. This will be earthed at one point only. Alternatively, local earthing can also be done at one point only. Earthing should be done at designated place.

9. Welding Machines

Welding machines shall be earthed through incoming cable inside the machine. One spare core shall be provided for this purpose. Welding machines are required to be earthed at one point only. Alternatively, if earth is not provided through cable it will be earthed through crocodile clamps locally at one point only. Earthing should be done at designated place.

10. Portable Electrical Tools

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Portable electrical hand held tools are not required to be earthed. However, it is must to ensure that such tools are double insulated. For double insulated electrically operated hand tools, 2 core cable can be used. For others (non- double insulated) 3 core cable must be used.

11. Electrical Panels

Electrical panels are required to be earthed at two visible points. All doors and movable parts shall be earthed using flexible copper connection to the fixed frame of the panel/ JB.

Foundation bolt of equipment should not be used for earthing. Earthing should be done at designated place.

12. Hoist and Crane

Rails of Hoist and crane shall be earthed at two points (both ends). Earthing should be done by welding on rail of size 50x6 sq.mm GI strip.

The two rails should be connected by a flexible jumper with riveted or bolting system to make complete rail system connected electrically.

13. MLDB (Main Lighting Distribution Board)

MLDB shall be earthed at two visible points. Foundation bolt of equipment should not be used for earthing. Earthing should be done at designated place.

14. LDB (Lighting Distribution Board)

LDB shall be earthed at two visible points. Foundation bolt of equipment should not be used for earthing. Earthing should be done at designated place.

15. Light Fittings

Light fittings along with Control Gear Box shall be earthed via spare core of incoming cable. Earthing should be done at designated place.

16. Street Light Pole

All type of lighting pole shall be earthed at two points by connecting to the plant grid. Foundation bolt of equipment should not be used for earthing. Earthing should be done at designated place.

17. HIGH MAST AND FLOOD LIGHT POLE

Pole shall be earthed at two points by connecting to the plant grid. Foundation bolt of equipment should not be used for earthing. Earthing should be done at designated place.

18. Steel Structure Earthing

Steel structure should be earth at every 24 Meters by welding.

19. Steel Pipe Rack Earthing

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Steel pipe rack should be earth at every 24 Meters. However, valve and flange should be earthed with flexible copper cable.

20. Tank, Vessel and Sphere Earthing

All tank and vessel shall be earthed at two visible points.

21. RCC Chimney Earthing

- For Chimney up to 1.5 Diameter at Top, 1 no. air terminal and 1 no. down conductor shall be provided.
- For chimney more than 1.5 diameter at top, 2 no. air terminal and 2 no. down conductor shall be provided.
- A bonding ring of 20x3 mm GI strip welded to air terminals and reinforcement bars of chimney.
- Clamp at interval of 500 mm using GI spacer and saddles.

22. Lightning Arrester (LA) Earthing

- For LA earthing, earth connection to the earthing strip shall be short and direct without any loop.

23. Building Earthing

- For multi storied buildings (Apartment blocks), lightning arrester spike with insulated down conductors are provided. Also these are connected to the earthing network.

6.2.7 Other standard which is applicable and maintained as per IE rules

- 1 Unit shall have electrical safety procedures that are easily accessible and up-to-date. These procedures shall be developed using a risk-assessment process and shall contain the safe practices necessary to identify and manage the electrical hazard exposure. In addition to internal operations, these procedures should cover normal and emergency operations associated with the electrical supply utility.
- 2 Electrical safety procedures shall be reviewed and reauthorized at intervals not to exceed three years and shall be consistent with local regulations and the requirements of this standard.
- 3 As per IE rules all sub-stations should have minimum two exits with self-glowing signage.
- 4 When working on or near energized electrical equipment is that no work should be performed within the prohibited approach boundary.

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- 5 Risk controls that help achieve this goal shall include equipment and hazard assessment, limitation of work activities based on levels of risk, and the need for a higher level of formal authorization and work permits for work with higher levels of risk.
- 6 Sites should demonstrate a commitment to minimizing exposure of working on or near uninsulated or unguarded electrical circuits and conductors energized >50 V, including the contact of tools or any part of the body, regardless of the PPE used.
- 7 As per electrical rules, all sub standards should have minimum 2 exit.
- 8 Unit has implemented Zero Energy (LOTOTO) work permit system.
- 9 Test before Touch (Use LDL Method), including verification of the test instrument before and after the test.
- 10 Practices to help ensure identification, communication, and understanding of the limits of the safe work boundary. Personnel should know the safe work boundary to avoid electrical hazards. Techniques to enhance communication and understanding of the safe work boundary should include, but not be limited to, temporary signs, locking doors and covers on adjacent compartments, barricades, job walk-through, a description of the safe work boundary in job plans,
- 11 Identification of ownership and control of hazardous energy during construction, commissioning, turnover to operations, maintenance, and other situations in which control responsibility may change.
- 12 Warning and Danger label must be placed on all electrical equipment more than 230 volt.
- 13 For high voltage equipment label must be present as per NECR Article 110.16. OSHA guideline and NFPA 70E.

6.2.8 Battery Safety:

PRECAUTION DURING SHIFTING:

1. Do not place or drop metal objects on top of the battery.
2. Remove rings, wristwatch, loose coins from the pockets and articles of clothing with metal parts that might come in contact with the battery terminals.
3. Do not smoke in the battery room as it is a fire hazard.
4. Keep the ventilation cap always closed, it may cause an accident to shifting personnel.

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5. Use proper shifting vehicle/ arrangement to shift the battery from one place to another place.
6. After shifting, install as per OEM installation manual.

STORAGE OF NEW BATTERY IN FILLED AND CHARGED CONDITION:

1. A filled and charged battery can be stored for a period of one year.
2. Store the battery in a clean, dry and cool location.
3. Do not smoke in the battery room as it is a fire hazard.
4. Cover the battery with a sheet or plastic or similar protective cover to keep out water and shield against direct sunlight.
5. Do not store other material on top of the battery.

STORAGE OF NEW BATTERY IN DRY AND DISCHARGED CONDITION:

1. A dry and discharged battery can be stored for a period of around ten years.
2. Store the battery in a clean, dry and cool location.
3. Do not smoke in the battery room as it is a fire hazard.
4. Cover the battery with a sheet or plastic or similar protective cover to keep out water and shield against direct sunlight.
5. Do not store other material on top of the battery.
6. Do not remove the plastic film sealing the flip top vent.
7. After removing from the storage, follow the instructions for electrolyte filling and first charging.

STORAGE OF USED BATTERY IN FILLED AND CHARGED CONDITION:

1. If the battery is going to be left idle for a long period of time, but not more than one year, it should be removed from service and properly stored.
2. Check the electrolyte level if the batteries are not maintenance free type.
3. Fill the DM/ Distill water up to maximum limit and not below the plate surface. Only DM water is to be used to compensate for the loss of water during charging, and maintain the required electrolyte level and specific gravity.
4. Clean the battery thoroughly, and then coat the inter-cell connector with anti- corrosion oil.

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5. Store the battery in a clean, dry and cool location.
6. Do not smoke in the battery room as it is a fire hazard.
7. Cover the battery with a sheet or plastic or similar protective cover to keep out water and shield against direct sunlight.

STORAGE OF USED BATTERY IN DRY AND DISCHARGED CONDITION:

1. If the storage period is more than one year, the battery should be fully discharged to an end voltage of 0.6 volt per cell and the electrolyte fully drained by inverting the batteries.
2. Use a plastic seal to seal the flip top ventilation cap.
3. Clean the battery thoroughly, and then coat the inter-cell connector with anti-corrosion oil.
4. Store the battery in a clean, dry and cool location.
5. Do not smoke in the battery room as it is a fire hazard.
6. Cover the battery with a sheet or plastic or similar protective cover to keep out water and shield against direct sunlight.
7. Store the electrolyte in cool, air tight plastic container.
8. DONT'S DURING BATTERY MAINTENANCE:
9. The battery will produce a mixture of oxygen and hydrocarbon gases during the last portion of high charging rate, so keep flames away.
10. Do not place or drop metal objects on top of the battery.
11. Remove rings, wristwatch, loose coins from the pockets and articles of clothing with metal parts that might come in contact with the battery terminals.
12. Do not use petrol, kerosene or any strong chemicals for cleaning batteries. This may affect the nickel plating on the steel and copper components.
13. Do not use wire or any hard brush to clean deposits on the inter-cell connectors and terminals since this will damage the nickel plating.
14. Do not use aluminium cables for making connections to the battery terminals since aluminium reacts with alkaline electrolyte.
15. Do not keep vent caps open and expose electrolyte to air, since this will cause some of the electrolyte to be converted to potassium carbonate and thereby reduce the conductivity of the electrolyte.

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16. Do not spill water or electrolyte on and around the battery since this will create conductive paths leading to leakage of current.
17. Do not measure specific gravity immediately after adding D.M. /Distill water since this will indicate a lower specific gravity due to inadequate mixing of the water with the electrolyte in the cell.
18. Do not expose the battery directly to sunlight for long duration since this will accelerated aging of plastic components due to ultra violet radiation.
19. Do not adjust terminal connections during charging to prevent sparking which can ignite the oxygen and hydrogen gases which are given off by the battery towards completion of charge and cause a fire/explosion.
20. Do not use acid since the battery requires alkaline electrolyte. Addition of acid will cause it to react with the alkaline electrolyte and cause permanent battery damage.
21. Do not charge the battery without removing the transport seal from the vent, or while the battery is covered, since it is important to ventilate the battery and permit the gases produced towards the end of charge to escape.
22. Do not adjust terminal connections during usage to prevent sparking which can ignite the oxygen and hydrocarbon gases which are given off by the battery towards completion of charge and cause a fire/ explosion.
23. Do not smoke in the battery room as it is a fire hazard.

Safety Precaution during testing of Battery:

1. Fire extinguishers are to be kept nearby machine
2. No smoking Zone, No any sparking near the batteries.
3. Water availability to flood any electrolyte spill occurring in battery operation and also for washing body parts if affected.
4. Sufficient ventilation is to be there to prevent accumulation of explosive atmosphere.
5. Use Chemical resistance glove, safety glass and other mentioned PPE in HIRA.
6. Keep small quantity of dry Lime near the battery / wash basin to neutralise the electrolyte during spillage.

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6.2.9 Operation and maintenance of HT breaker (3.3 KV and above):

KEY PRINCIPLES

1. 100% compliance of permit to work system.
2. No non E & I personnel is allowed to come nearby panel area.
3. Minimum person to be present near breaker or feeder during operation and must use the rated Arc Flash suite.
4. 'DANGER' & "Man AT WORK" should be visible and tagged in that area.
5. Persons, who is involved in breaker operation and HT compartment maintenance must wear rated Arc Flash suit till the job completion.
6. Persons, who is involved in breaker maintenance must work outside of arc flash boundary/ HT door must be closed. In this condition wearing arc flash suit is not required.
7. All persons within arc flash boundary must wear rated arc flash suit.
8. During de-energizing and energizing the bus bar, area-in-charge must be present near the spot.
9. Earth discharge rod and Rescue hook must be present at site.
10. Avoid making direct contact with any exposed conductor of the cable.
11. Always keep the hands and the body dry.
12. Recheck & confirm that the electrical circuit has been switched off in all respect (More than one feed) before start of work.
13. Identification to be done for good/defective breaker or feeder module, if kept outside.

PROCEDURE:-

Sl no	Description	Purpose	Method
1.	Normal operation of HT breaker (3.3 Kv & above breaker switchgear)	For equipment maintenance	• HT breaker is isolated/ made OFF • Control supply is cut off (remote operation is not permitted) • With door closed condition, breaker is made free (from locked service position) and raked out with handle from outside to isolated position. Operator (Person doing racking) must wear arc flash suite with face shield and gloves.



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			• After work completion in the specific equipment, breaker is raked in thru handle with door closed condition and locked in the service position. During racking in also operator wears arc flash system. • Control supply is restored • Equipment is allowed to start
2.	Normal operation of HT breaker (3.3 Kv & above breaker switchgear)	For HT breaker & compartment maintenance	• HT breaker is isolated/ made OFF • Control supply is cut off (remote operation is not permitted). • With door closed condition, breaker is made free (from locked service position) and raked out with handle from outside to isolated position. Operator (Person doing racking) must wear arc flash suite with face shield and gloves • While Breaker in isolated position, the door of HT compartment can be unlocked by wearing Arc flash system and the breaker can be drawn outside of the HT panel for maintenance. After maintenance, the breaker again to be put at isolated position and door must be locked to proceed further. Please note there is no rack in / rack out process involve in this whole process. • After work completion in the specific breaker, breaker is raked in thru handle with door closed condition and locked in the service position. During racking in also operator wears arc flash system. • Control supply is restored • Equipment is allowed to start
3.	Normal way of HT switchgear when it gets stuck up	For maintenance breaker in	• In unit which is under shutdown, Breaker stuck up issue is attended by taking shutdown of bus section –A /B.



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		dead bus condition	- In running unit team try to take shut down of bus A/B as required and - In a running unit , If bus isolation is not possible , Team try to operate breaker for raking IN or OUT in presence of senior people with door closed condition & with PPEs and protection as mentioned above - If still, it is not raked in or out, then it is marked OUT and team wait for earliest opportunity of shutdown of unit. - This type of situation happens once or twice in a year if Preventive Maintenance of switchgear is done properly during overhauling of units
4.	Emergency way of maintenance of HT Breaker when it gets stuck up	For maintenance breaker in LIVE bus condition	After all above conditions, if it felt by the senior team to attend the breaker problem in Running unit in BUS live condition, then in door open condition with proper PPES like i) Arc flash suit, ii) Arc flash helmet, iii) Hand gloves , Issue of breaker stuck up is handled to resolve. - Frequency of such operation/occurrence is quite rare
5.	summary		In view of rare occurrence of situation -3 or C and high risk involved, it is recommended that such operation should not be conducted in live bus condition. It should be attended/resolved only after taking the relevant bus under shutdown.

6.2.10 E-waste Management System:

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GUIDELINES

- Hazardous Wastes (Management, Handling & Trans boundary Movement Rules 2008 and subsequent amendments).-Transformer oils, grease
- E-Wastes (Management & Handling) Rules, 2011. - Cables, fuses, electronics component etc.
- Batteries (Management & Handling) Rules – 2001 – Notification Amendment 2010.

PROCEDURE

- Generation of Used oil/ spent oil, E-waste & used batteries and keep it identified place in shop floor/ Substation. Material should be kept at designated place and tagged.
- After reaching $\frac{3}{4}$ th level of stock at Substation, user department will inform to Scrap Management Cell for shifting the drums/ wastes.
- Scrap Management Cell will coordinate with Store Department for availability of machinery for shifting.
- Scrap Management Cell will give information to Environment Cell and confirm where the material to be shifted.
- Scrap Management will also provide a receipt note for the collected material; though mail.
- This mail is kept as a record.

6.2.11 Zero Joint Cable Policy.

1.	New Project/Installation	a) In principal “No cable joints “is permissible in Power (HT&LT) and Control cables up to standard cable length (HT Cable – 500 m, LT Cable – 600 m, Control cable – 1000 m) which can be further increased with vendor negotiation. b) To safeguard the cable from any physical damage/ Fire/ Alkali & Acidic fumes/ flammable hot fumes / dust, appropriate cable tray covering should be provided. c) All cable should have fire resistant coating in fire prone area. d) No cable joints should be allowed in highly flammable area i.e. Propane / LPG yard.



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2.	Existing/ Running Plant	In case cable joints are required to meet plant emergency in running / existing plant during exigency, it should be made properly as per IS: 1255-1983 by skilled cable Joiner / Electrician. <u>Power Cable (HT &LT): (3 Phase / single phase, 11.5 KV, 3.3 KV, 415 Volts AC/DC & above and 220 V /110 V AC/DC)</u> a) All Joints to be made with appropriate & suitable cable Jointing Kit with standard procedure as per IS: 1255 -1983. b) Maximum one joint per length of power cable is permissible as per cable length mentioned above (new project /installation) in case of emergency in running plant. c) More than one cable joints in one length of power cable to be replaced at the earliest on planned basis. d) Proper records of cable jointing to be maintained with equipment and joint location. e) Every jointing place / location should have proper VIS at nearest location. f) In any case no any cable joint is to be made inside the MCC / Switch house room. g) All power feeders cables (Transformer to PCC) having joints to be identified and replaced at the earliest. h) As far as possible, cable joint should be on straight bridge or separate cable tray (Should not be mixed with existing cable tray) or should be inside separate closed Junction Box. i) Joints not to be made inside Pit / Trench where chances of accumulation of water / Caustic / any other liquid exist. e) To safeguard the cable from any physical damage/ Fire/ Alkali & Acidic fumes/ flammable hot fumes / dust, appropriate cable tray covering should be provided. f) All cable should have fire resistant coating in fire prone area. j) No cable joints should be allowed in highly flammable area i.e. Propane / LPG yard <u>Control Cable: (Single Phase , 220 Volts AC/DC & below)</u> a) Maximum one joint per length of cable is permissible as per cable length mentioned above (new project /installation) in case of emergency in running plant. b) Preferably all control cable joints to be made in CLOSED Junction Boxes (IP 56) preferably with Wago terminals. c) Joints not to be made inside Pit / Trench where chances of accumulation of water / Caustic / any other liquid exist. d) All cable should have fire resistant coating in fire prone area. e) No cable joints should be allowed in highly flammable area i.e. Propane / LPG yard

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6.2.12 ARC Flash Boundary:

ARC Flash study has been carried out by competent authority of all the switchgears on the Plant and Protection Boundaries have been marked.



6.2.13 Use of ARC Flash Suits :

For carrying out all electrical Operation and Maintenance Jobs, the concerned person wears Arc Flash Suit of appropriate rating.



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6.2.14 LOTOTO Arrangement :

6.2.14.1 LOTOTO Arrangement in all the ACBs have been provided for safe and secure Isolation of power.





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6.2.14.2: LOTOTO Arrangement in 6.6/11 KV Panel:



6.2.14.3: LOTOTO Arrangement in 415V Feeders:



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6.2.15: Artificial Respirator:

Artificial respirator have been provided in all the switchgears for any emergency use.





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6.2.16: Rescue Hook :

Rescue hook has been provided in all the switchgears for emergency use.



6.2.17 : Safety Visual Identification System (VIS) at Site :

6.2.15.1: Motors and Transformers Danger Sign:

VIS for Danger sign display is being done on all the Electrical Equipment such as Motor, Transformer, and Panels etc. As per IS: 2551



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6.2.17.2: Phase marking at site :

For easy identification, phase marking has been done for major equipment.



6.2.17.3 : SLD Display at site:

For better understanding and clarity of the system, SLD has been painted at site.



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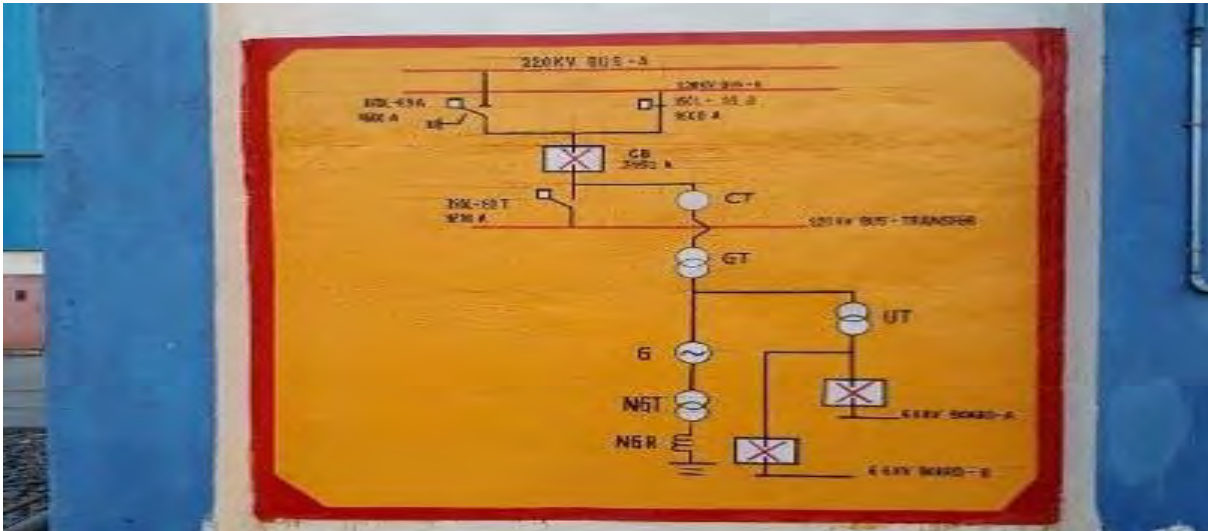
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6.2.18 : Use of Insulated Tools:

Insulated tools are being used whenever we are working in live circuit.



6.2.19 : Use of Non-Contact Type Voltage Detector:

Non-contact type voltage detector (up to 245 KV) is being used to ensure no power in the circuit / system before start of work. This makes sure of extra precaution after LOTOTO.



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Check sheets

ANNEXURE-1

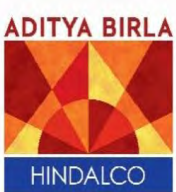
Safety check sheet for electrical operated hand tools:

		SAFETY CERTIFICATION FOR ELECTRICAL HAND TOOL							
		AREA				AREA OWNER			
		Make		Incoming Supply		DATE			
		Model				CHECKED BY			
		Serial No.							
Sl. No	Check Points	Observed Status	YES	NO	Action Taken / Remark				
01.	Incoming power cable Plug-top connection at Power Socket cabinet	Plug-top used							
		Connection proper / Tightened							
		Suitable Insulated cables used							
		Cable is secure at both the tool and plug							
		Verify the polarity of the supply cables and correctly connected (Phase & Neutral)							
02.	Human / Hand tool Safety	Hand tool proper Earthing done (if not double insulated)							
		Body condition free from any damages/dent							
		insulation resistance between the electrical parts and the touchable and metallic housing							
03.	Hand tool internal circuit Checking	ON/OFF switch properly working							
NAME OF TESTING TECHNICIAN									
SIGNATURE OF THE E & I WORKSHOP INCHARGE									

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ANNEXURE –2

Safety check sheet for welding machine:

 SAFETY CHECK SHEET FOR WELDING MACHINE							
		AREA			AREA OWNER		
		Make	Incoming Supply			DATE	
		Model				CHECKED BY	
		Serial No.					
S.No	Test	Check Points	Observed Status	YES	NO	Action Taken / Remark	
1	E & I Test	Incoming power cable	Industrial Plug-top used				
			Connection proper & tightened inside top				
			Suitable Insulated cables used				
			Max. 15 Mtr. Length without any joints				
2		power cable connection at Machine End	Cable entered via gland				
			Connection proper / tightened				
			Machine Terminal is in good condition				
3		Machine Output Cables	Insulated cables of suitable length & size				
			Supply and return cable both shall be available with same length				
4		Machine internal circuit Checking	Machine cooling Fan working				
			ON/OFF switch properly working				
			Connection tightened properly				
5		Machine functionality checking	Transformer Tap position working				
			Rectifier Circuit connection Ok				
			Output internal terminal loose				
			Output external cable loose				



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			Output cable connected via Lugs			
			Ammeter in working condition			
			Voltmeter in working condition			
			Current limiting as per nameplate			
			VRD Functionality check			
6		IR value	Primary to body			
			Body to Earth			
			Primary to Earth			
			Secondary to Earth			
			Primary to Secondary			
7	Mechanical Test	Machine mechanical checking	Body condition free from any damages/dent			
			Machine trolley is in healthy condition			
			Trolley wheels working ok			
			Machine lifting handle is in good condition			
			Welding holder insulation is in healthy condition and it is to be double insulated			
			Welding holder tip insulation in healthy condition			
			Return cable clamp in healthy condition			
			Machine cooling Fan net is in good condition			
8	Human / Machine Safety	Functional Checks	Machine proper Earthing done			
			No Abnormal Sound			
9	Operation.	Checks	ELCB/ RCCB/ MCB is Ok			
NAME OF TESTING TECHNICIAN						
SIGNATURE OF THE E & I WORKSHOP INCHARGE						
SIGNATURE OF THE Mech. WORKSHOP INCHARGE						

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Annexure –3

Check sheet for Fitness Certification procedure for all portable cabin, metallic container



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MAHAN ALUMINIUM, Bargarh

Electrical Safety Checklist for Metal Container.

Tick ☒ inside the box

1. Incoming supply should be provided with single phase RCCB with 30mA Rating only.	☐
2. RCCB should be enclosed with proper Junction box with rain protection provision.	☐
3. Cable gland should be used for incoming and outgoing cable, avoid any loose entry.	☐
4. Metal enclosure of RCCB should be earthed at two points.	☐
5. Incoming Power cable should be of armored type only with suitable size.	☐
6. Container Earthing should be done at least two point with earth flat.	☐
7. Container Door earthing continuity to be ensured by providing looping cable.	☐
8. Incoming Power cable should be properly routed through cable tray or in underground with at least 300mm depth with route marker.	☐
9. Incoming power supply feeder name should be clearly mentioned on RCCB Board.	☐
10. No joint policy should be strictly followed.	☐
11. Provision of Class C/CO2 Fire extinguisher (at least 1 in common vicinity)	☐

Verified By

(Mahan Aluminium-Electrical)

(Mahan Aluminium -Safety)

REMARKS-

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Annexure –5

Check sheet for audit of electrical installations as per CE-2010.

ELECTRICAL SAFETY-AUDIT REPORT				Rev-01 dtd: 25.09.2019		
	AREA:		Area Head		Auditor	
	Section:		Section Head		Audit Date	
Sr.No	Category	Description	Under CE Regulation	WAITAG E	EFFECTIVENESS	REMARKS
1	Display of VIS & safety Devices & its placement	SLD	Regulation-8			
2		Equipment layout	Regulation-8			
3		Earthing Layout	Regulation-8			
4		List of Authorized Persons	Regulation 3(2)			
5		List of First Aider	Regulation-27			
6		Arc Flash Boundary poster	Regulation-28			
7		Shock Hazard poster	Regulation-28			



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8		Arc Hazard poster	Regulation-28			
9		Electrical PPE poster	Regulation-28			
10		Emergency Contact Number	Regulation-27			
11		Marking of Arc Flash Boundary	Regulation-28			
12		Electrical Safety Devices - Rescue hook	Regulation-19			
13		Earth Discharge Rod	Regulation-19			
14		Voltage Detector	Regulation-19			
15		Amu Bag	Regulation-27,28			
16		Electrical Shock Treatment chart	Regulation-28			
17		Danger Board- HT Panel	Regulation-18			
18		Danger Board- Transformer yard	Regulation-18			
19		Danger Board- LT Panel	Regulation-18			
20		Danger Board- Distribution Board	Regulation-18			
21		Earth Resistance value & due date at Pit	Regulation-30			
22		Emergency Exit Sign	Regulation-28			
23		Opening of emergency Gate	Regulation-28			
24		Working of DC lighting system	Regulation-30			
25		RCCB sticker on lighting DB	Regulation-42			
26		Danger Board- Motors	Regulation-18			
27	Safety Documents & Records	Display of SWI/HIRA for working on electrical apparatus during works.	Regulation-28			



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28		Do these HIRA/SWIs take into account safety / address safety precautions like discharge of electricity, stored energy, earthing, coming in contact with adjacent live conductor or apparatus?				
29		SOP Updation Record	Regulation-7			
30		SWI updation Record	Regulation-7			
31		HIRA Updation record	Regulation-7			
32		Earth pit Resistance Records	Regulation-48			
33		Electrical Safety Training Records	Regulation-7			
34		FAB Updation record	Regulation-27			
35		Fire extinguishers/ fire Bucket	Regulation-27			
36		CPR Training Record	Regulation-7			
37		Lifting Tool & Tackles	Regulation-19			
38		Ladders	Regulation-19			
39	Has the area identified equipment as mentioned & its Testing & Calibration Record	Electrical Measuring Instrument	Regulation-19			
40		RCCB/ELCB	Regulation-30			
41		Full Body Harness	Regulation-19			
42		Portable Electrical tool Electrical safety Compliance	Regulation-19			
43		Other PPE related with job	Regulation-19			
44	Fire fighting system	Healthiness of Fire Alarm System if available	Regulation-27			
45		Provision of Fire Hydrant Line & its safety compliance	Regulation-27			



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46		Fire extinguisher- Panel Room	Regulation-27			
47		Fire extinguisher- Cable Cellar Room	Regulation-27			
48	Unwanted Material	Panel Room				
49		Cable Celler				
50		MCC Room				
51		Other area- Roof top, Near S/s Ladder				
52	Building Earthing	Is Lightning Arrestor Provided	Regulation-74			
53		Is Building Earthing system Provided	Regulation-74			
54		Building Lightning arrestor Condition and Continuity with pit	Regulation-74			
55	Earthing system	Is earth strip welded to Earth Riser	Regulation-16,41 Regulation-48			
56		Is Earth strip Corroded	Regulation-16,41 Regulation-48			
57		Is Earth Strip nut bolt Corroded	Regulation-16,41 Regulation-48			
58		Is earth wire corroded	Regulation-16,41 Regulation-48			
59		Double earthing of panels	Regulation-16,41 Regulation-48			
60		Double earthing of Transformers	Regulation-16,41 Regulation-48			



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61		Double earthing of LPIC/JB/PB station/PSC/Power Panel/ Lighting Panel]	Regulation-16,41 Regulation-48			
62		Double earthing of Motors	Regulation-16,41 Regulation-48			
63		Taping of Earth terminals of lighting Transformer	Regulation-16,41 Regulation-48			
64		Neutral point of Gen has two separate earth pit system	Regulation-16,41 Regulation-48			
65	Provision of Insulation Mat as per Voltage	Front of the panel	Regulation-19			
66		Rear of the Panel	Regulation-19			
67	Feeders	Is PFD/SLD has been marked on each cut out	Regulation-24			
68		Area has provided suitable cut-outs provided in every power supply line.				
69	Cables	Three core cable for single phase DB	Regulation-21			
70		Four Core cable for three phase DB	Regulation-21			
71		No accessibility of bare conductors	Regulation-17			
72		Armoured cable- metallic covering, must cover is in contact with frame of apparatus and earthed	Regulation-21 Regulation-48			
73	Battery Room	Min. 2 nos. exhaust Fan in running for closed battery Room				
74		Flameproof Light Fitting	Regulation-37			
75		No Switch/ Cut out Devices inside Room				



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76		No water Leakage from tap				
77		Functioning of Eye Shower				
78	EOT Crane	Provision of Phase indication	Regulation-28			
79		Cut out devices at easily accessible location	Regulation-20			
80		Working of Hooter in Running condition	Regulation-28			
81		Provision of Anti Collision device if two crane travelling on same gantry				
82		Pendent is hanging on cable or Chain				
83		Metal Rails electrically continuous and earthed	Regulation-20			
84	Transformer	Name plates in transformer room				
85		Danger boards in transformer room	Regulation-18			
86		Sand buckets are available in good condition	Regulation-27			
87		Fire extinguishers available & checked	Regulation-27			
88		Transformer room doors are locked and in good condition				
89		Oil level of transformer-MOG & Level				
90		WTI & OTI working ok				
91		Cable trench covered				
92		Gravel filled	Regulation-48			
93		Silica gel condition				
94		Earth pit marked and covered	Regulation-16,41 Regulation-48			
95		Equipment & neutral earthing at two separate pits	Regulation-16,41 Regulation-48			



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96		Is Transformer Radiator Earthing done	Regulation-16,41 Regulation-48			
97		Is Bus Duct Earthing done	Regulation-16,41 Regulation-48			
98		Is any Missing structural parts/ nut bolts missing in bus duct				
99		Is illumination Ok				
100		Transformer room cleaning				
101		Unwanted Material				
102	Misc. Audit Points	Are all street boxes or pillar containing circuits or apparatus are having enclosures are physically located to prevent ingress of water into them?	Regulation-12, 22			
103		Trenches inside sub-station containing cables are filled with non-inflammable material or completely covered with non-inflammable slabs.	Regulation-44			
104		In the area suitable linked switch, or circuit breaker, or emergency tripping device is placed near the point of commencement of supply so as to be readily accessible and capable of being easily operated to completely isolate the supply?	Regulation-14 Regulation-15			
105		Pressurisation blower was found not running				
106	LOTOTO implementation	Check Physical system if LOTOTO available on any feeder	Regulation-13 (3)			



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107		Any other defect or condition which may be a source of danger.	Regulation-12			
108	Others	Whether any type of Temporary installation exist	Regulation-12			

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Annexure –6

Minimum Recommended equipment wise earth conductor size.

Sl. No.	Equipment	Rating	GI	Copper wire	Copper cable
1	Motor	<= 5.5 KW	8 SWG	12 SWG	6 SQMM
2		5.5 KW to 11 KW	6 SWG	12 SWG	6 SQMM
3		>11 Kw to 30 Kw	25X3 GI Flat	8 SWG	10 SQMM
4		> 30 Kw to 110 Kw	35x6 GI Flat	4 SWG	35 SQMM
5		>110 Kw	50X6 GI Flat	Nil	Nil
6		HT Motor	50X6 GI Flat	Nil	Nil
7	JB	Power boxes	8 SWG GI Wire or 25X3 GI Flat	8 SWG	10 SQMM
8	Receptacle Box	Three Phase welding	25X3 GI Flat	8 SWG	10 SQMM
9		Single Phase	8 SWG GI Wire or 25X3 GI Flat	8 SWG	10 SQMM
10	Mobile Extension Board	Single Phase	Spare Core of incoming cable		
11		Three Phase	Spare Core of incoming cable		
12	Welding Machine		As per Sr. no-10		
13	Electrical Portable Tools		Not Required if double insulated		
14	Electrical Panel		50X6 GI Flat		
15	Hoist and Crane		Only Rail should earth with 35X6 GI Flat		
16	MLDB		35X6 GI Flat		
17	LDB		35X6 GI Flat		
18	Light Fitting		As per Sr. No-16		
19	Tank, Vessel and Sphere	Diameter< 20 Meter	2X40X5 GI Flat at 180 Degree		



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20		20<=D<30	3X40X5 GI Flat at 120 Degree		
21		30<=D<40	4X40X5 GI Flat at 90 Degree		
22		40<=D<50	5X40X5 GI Flat at 72 Degree		
23		50<=D<60	6X40X5 GI Flat at 60 Degree		
24		60<=D<70	7X40X5 GI Flat at 51.43 Degree		
25		70<=D<80	8X40X5 GI Flat at 45 Degree		
26		80<=D<90	9X40X5 GI Flat at 40 Degree		
27	Pipe Rack, Heat Exchanger		40x5 GI Flat and 24 meter distance		
28	Flange & Valve Connection		25 Sqmm copper flexible		
29	Fence Gate (Transformer Yard)		50X6 GI Flat (Main grid) and 8 SWG GI Wire for fence		
30	High Mast and Flood Light Pole		2X40x5 GI Flat		
31	Building Columns		40 x 5 GI strip		
32	Loading racks.		40 x 5 GI strip		
33	Small equipment's & instruments		8 SWG	12 SWG	6 SQMM
34	instrument panels		20 x 3 GI strip		
35	Main earth bus		75 x 10 GI strip		
36	LT & HT switchgears		75 x 10 GI strip		
37	Power transformer		75 x 10 GI strip		
38	Lighting transformer		16 mm (5/8") Dia. GI wire rope.		

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Annexure –7

Minimum Recommended equipment wise earth conductor size of Transformer.



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Acronyms and Abbreviations:

ANSI	American National Standards Institute
CFR	Code of Federal Regulations
EHS	Environment, Health & Safety
IEEE	Institute of Electrical and Electronics Engineers
LOTOTO	Lockout, Tagout & TryOut
mA	Milliampere
MCC	Motor Control Center
NEC	National Electrical Code
NFPA	National Fire Protection Association
OEM	Original Equipment Manufacturer
OSHA	Occupational Safety and Health Administration
PPE	Personal Protective Equipment
LDL	Live- Dead - Live



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ATTACHMENT-14
VOID



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ATTACHMENT-15 SCHEDULE OF PRICES

SCHEDULE OF PRICE

GRAND SUMMARY

Sl. No	WORK DESCRIPTION AND SUPPLY	CONTRACT / BID PRICE (inclusive of all taxes) [IN FIGURES]	CONTRACT / BID PRICE (inclusive of all taxes) [IN WORDS]
1	PRICE SCHEDULE:- Section 1 - Offshore supply of goods		
2	PRICE SCHEDULE: Section 2 - Onshore supply of goods		
3	PRICE SCHEDULE: Section 3 - Onshore services		
4	GRAND TOTAL OR OFFERED CONTRACT PRICE (INCLUDING ALL APPLICABLE TAXES)		

BIDDER HEREBY CONFIRMS THAT THE PRICE BID SUBMITTED IS AS PER THE TENDER SPECIFICATION

Signature : _____

Name : _____

Designation : _____

Company Seal Name & Address of the Company : _____

Date : _____

PRICE SCHEDULE: - Section 1 - Offshore supply of goods

Sl.No	Description	Price in Indian Rupee (Exchange rate as per clause no. 30.1 of Section A2 of Vol I)
1.1	FOB price for Steam Generator with auxiliaries	
1.2	FOB price for Steam Turbine Generator with auxiliaries	
1.3	FOB price for HP/LP Piping system	
1.4	FOB price for Electrical works	
1.5	FOB price for Instrumentation & Control System including DCS	
1.6	Others if any (Bidder to specify)	
1.7	FOB prices for scope of supply including design and engineering integral to the equipment, packing and forwarding for sl.no 1.1 to 1.6 above	
1.8	FOB prices for supply of Essential Spares including packing and forwarding	
1.9	FOB Prices for supply of maintenance tools and tackles including packing and forwarding	
1.10	Total FOB Prices (sum of Sl.No 1.7 to 1.9 above)	
1.11	Ocean/ Air freight upto Indian port of destination for sl.no 1.7 to 1.9	
1.12	Marine Insurance Charges upto Indian Port of destination	
1.13	CIF Price for Offshore-Supply (sum of 1.10 to 1.12)	
1.14	Custom duty with percentage applicable for Sl.No 1.10 above (break-up of duties to be provided item wise)	
1.15	Other taxes & duties, if any	
1.16	Contract Price for Offshore Supplies (sum of 1.13 to 1.15)	



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Company Seal	Signature	:	_____
	Name	:	_____
	Designation	:	_____
	Name & Address of the Company	:	_____
	Date	:	_____

PRICE SCHEDULE: Section 2 - Onshore supply of goods

Sl.No	Description	Price in Indian Rupee
2.1	Ex-works price for Steam Generator and auxiliaries	
2.2	Ex-works price for Steam Turbine Generator and auxiliaries	
2.3	Ex-works price for HP/LP Piping System	
2.4	Ex-works price for Electrical works	
2.5	Ex-works price for Instrumentation & Control Systems including DCS	
2.6	Others if any (Bidder to specify)	
2.7	Ex- works prices for scope of supply including design and engineering integral to the equipment, packing and forwarding (sl.no 2.1 to 2.6 above)	
2.8	Ex-works price for supply of Essential Spares including packing and forwarding	
2.9	Ex-works price for supply of maintenance tools and tackles including packing and forwarding	
2.10	Excise Duty as applicable with percentage thereof (sl.no 2.7 to 2.9 above) (Break-up in duties to be provided item wise)	
2.11	Sales Tax/ Value Added Tax for sl.no 2.7 to 2.10 above	
2.12	Other taxes & duties, if any	
2.13	Contract Price for Onshore Supplies (sum of Sl.No 2.7 to 2.12)	

Signature : _____

Name : _____

Designation : _____

Company Seal Name & Address of the Company : _____

Date : _____



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ATTACHMENT-16 SCHEDULE OF UTILITY CONSUMPTION

1.1 Auxiliary Cooling Water Requirement

1.1.1 BIDDER shall furnish the break-up of auxiliary cooling water requirements as below :

Sl. No.	Equipment Requiring Aux. Cooling Water	Number of Coolers		Maximum heat load for each cooler kcal/h	Auxiliary cooling water flow through each cooler m ³ /h	Total aux. cooling water flow m ³ /h	Remarks
		Operating	Standby				

1.1.2 Guaranteed pressure drop across
BIDDER's terminal point (maximum) = ----- kg/cm²

1.2 Instrument / Service Air Requirement

1.2.1 BIDDER shall furnish the break-up of instrument / service air requirements as below:

Sl. No.	Item Requiring Compressed Air	Instrument Air flow, Nm ³ /h		Service Air Flow, Nm ³ /h		Remarks
		Continuous	Intermittent	Continuous	Intermittent	



1.2.2 Service air pressure required at
BIDDER's terminal point : ----- kg/cm² (g)

1.2.3 Instrument air pressure required
at BIDDER's terminal point : ----- kg/cm² (g)

1.2.3.1 Maximum temperature of service/
Instrument air at BIDDER's
terminal point : ----- °C

SIGNATURE -----

NAME -----

SEAL OF COMPANY

DESIGNATION -----

ADDRESS -----

DATE -----



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ATTACHMENT-17

SCHEDULE OF ELECTRICAL LOAD LIST

FOR APPROVAL

Rev	DATE	PREPARED	CHECKED	APPROVED	STATUS

Owner: Hindalco

Consultant : Tata Consulting Engineers Limited

Sub-Supplier

Project

DE Service for 2x30 MW CGPP

Document Title

ELECTRICAL LOAD LIST FOR MAIN PLANT SYSTEM

Document Type

☐ Basic Engineering Document ☒ Detail Engineering Document ☐ Vendor Document ☐ Other

Document No.

[illegible]



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TECHNICAL SPECIFICATION FOR MAIN PLANT SYSTEM

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ATTACHMENT-18

GENERAL CONDITIONS OF CONTRACT



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GENERAL CONDITIONS OF CONTRACT

SECTION – A2



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1.0 SCOPE OF CONTRACT

Performance Guarantee include Basic Design and Detailed Engineering, Procurement, Supply, Supply of License (if applicable), Fabrication, Inspection by Third Party Inspection Agency as applicable, Expediting, Route Survey for ODC's, Insurance, Transportation of All EQUIPMENT/ Materials to Work Site, Storage, Construction and Erection of all Civil, Mechanical, Electrical and Instrumentation Works, Assembly and Installation, Obtaining all necessary Statutory Approvals, Testing, Mechanical Completion, Pre-Commissioning, Commissioning, Performance Guarantee Test Run including Total Project Management and Handing Over of Plant(s) and all related Offsite & Utilities Facilities at designated project site (as per Scope of Work detailed in Clause 3.2 of SCC) on a Lump-Sum Turnkey contract Basis with Single Point Responsibility.

- 1.1 Carrying out Basic Engineering, Detailed Engineering, Conducting HAZOP Study and incorporating its recommendation in the Project, Supply of PLANTS and associated Offsites & Utilities, EQUIPMENT, Machinery, accessories, auxiliaries, spares and other related items, packing, supplying, arranging comprehensive insurance, primary protection and testing of individual items and assembly where necessary, construction, erection, testing, PRECOMMISSIONING and Commissioning, PERFORMANCE AND GUARANTEE TEST RUNS as per CONTRACT specifications, supply of final DRAWINGS & DOCUMENTS, etc. on LSTK basis by the CONTRACTOR himself and with stage wise review of all the aforementioned.
- 1.2 Arrange services of ocean transportation as applicable, carry out the services of port clearance, handling, loading on Trailer/ Trucks and inland transportation up to SITE, Comprehensive insurance, unloading, storage at SITE in OWNER's premises, transportation within SITE, unloading, storage, handling, site Assembly, fabrication, insulation, painting, testing, arranging commissioning spares, complete services of erection, structural and Pre-commissioning, commissioning and performance & guarantee tests for plant.
- 1.3 The CONTRACTOR shall take all necessary steps and comply with all formalities to get the CONTRACT registered with the appropriate Indian Custom Authorities to have the various imported equipment including spares, assessed as applicable. Any Government Clearances/ Permissions like Labour License/Import License, etc. shall be obtained by CONTRACTOR with assistance, as required, by OWNER. Only Statutory fees paid to Government Authorities or Regulatory bodies for Licenses / permits obtained by CONTRACTOR in OWNER's name, shall be borne by OWNER.

- 1.4 The CONTRACTOR shall be responsible on completion of CONTRACT or whenever required to undertake Customs reconciliation work with Indian Customs Authorities and finalize the Customs assessment by furnishing the necessary Technical Documents, technical information etc. to the said Authorities.
- 1.5 Any additional equipment whether mentioned or not, but which is necessary for the satisfactory operation and maintenance of plant and for achieving the guaranteed performance of the PLANT shall be supplied, erected and commissioned by CONTRACTOR at no additional cost to the OWNER as though such equipment were originally specified and formed part of scope of WORK.
- 1.6 The scope of CONTRACT shall include spare parts necessary for commissioning of the PLANT and special tools & tackle required for the maintenance of the Plant and shall be concurrently ordered and supplied along with the main EQUIPMENT. The total bid price shall also be inclusive of spares for two years required for satisfactory operation & maintenance of the PLANT (Refer Clause 50.0 of GCC). In case any Catalysts/Adsorbent has life less than 6 months, suitable additional quantities shall be supplied along with the first charge of Catalyst/Adsorbent.
- 1.7 The CONTRACTOR shall give DRAWINGS, catalogues, sketches and literature that the OWNER shall specify in the CONTRACT. CONTRACTOR shall also handover to the OWNER the commissioning spares, if any, which are not consumed during COMMISSIONING of the PLANT, at no additional cost to OWNER. In case any of the mandatory spares (if part of contract) are consumed by the CONTRACTOR during COMMISSIONING and/ or TRIAL RUN of the PLANT prior to PRELIMINARY ACCEPTANCE, the same shall be replenished by the CONTRACTOR within a reasonable time, failing which delivered cost of such replacement spares shall be realised from the CONTRACTOR's Final Bill or Performance Bank Guarantee. It is also expressly understood by both Parties that there could be minor variations in the supplier-specific description / nomenclature of a particular spare part vis-à-vis the description/ nomenclature as per the list of mandatory spare parts included in technical Section of the ITB and any amendments thereto, which shall be mutually resolved by the OWNER and CONTRACTOR with necessary inputs from the supplier.
- 1.8 Completeness of the EQUIPMENT shall be the responsibility of the CONTRACTOR. Any equipment, fittings and accessories which may not be specifically mentioned in the specifications or drawings, but which are usual or necessary for the satisfactory

functioning of the equipment (successful operation and functioning of the EQUIPMENT being CONTRACTOR'S responsibility) shall be provided by the CONTRACTOR without any extra cost.

- 1.9 The CONTRACTOR shall follow modern engineering practices in design and manufacture of high-quality equipment notwithstanding any omission in the specifications. The true intent and meaning of these documents is that, CONTRACTOR shall in all respects design, engineer, manufacture and supply the EQUIPMENT in a thorough workman-like manner and supply the same in prescribed time to the entire satisfaction of OWNER.

In case any changes, modifications or substitutions from the original specifications are mutually agreed to be implemented, an equivalent or better solution than what was originally envisaged, shall be selected at no additional cost to OWNER, so that the overall performance of the PLANT is not jeopardized in any manner.

- 1.10 The CONTRACTOR shall furnish twelve (12) copies in English language of technical DOCUMENTS, final DRAWINGS, preservation instructions, operation and maintenance manuals, test certificates, spare parts catalogues, SOFTWARE and hardware configuration.CD/DVD/USB Drive containing soft editable version of all “As-built” drawings / final drawings in Auto-CAD (.dwg format) shall also be furnished along with above 12 copies (Also refer Clause 20.9 of GCC).
- 1.11 The Documents once submitted by the CONTRACTOR shall be firm and final. The CONTRACTOR shall be responsible for any loss to the OWNER consequent to furnishing of the incorrect data/drawings.
- 1.12 All dimensions and weights shall be in metric system.
- 1.13 All EQUIPMENTS to be supplied and WORK to be carried out under the CONTRACT shall conform to and comply with the provisions of relevant regulations/acts of Government of India and State Govt. relevant to project site as may be applicable to the type of EQUIPMENT/WORK carried out and necessary certificates shall be furnished.
- 1.14 The CONTRACTOR shall provide cross-sectional drawings wherever applicable to identify the spare part numbers and their location. The sizes of bearings, seals, etc. their make & number shall also be furnished along with bearings/ seals of other make & number which can be also used.

- 1.15 Specifications, design and drawings issued to the CONTRACTOR along with tender specifications and CONTRACT are not sold or given but allowed for execution of the WORK. These or its any copy made remain property of OWNER or his assignees and are subject to recall by OWNER. The CONTRACTOR, his employees, and SUB-CONTRACTOR and his employees shall not make use of the drawings, specifications and technical information for any purpose at any time except for manufacture against the CONTRACT and shall not disclose, the same to any person, firm or corporate authorities, without written permission of OWNER. All such details shall be kept confidential and in case of dire necessity can be shared with supplier or engineering sub-contractor only after a confidentiality agreement with the owner.
- 1.16 CONTRACTOR shall pack, protect, mark and arrange for dispatch of EQUIPMENT as per instructions given in the CONTRACT.

2.0 CONTRACT DOCUMENTS

The term 'Contract Documents' shall mean the signed CONTRACT between the Parties and includes the following which shall be deemed to form an integral part of the CONTRACT:

- a. Special Conditions of Contract (duly revised & updated, incorporating agreed changes in terms & conditions)
- b. General Conditions of Contract (duly revised & updated, incorporating agreed changes in terms & conditions)
- c. FINAL PROPOSAL (duly revised & updated or all amendments included and recognized in list of contract agreement documents, incorporating agreed changes in Technical Specifications, Performance Guarantees, Drawings, Scope of Work, Time Schedule, etc.)
- d. Schedule of Prices submitted by the CONTRACTOR along with Final Price Bid with date(s), including subsequent discounts/rebates offered in WRITING by the CONTRACTOR.
- e. Letter of Waiver, if any.
- f. CONTRACTOR's Technical & un-priced Commercial Bid, prior to the opening of the final Priced Bid, Addenda and Corrigenda thereto issued by Owner/ Owner's Project Management Consultant (PMC) based on relevant correspondences and Minutes of clarification meetings which shall not make part of contract.

- g. Notice Inviting Tender (Invitation to Bid), including Instructions to Bidders, General Conditions of Contract, Special Conditions of Contract, Technical Specifications.

Annexures thereto along with the pre-bid queries raised by the CONTRACTOR as a BIDDER and responses thereto, from OWNER / OWNER's Project Management Consultant limited to only which have been issued to contractor(s) in the form of Addenda & Corrigenda thereto.

The several Contract documents forming the CONTRACT are to be read together as a whole and are to be taken as mutually explanatory.

2.1 Interpretation of Contract Documents

- 2.1.1 Notwithstanding the sub-division of the CONTRACT into these separate documents and/or volumes and/or heads, every part of each separate section/volume/head shall be deemed to be supplementary of every other part and shall be read with and into the CONTRACT so far as it may be practicable to do so.
- 2.1.2 If in respect of any commercial term or condition, any provision in the GENERAL CONDITIONS OF CONTRACT is repugnant to or at variance with any provision(s) of the SPECIAL CONDITIONS OF CONTRACT and / or the Agreed Variations or if any provision of the SPECIAL CONDITIONS OF CONTRACT is repugnant to or at variance with any provision(s) of the Agreed Variations, and the two cannot be reconciled or otherwise co-exist, then unless a different intention appears, the provision(s) of the SPECIAL CONDITIONS OF CONTRACT shall be deemed to override the provision(s) of GENERAL CONDITIONS OF CONTRACT and the provision(s) of the Agreed Variations shall be deemed to override the provision(s) of the SPECIAL CONDITIONS OF CONTRACT, but only to the extent that such repugnancy in the GENERAL CONDITIONS OF CONTRACT cannot be reconciled with the SPECIAL CONDITIONS OF CONTRACT and/or Agreed Variations or to the extent that such repugnancy in the SPECIAL CONDITIONS OF CONTRACT cannot be reconciled with the Agreed Variations, as the case may be.
- 2.1.3 Without prejudice to the provisions of the GENERAL CONDITIONS OF CONTRACT, whenever in the Bidding documents it is mentioned or stated that the CONTRACTOR shall perform certain work or provide certain facilities, it is understood that the CONTRACTOR shall do so at his own cost and the Lump-sum Price shall be deemed to have included the cost of such performance and/or provision, as the case may be.
- 2.1.4 The MATERIALS, design and workmanship shall satisfy the applicable relevant Indian standards, the job specifications contained herein, and the codes referred to by

expression or implication. Where the job specifications stipulate requirements in addition to those contained in the standard codes and specifications, these additional requirements shall also be satisfied and fulfilled. In the absence of any standard/specification/code of practice for detailed specifications covering any part of the work covered in this tender, the instructions/directions of the Engineer-In-charge shall be binding on the CONTRACTOR.

2.1.5 In case of an irreconcilable contradiction in the Commercial Terms or Conditions/Technical Requirements or technical specifications between Indian Standards / Applicable Codes & Standards, GENERAL CONDITIONS OF CONTRACT, SPECIAL CONDITIONS OF CONTRACT, Specifications, DRAWINGS, Schedule of Lump-sum Price and or Agreed Variations to the extent that the two provisions cannot co-exist or be read together to satisfy both or all, the following order of precedence shall prevail:

- i. Formal CONTRACT
- ii. Letter of Intent
- iii. Special Conditions of Contract (duly revised & updated, incorporating agreed changes in terms & conditions).
- iv. General Conditions of Contract (duly revised & updated, incorporating agreed changes in terms & conditions).
- v. FINAL PROPOSAL including Agreed Variations
 - a. Job specifications/ Scope of Work
 - b. Drawings
 - c. Technical/Material Specifications
 - d. Quality Assurance Procedures
 - e. Applicable Codes & Standards
- vi. Schedule of Prices
- vii. CONTRACTOR's Bid including post bid Addenda / Corrigenda thereto.
- viii. Notice Inviting Tender (Invitation to Bid) and pre-Bid Clarifications

2.1.6 Should there be any doubt or ambiguity in the interpretation of the CONTRACT documents or contradiction therein or should there be any discernible error or omission in any CONTRACT document, the CONTRACTOR shall, prior to commencing the relative work or supply, as the case may be, apply in WRITING to

the EIC for his decision for resolution of the doubt, ambiguity or contradiction or correction of the error or making good the omission, as the case may be. Should the CONTRACTOR fail to apply to the EIC for his decision as aforesaid prior to commencing the relative work or supply, the CONTRACTOR shall perform the said work or make the said supply, as the case may be, at his own risk, and the provisions of Clause 2.1.9 hereof shall apply to any such work performed or supply made by the CONTRACTOR.

- 2.1.7 Notwithstanding anything provided in Clause 2.1.6 above, either the CONTRACTOR or any representative of the OWNER or CONSULTANT may, at any time prior to or during the execution of the work or supply of any material or any part thereof (if the CONTRACTOR has failed to make an application as provided for in Clause 2.1.6), apply to the EIC in WRITING for his decision in resolution of any doubt, ambiguity or contradiction or for the correction of any error or for making good the omission as the case may be.
- 2.1.8 The decision of the EIC on any application under Clause 2.1.6 or Clause 2.1.7 hereof shall be in WRITING and shall be final and binding upon the CONTRACTOR and shall form part of the CONTRACT documents, with the intent that the CONTRACT documents shall be read as though the said decision is and was at all times incorporated therein.
- 2.1.9 In the event of the CONTRACTOR performing or executing any work or making any supply at variance with the decision of the EIC as aforesaid, then such work shall, if the EIC so consider necessary, be deemed to be a defective work/ supply and the provision of Clause 46.0 of GCC and associated clauses there under shall apply thereto.
- 2.2 Any work or supply shown, indicated or included in any description of the work, plans, drawings, Specifications and/or Price Schedule or other CONTRACT or Bid documents, shall be deemed to form part of the WORK and/or supply contracted for, as the case may be, notwithstanding failure to show, indicate or include such work or supply in any other or others among the documents aforesaid with the intent that the indication or inclusion of the work or supply within any one of the said documents shall be deemed to be a sufficient indication or inclusion of the work or supply, as the case may be, within the work and supply covered by the CONTRACT.
- 2.3 No verbal agreement, assurance, representation or understanding given by any employee or officer of the OWNER or so understood by the CONTRACTOR, whether given or understood before or after the execution of the CONTRACT, shall

any-wise bind the OWNER or alter the CONTRACT documents unless specifically given in writing and signed by the OWNER or by the EIC on behalf of the OWNER and CONTRACTOR'S authorized representative as an Agreed Variation and amendment of the relative term(s) in the Contract Documents.

- 2.4 Clause headings given in this or any other contract documents are intended only as a general guide for convenience in reading and segregating the general subject of the various Clauses, but do not form part of the contract documents, with the intent that the Clause headings shall not govern the meaning or import of the Clauses thereunder appearing or confine or otherwise affect the interpretation thereof.

3.0 DEFINITION OF TERMS & INTERPRETATION

In the CONTRACT, unless the context otherwise requires, the following expressions shall have the following meanings. The singular shall include the plural and the plural include the singular except where the context otherwise requires and the words 'he', 'him', and 'his' shall be taken to mean 'she', 'her' and 'hers' where appropriate.

1. 'APPROVAL' shall mean and include the written approval by the OWNER of documents, drawings or other particulars in relation to this CONTRACT through OWNER's Project Management Consultant (PMC) or ENGINEER-IN-CHARGE (EIC).
2. 'BATTERY LIMIT' shall mean the outer limits of boundaries of the areas within which the Plants and associated facilities shall be located.
3. 'BID' shall mean the proposal/document that the BIDDER submits in the requested and specified form in the specification in response to this NIT.
4. 'BIDDER' shall mean the firm/party who quotes in response to an invitation to bid from the OWNER.
5. 'CHANGE ORDER' means an order by which a change is ordered or other notification made to the CONTRACTOR in accordance with the CONTRACT.
6. 'CODES' shall mean the following, including the latest amendments, and/or replacements, if any:
 - a. All relevant Indian Acts, and Rules and Regulations made there under.
 - b. ASME Codes
 - c. AIEE Codes
 - d. American Society of Testing of Materials (ASTM) Codes
 - e. Other internationally applicable standards and/or Regulations the subject matter of the CONTRACT.

- f. Indian Employees Provident Fund Act,
 - g. Pollution Control norms of INDIA
 - h. Contract Labour Act
 - i. Minimum Wages Act
 - j. Any other labour laws of INDIA applicable during execution of contract.
 - k. Any other codes/standards specified in the contract documents.
 - l. IBR
 - m. API
7. 'COMMERCIAL OPERATION' shall mean the condition of operation in which the complete equipment covered under the CONTRACT is officially declared by the OWNER to be available for continuous operation at different loads up to and including rated capacity after completion of COMMISSIONING as per CONTRACT. Such declaration by the OWNER however, shall not relieve or prejudice the CONTRACTOR any of his obligations under the CONTRACT.
8. 'COMMERCIAL USE' shall mean that use of the PLANT, which CONTRACT contemplates or of which it is commercially capable.
9. 'COMMISSIONING' shall mean the putting into operation of PLANT by CONTRACTOR with the active association from owner's personnel.
10. 'CONSULTANT' shall mean the agency nominated/appointed by the OWNER for the project/job/WORKS.
11. The 'CONTRACT' shall mean the written agreement made between the OWNER and the CONTRACTOR for the execution of the WORK, including all attachments and Annexures thereto and all documents incorporated by reference therein.
12. 'CONTRACTOR' shall mean the successful BIDDER whose bid has been accepted by the OWNER and who has been selected by the OWNER for the award of WORKS and shall include his heirs, legal representatives, successors and permitted assigns.
13. 'CONTRACT PERIOD' shall mean the time period (as extended by the OWNER from time to time where appropriate) during which the CONTRACT shall be executed as agreed between CONTRACTOR and the OWNER in the CONTRACT.
14. 'CONTRACTOR'S EQUIPMENT' means all equipment, construction plant, vehicles, temporary facilities, material, tools or things brought on to the SITE by or on behalf of the CONTRACTOR for carrying out the WORKS but not for permanent incorporation in the PLANT.

15. 'CONTRACTOR's WORKS' OR 'MANUFACTURER's WORKS' shall mean the place or places of work used by the CONTRACTOR/SUB-CONTRACTOR or their collaborator(s) for the manufacture of EQUIPMENT or performance of WORKS.
16. "COST" means the cost incurred by the CONTRACTOR in carrying out any of his obligations under the CONTRACT, and "Cost" shall be constructed accordingly.
17. 'DAY' shall mean a calendar day of 24 hours.
18. "DEEMED ACCEPTANCE" shall have the meaning as defined in Clause 16.0 of SPECIAL CONDITIONS OF CONTRACT.
19. "DEFECT" means any work done or any Material or the Plant or any part of it which does not comply with the CONTRACT, provided that such matter shall not be a DEFECT if it is caused by:
 - a. normal wear and tear after 6 months.
 - b. a failure by the PURCHASER to operate and maintain the PLANT in accordance with any operating and maintenance manuals provided by the CONTRACTOR and/or with good engineering practice; and/or
 - c. failure by the PURCHASER to comply with any of his obligations under the CONTRACT.
20. 'DEFECTS LIABILITY PERIOD' shall mean a period of 12 months commencing from the date of PRELIMINARY ACCEPTANCE. The CONTRACTOR shall warrant that the EQUIPMENT and MATERIALS supplied under the CONTRACT shall be new and free from any defect or deficiency with respect to design, material and workmanship. In the event of any defect or deficiency arising during the DEFECTS LIABILITY PERIOD, CONTRACTOR shall repair or replace the defective or deficient EQUIPMENT and MATERIALS at its own cost. In such event the DEFECTS LIABILITY PERIOD for the equipment shall be another 12 months from the date of acceptance by OWNER of such replaced/repared equipment/material subject to an upper limit of 60 months from date of PRELIMINARY ACCEPTANCE or the date of issuance of a conditional PRELIMINARY ACCEPTANCE CERTIFICATE (as envisaged under Sub Clause of 20.8 of SCC), whichever is earlier.
21. "documentation" means any relevant documents in paper or electronic form, including drawings, technical software, images, designs, manuals, or records.
22. 'DRAWINGS', 'PLAN' shall mean all:
 - d. Drawings furnished by the OWNER as a basis for proposals.
 - e. Supplementary drawings furnished by the OWNER to clarify and to define in greater detail the intent of the CONTRACT.

- f. DRAWINGS submitted by the CONTRACTOR with his proposal provided such drawings are acceptable to the OWNER.
 - g. DRAWING furnished by the OWNER to the CONTRACTOR during the progress the WORKS; and
 - h. Engineering data and DRAWINGS submitted by the CONTRACTOR during the progress of the WORK provided such drawings are acceptable to the OWNER.
23. 'EFFECTIVE DATE OF CONTRACT' shall mean the calendar date on which the last of the following conditions precedent are fulfilled:
- i. Issuance of a Letter of Intent (Notification of Award) by OWNER and unconditional acceptance of the same by CONTRACTOR or Signature of the CONTRACT
 - j. Payment of Mobilization Advance by OWNER against submission of Advance Bank Guarantee by CONTRACTOR
 - k. Submission of a Performance Bank Guarantee by the CONTRACTOR for
10% of TOTAL CONTRACT PRICE
 - l. License agreement by OWNER with Process Licensor (if applicable) for Licensed plant(s) as set out in Sub-clause 4.9 of SCC.
24. The above conditions b), c) and d) shall be fulfilled within 30 days from the date of Issuance of Letter of Intent. In case delay beyond 30 days is attributable to OWNER, the EFFECTIVE DATE OF CONTRACT shall be shifted by the number of days of delay attributable to OWNER. In case delay beyond 30 days is on the part of CONTRACTOR, the effective date shall be 30 days from the date of Issuance of Letter of Intent.
25. ENGINEER-IN-CHARGE (EIC) shall mean the officer or any executive of the Owner, any consultant, or any other organisation, appointed by the Owner to act as the
'Engineer-in-charge' for the purposes of the contract or any other persons appointed from time to time by the owner and notified to the contractor.
26. EIC's INSTRUCTIONS shall mean any drawings and/or instructions, oral and/or in WRITING, details, directions and explanations issued by the OWNER from time to time during the CONTRACT PERIOD to the CONTRACTOR/ SUBCONTRACTOR for carrying out the WORK.
27. "EXTENDED PERFORMANCE TEST PERIOD" has the meaning stated in clause 20 of Special Conditions of Contract.

28. "Equipment" or "stores" shall mean the equipment, machinery, and structure of any kind which the CONTRACTOR is obliged to design, supply, deliver, unload, store at site, erect, set to work and test under the CONTRACT.
29. "FINAL ACCEPTANCE" shall mean that date when all of the conditions set forth in Clause 21 of SPECIAL CONDITIONS OF CONTRACT have been satisfied, all liabilities and obligations under this CONTRACT have been discharged, except those specially to be continued or performed after FINAL ACCEPTANCE, and OWNER has issued the FINAL ACCEPTANCE CERTIFICATE to CONTRACTOR.
30. "FINAL ACCEPTANCE CERTIFICATE" shall mean that certificate issued by the PROJECT MANAGER or OWNER to the CONTRACTOR subject to clause 21 of SPECIAL CONDITIONS OF CONTRACT at the end of the DEFECTS LIABILITY PERIOD.
31. "FINAL COMPLETION" shall mean the completion of guarantee tests and handing over of the PLANT and facilities to OWNER, all temporary construction to facilitate construction has been removed and peaceful possession of all construction area has been restored to owner.
32. FINAL PROPOSAL means the document containing up to date technical offer of CONTRACTOR and technical information, data, etc., including drawings as agreed to in WRITING between the CONTRACTOR and OWNER, which is annexed to CONTRACT.
33. "GCC" or CONDITIONS OF THE CONTRACT shall mean all the terms and conditions forming part of this agreement as defined herein.
34. "GUARANTEED COMPLETION DATE" shall mean the date (or time period) specified in the Contract with reference to the EFFECTIVE DATE OF CONTRACT, subject to any extensions expressly provided for hereunder upon which date CONTRACTOR shall have achieved COMMISSIONING of Process Plant and offsite / utility Units which are integral part of contract.
35. "INDIAN AGENT" shall mean the person, firm or company nominated as such by the CONTRACTOR to represent the CONTRACTOR for this CONTRACT in India in case of normal place of business of contractor is a foreign country City.
36. 'INITIAL OPERATION' shall mean the first integral operation of the complete EQUIPMENT covered under the CONTRACT with sub-systems and supporting equipment in service or available for service and shall be undertaken as part of COMMISSIONING after completion of start-up activities.

37. 'INSPECTOR' shall mean the duly authorized representative of the OWNER nominated for stage wise or final inspection of WORKS or of EQUIPMENT or MATERIALS to be supplied under the CONTRACT.
38. "LEGISLATION" means all applicable laws, directives, codes, statutes, rules, ordinances, approvals, licenses, decrees, authorizations, by-laws, regulations, standards and any other requirement of any governmental authority or agency whether international national, state, municipal, local or other government subdivision, having the force of law in any place where the WORKS or any part of the WORKS are being carried out.
39. "MANUFACTURER" shall mean a person or firm who is the producer and supplier of material and/ or designer and/or fabricator of equipment to either the OWNER or, the CONTRACTOR or both under the CONTRACT.
40. "MATERIALS" means machinery, plant and other items of equipment and materials intended to form part of the PLANT and other things needed for its operation, to be supplied by the CONTRACTOR.
41. "MECHANICAL COMPLETION" shall mean completion of erection and testing /pre commissioning activities to such an extent that the PLANT is ready for commissioning. For process plant(s) it shall mean the date on which the plant is ready for acceptance of process fluids / feed to be introduced leading to production and for Off-site and Utilities its shall mean the date on which the clearing / flushing / blowing and other pre-commissioning activities has been completed in all respect and these facilities are ready for commissioning.
- a. The EQUIPMENT capable of producing to rated capacities are installed, aligned and grouted (wherever applicable) in accordance with drawings, specifications as per finally approved P&I Diagrams after HAZOP Studies and in accordance with all applicable codes, and laws.
 - b. All pressure EQUIPMENT is hydrostatically or pneumatically tested once either in CONTRACTOR'S shop or in the field in accordance with Technical Specifications.
 - c. Boilers are hydrostatically or pneumatically tested and clearance from IBR is obtained. All non-operating preferring checks are made in accordance with the manufacturer's instructions.
 - d. Compressor, Pumps, Machinery etc. are cold aligned. Couplings are assembled and guards installed.
 - e. Instruments, control system, instrument cable, safety-interlock are installed, inspected and such non-operating checks are made as to ensure operability in the

manner required for the process application. Instrument air lines are checked for correct hook up. Air lines are leak tested.

- f. Relief valves are installed prior to this, they will have been checked and calibrated by the CONTRACTOR in the CONTRACTOR's shop and witness by owner or its representative (Consultant/ Inspector)
 - g. Piping is hydrostatically or pneumatically tested in accordance with the specifications. Special treatment such as chemical cleaning is done as required by drawing or specifications. Suction screens are installed and test blinds are removed. Spring support anchors and guide are checked for removal of all shipping locks.
 - h. The electric system is installed and tested in accordance with and to the extent required by electrical specifications. All wiring is checked for correct hook up. Motor rotation is checked. All power system protective devices are set.
 - i. Insulation and drying out are completed to the extent necessary to permit start of commissioning and start up.
 - j. Pipe support system installed as per drawings and spring supports are set for cold condition.
 - k. Painting is completed. EQUIPMENT /MACHINERY, piping duly marked and labelled.
 - l. Safety equipment, systems are installed and checked for operations. Effluent management and treatment systems are installed and operational.
 - m. PRECOMMISSIONING has been completed and shipping brackets of any equipment / instrument / valves / expansion bellows have been removed.
 - n. The PLANT is ready to take feed.
42. 'MONTH' shall mean the calendar month.
43. 'NOTICE OF AWARD OF THE CONTRACT'/'LETTER OF INTENT' shall mean the official notice issued by the OWNER notifying the CONTRACTOR that his bid has been accepted, subject to such conditions as may have been stated therein and as agreed between OWNER and CONTRACTOR and that the CONTRACTOR is required to sign the CONTRACT Agreement.
44. 'NOTICE IN WRITING', 'WRITTEN NOTICE' shall mean a notice in written, typed or printed characters sent (unless delivered personally or otherwise proved to have been received) by registered post/ Speed Post 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. Fax / mail with Post copy confirmation.

45. "OTHER CONTRACTOR/OTHERS" shall mean any person(s) having a contract with the OWNER to design, supply, erect, set to work, or do any other thing to or in connection with any other plant and shall include their heirs, legal representatives, successors and permitted assigns.
46. 'OWNER' shall mean (Group Company name) having its registered office at One Unity Centre Tower 4, 21st Floor, Senapati Bapji Marg, Prabhadevi, Mumbai 400013. and shall include its heirs, legal representatives, successors and permitted assigns.
47. 'PERFORMANCE & GUARANTEE TESTS' shall mean all operational checks and tests required to determine and demonstrate capacity, efficiency and operating characteristics as specified in the CONTRACT documents of the equipment by the CONTRACTOR, before the plant is taken over under guarantee by the OWNER.
48. "PERFORMANCE TEST PERIOD" shall mean regular operation for a period of 3 months from COMMISSIONING or 6 months from MECHANICAL COMPLETION, whichever is later.
49. "PLANT" means process plant(s) and ASSOCIATED FACILITIES which shall be designed, engineered, procured, tested, constructed, pre-commissioned, commissioned and started up under the terms of this CONTRACT.
50. "PRELIMINARY ACCEPTANCE" shall mean that following milestones have been achieved.
 - a. MECHANICAL COMPLETION has occurred,
 - b. PRE-COMMISSIONING and COMMISSIONING of the PLANT have been accomplished,
 - c. the Sustained Load Test has been passed,
 - d. The PLANT has passed all Performance Tests and is in compliance with all applicable Laws.
 - e. OWNER has Accepted the Plant or has been deemed to have accepted the PLANT.
 - f. CONTRACTOR and OWNER agree that the PLANT is ready for normal continuous operation.
 - g. all Statutory approvals required to operate and maintain the PLANT have been obtained.
 - h. OWNER has confirmed that the PLANT conforms with the requirement under the WORK.

- i. OWNER has received all DOCUMENTS required hereunder for OWNER to start up, operate and maintain the PLANT.
 - j. OWNER has received all operations, maintenance, and spare parts manuals and instruction book necessary to operate and maintain the PLANT in a safe, efficient and effective manner.
 - k. all special tools and spare parts purchased by CONTRACTOR as provided herein have been delivered to OWNER; and
 - l. CONTRACTOR has completed the training program of OWNER's personnel as required under this CONTRACT.
51. "PRELIMINARY ACCEPTANCE CERTIFICATE" shall mean that certificate issued by the EIC or OWNER to the CONTRACTOR following satisfaction of conditions under PRELIMINARY ACCEPTANCE, the acceptance of which commences the DEFECT LIABILITY PERIOD.
52. "PRE-COMMISSIONING" shall mean preparation of PLANT so that it is capable of operating on a continuous basis at or near rated capacity for carrying out COMMISSIONING activities.
53. 'PROJECT' shall mean the Project specified in the technical specification.
54. 'PURCHASE ORDER' / 'WORK ORDER' shall mean the order and associated specifications executed by the OWNER and CONTRACTOR.
55. "PURCHASER" shall mean OWNER.
56. "SCC" or SPECIAL CONDITIONS OF THE CONTRACT shall mean all the terms and conditions forming part of this agreement as defined herein.
57. 'SITE' shall mean and include the land and other places on, into or through which the EQUIPMENT and related facilities shall be erected and any adjacent land, paths, streets or reservoirs which may be allocated or used by the OWNER or CONTRACTOR in the performance of the CONTRACT.
58. "SOFTWARE" means all forms of software and firmware and their condition.
59. 'SPECIFICATION' shall mean collectively all the terms and stipulations in Conditions of the CONTRACT, the Technical Specifications, schedules, detailed descriptions, statement of Technical Data, performance characteristics, standards & codes etc., and subsequent addenda issued thereto before the date of closing of bid and all written agreements made or to be made pertaining to the method and manner of performing the Work or to the quantities and the qualities of the materials to be furnished under this CONTRACT.

60. 'START UP' shall mean bringing the equipment covered under the CONTRACT from an inactive condition, when construction is essentially complete, to the state ready for initial operation. The start-up shall include preliminary inspection and checkout of EQUIPMENT and supporting sub-systems; perform calibration and corrective action and chemical cleaning of the plant/system/equipment covered under the CONTRACT.
61. 'SUB-CONTRACTOR' shall mean any person or persons, or firm(s) including his/ their heirs, legal representatives, successors and permitted assigns selected by the CONTRACTOR with prior written approval of the OWNER for undertaking any part of the Works under the CONTRACT or to whom any part of the CONTRACT is sublet by the CONTRACTOR with the consent in WRITING of the OWNER.
62. "TAKE OVER", "TAKING OVER" AND "TAKEN OVER" shall mean OWNER will take possession of and use of the PLANT for any intended purpose following issue of PRELIMINARY ACCEPTANCE CERTIFICATE or the issuance of a conditional PRELIMINARY ACCEPTANCE CERTIFICATE (as envisaged under Sub-Clause of 20.8 of SCC), whichever is earlier.
63. "TEMPORARY WORKS" means all temporary works and structures of every kind construed at the Site and required for the provision and construction of the PLANT.
64. 'TOTAL CONTRACT PRICE' shall mean the total price payable to the CONTRACTOR for the full and proper performance of its contractual obligations under the CONTRACT.
65. 'TRIAL OPERATION' or 'TRIAL RUN' shall mean the extended period of time after the initial operation. During this trial operation period the unit shall be operated over the full load range. The length of Trial Operation shall be determined by the OWNER unless otherwise specified elsewhere in the CONTRACT.
66. 'WEEK' shall mean continuous period of 7 (Seven) DAYS.
67. 'WORK' OR 'WORKS' means the design, engineering and other services to be provided by the Contractor including, but not limited to, the provision and construction of the PLANT and any Temporary Works and the subsequent dismantling or removal of the Temporary Works when no longer required, and any other works to be carried out by the CONTRACTOR in accordance with the CONTRACT.
68. 'WRITING' shall include any manuscript, typewritten or printed statement, under or over signature and/or seal as the case may be.

4.0 CONTRACT CONFIRMATION

- 4.1 The CONTRACTOR (along with its Consortium Member/s, if applicable) and OWNER shall sign Four (4) copies of the CONTRACT, retain Two (2) copies of the signed CONTRACT with itself and return Two (2) copies to the OWNER. The copies of the CONTRACT shall be signed by authorised officers of the OWNER and CONTRACTOR respectively in whose name Power of Attorney has been issued in the presence of two witnesses each for the OWNER and CONTRACTOR.
- 4.2 After CONTRACT confirmation/signing, the terms and conditions contained therein take precedence over CONTRACTOR's bid conditions and all previous correspondence.
- 4.3 If after award of CONTRACT, the CONTRACTOR does not acknowledge receipt of award of order and/or fails to deposit the PERFORMANCE BANK GUARANTEE within the time period specified in the CONTRACT, the OWNER reserves the right to cancel the CONTRACT and forfeit the Earnest Money Deposit (if any) without prejudice to various rights and remedies the OWNER may be entitled to as per terms and conditions of CONTRACT and without being liable in any manner whatsoever to the CONTRACTOR.

5.0 MODIFICATIONS IN CONTRACT

- 5.1 All modifications leading to changes in the CONTRACT with respect to technical or commercial aspects including terms of completion period shall be considered valid only when accepted in WRITING by OWNER by issuing amendment to the CONTRACT. Issuance of acceptance or otherwise in such cases shall not be any ground for extension of agreed completion date and also shall not affect the performance of CONTRACT in any manner except to the extent mutually agreed to, through a modification to CONTRACT. OWNER shall have the right to modify or amend the CONTRACT subject to an adjustment in the TOTAL CONTRACT PRICE and/ or COMPLETION DATE in accordance with the applicable provision of the CONTRACT, if any, or pursuant to mutual agreement.
- 5.2 OWNER shall not be bound by any printed conditions, provisions in the CONTRACTOR's bid forms or acknowledgement of CONTRACT, packing list and other documents which support to impose any condition at variance with or supplemental to CONTRACT.
- 5.3 **ALTERATIONS IN DESIGNS, PLANS, DRAWINGS, SPECIFICATIONS, ORDERS AND INSTRUCTIONS:**

5.3.1 If the Engineer-in-Charge is of opinion that any plan, drawings, design or specification or order or instruction relative thereto within the CONTRACTOR'S scope of work or supply is anywhere erroneous or is otherwise required to be modified, altered, amended or improved to conform to the Contract requirements, whether or not the same has or have been prior approved by or on behalf of the OWNER, the Engineer-in-Charge may by written notice to the CONTRACTOR at any time prior to or in the course of the execution of the works or any part thereof to modify or amend the relevant plan, drawing, design, specification, order or instruction relative thereto. The CONTRACTOR shall thereupon either convince the Engineer-in-Charge of the unnecessary in the whole or part of the amendment(s) or modification(s) or shall implement the same and shall cause the plan, drawing, design, specification, order or instruction as the case may be to be accordingly amended. The CONTRACTOR shall thereafter carry out the work or supply or the related work or supply, as the case may be, in accordance with such altered specification, order, instruction, plan, drawing and/or design, as the case may be, on the same terms and conditions in all respects without entitlement to any additional remuneration or price.

5.3.2 Any iteration, amendment or modification not covered under Clauses 5.3.1 above shall be governed by change order management as defined in Clause 5 of SCC.

5.3.3 Pending finalization in respects of the revision pursuant to the provisions of Clause 5.3.2 hereof, the CONTRACTOR shall continue and be bound to continue and perform the works and/or make the supply to completion in all respects according to the contract and the CONTRACTOR shall be liable and bound in all respects under the Contract.

5.3.4 The CONTRACTOR shall not be entitled to any compensation in addition to the payment for the works actually performed by the CONTRACTOR and/or supplies actually made by the CONTRACTOR calculated on the basis of the Lump sum Price except as provided in Clause 5.4 hereof where applicable as a result of any alternation, amendment, modification or improvement in the specifications, plans, designs or drawings as aforesaid, in which event the payment shall be calculated for the affected work or supply on the basis of the Lump sum Price as reduced or increased as the case may be under Clause 5.3.2

5.4 ALTERATION IN THE SCOPE OF WORK OR SUPPLY

The OWNER may at any time(s), before or after the commencement of the work or supply, by notice in writing issued to the CONTRACTOR, alter the scope of work or supply, by increasing or reducing the quantities relative to any job(s) or supply(ies) or

by increasing or reducing the job(s) required to be done or supplied with respect thereto or by omitting therefrom any specific job(s) or portion(s) or by substituting any existing jobs or operations with other jobs and/or operations, or by requiring the CONTRACTOR to perform any extra works. Upon receipt of such notice the CONTRACTOR shall execute the job(s) and/or make supplies as required within the altered scope of work and/or supply.

- 5.4.1 If any alteration in the scope of work and/or supply shall in the opinion of the CONTRACTOR, necessitate any extension in time for completion, the provisions of Clause 31.3 hereof and related Clauses with regard to the extension of time shall apply.
- 5.4.2 If such alteration shall, in the opinion of the Engineer-in-Charge, result in a reduction or increase or change in the work or supply covered by the Lump sum Price so as to render unreasonable the Lump sum Price, the provision of Clauses 5.3.2 and 5.3.3 shall apply.
- 5.4.3 The CONTRACTOR shall not be entitled to any compensation in addition to the payment for the work actually performed and supply actually made by the CONTRACTOR included in the Lump sum Price except as provided in Clause 5.4.2 hereof where applicable as result of any alteration in the scope of work, in which event the payment shall be calculated for the affected work or supply on the basis of the Lump sum Price as reduced or increased, as the case may be, under Clause 5.4.2

6.0 USE OF CONTRACT DOCUMENTS AND INFORMATION

- 6.1. The CONTRACTOR shall not, without the OWNER's prior written consent, disclose the CONTRACT or any vision thereof, or any specification, plan, drawing, pattern, sample or information furnished by or on behalf of the OWNER in connection therewith, to any person other than a person employed by the CONTRACTOR in the performance of the CONTRACT. Disclosure to any such employed person shall be made in confidence and shall extend only as may be necessary for purpose of such performance.
- 6.2. The CONTRACTOR shall not without the OWNER's prior written consent, make use of any document or information enumerated in Clause 6.1 except for purpose of performing the CONTRACT.
- 6.3. Any document other than CONTRACT itself, enumerated in Clause 6.1 shall remain the property OWNER and shall be returned (all copies) to the OWNER on completion

of the CONTRACTOR's performance under the CONTRACT if so required by the OWNER.

6.4 SECRECY

The technical information, drawings, specifications and other related documents forming part of the Invitation to Bid or the CONTRACT or such of those materials prepared during the execution of the project including photographs, micro-films, design, calculations, etc. are the property of the OWNER and shall not be used for any other purpose, except for execution of contract. All rights, including rights in the event of grant of patent and registration of designs are reserved. The technical information, drawings, specifications, records and other documents shall not be copied, transcribed, traced or reproduced in any other form or otherwise in whole and/or duplicated, modified, divulged and / or disclosed to a third party nor misused in any other form whatsoever, without the OWNER's previous consent in WRITING except to the extent required for the execution of this CONTRACT. Such technical information, drawings specifications and other related documents furnished shall be returned to the OWNER with all approved copies and duplicates, if any, immediately after they have been used for the agreed purposes

7.0 PATENT INFRINGEMENT AND INDEMNIFICATION

7.1 Patent Infringement

- 7.1.1 The CONTRACTOR undertakes that all equipment, machinery, instruments and materials used or supplied by the CONTRACTOR or methods or processes practiced or employed by the CONTRACTOR in the works shall not be covered by any third party patent, design or other rights, with the intent that the OWNER shall be entitled to the unfettered use of and right to the same and any subsequent works in which the same are incorporated without any third party right, claim or entitlement.
- 7.1.2 If any equipment, machinery, instruments and/or materials, used or supplied by the CONTRACTOR, or methods or processes practiced or employed by the CONTRACTOR in the performance of this contract or resultant works, is/are covered by a patent, design or other rights under which the CONTRACTOR, is not licensed, the CONTRACTOR shall before supplying or installing or using or employing or practicing the same obtain such license(s) and pay such royalty(ies) and license fees as may be necessary in connection with the performance of this contract. In the event that the CONTRACTOR fails to pay such royalty or obtain such license, the CONTRACTOR shall defend at its own expense, any suit

for infringement of patent, design or other right which is brought against the CONTRACTOR and/or the OWNER as a result of the failure, and shall pay any damages and costs awarded in such suit and shall keep the OWNER indemnified from and against all other consequences thereof, including (but not limited to) the costs incurred by the OWNER relative to such proceedings and in obtaining legal advice or opinion(s) relative to such proceedings, and shall perform all remedial and consequent works as shall be necessary.

- 7.1.3 OWNER shall promptly advise CONTRACTOR in WRITING of any claim of infringement or any action for infringement of patents brought against it by a third party and based upon the use of CONTRACTOR's Technical Information. If such use is in accordance with instructions given in WRITING by CONTRACTOR, CONTRACTOR shall undertake the defense, or assist OWNER in the defense, of the claim or suit up to final judgment or settlement.
- 7.1.4 CONTRACTOR shall undertake the defense on behalf of OWNER and shall have sole charge and direction of the defense and shall bear all costs related thereto. CONTRACTOR shall further hold OWNER harmless from any damages or other sums that may become payable by OWNER under a final judgment or settlement. However, OWNER shall render to CONTRACTOR all reasonable assistance that may be required by CONTRACTOR in the defense and shall have the right to be represented therein by advisory council of its own selection and at its own expense.
- 7.1.5 Neither CONTRACTOR nor OWNER shall settle or compromise any suit or action without the written consent of the other if settlement or compromise obliges the other to make any payment or part with any property or assume any obligations or surrender any rights or to be subjected to any injunction by reason of such settlement or compromise.
- 7.1.6 Notwithstanding any other provisions under this CONTRACT, the liabilities arising on account of patent infringement set out in this Sub-clause 7.1 shall be unlimited. For avoidance of doubt it is hereby clarified that provisions of Clause 30 of GCC dealing with limitation of liabilities shall not be applicable to the contractor.
- 7.1.7 Technology information provided both by Owner to Contractor as well as contractor to Owner shall be used for the purpose of execution of the PROJECT only. OWNER and CONTRACTOR shall sign Confidentiality Agreement before signing of the CONTRACT, thereby agreeing not to disclose the technology to a third party or in another project.

7.2 Indemnities

7.2.1 CONTRACTOR shall release, hold harmless and indemnify OWNER against any and all actions, suits, claims, demands, costs, charges and expenses arising in connection with any default.

or negligence or omission on part of, persons acting on CONTRACTOR's behalf, CONTRACTOR's SUB-CONTRACTORS, suppliers, and all tiers thereof for the purpose of the WORKS.

OWNER shall release, hold harmless and indemnify CONTRACTOR against all actions, suits, claims, demands, costs, charges, and expenses in connection with any wilful default or gross negligence directly attributable to the Owner for the purposes of the WORKS.

7.2.2 Damage to Property other than the PLANT or THIRD-PARTY Property

The CONTRACTOR shall release, hold harmless and indemnify OWNER against any and all actions, suits, claims, demands, costs, charges and expenses arising in connection with loss or damage to property of the CONTRACTOR, persons acting on CONTRACTOR's behalf, CONTRACTOR's SUB-CONTRACTORS, suppliers, and all tiers thereof, whether hired, owned or leased, arising out of or in connection with the performance of the CONTRACT, whether or not as a result of or contributed to by any wilful default or gross negligence of OWNER or any person directly or indirectly employed by the OWNER, persons acting on OWNER's behalf, OWNER's other contractors, suppliers, and all tiers thereof.

OWNER shall release, hold harmless and indemnify CONTRACTOR against all actions, suits, claims, demands, costs, charges and expenses arising in connection with loss or damage, or any person directly or indirectly employed by the OWNER, persons acting on OWNER's behalf, OWNER's other contractors, suppliers, and all tiers thereof, whether hired, owned or leased, arising out of or in connection with the performance of the CONTRACT, whether or not as a result of or contributed to by any default or negligent act or omission of the CONTRACTOR or any person directly or indirectly employed by the CONTRACTOR, persons acting on CONTRACTOR's behalf, CONTRACTOR's SUB-CONTRACTORS, suppliers, and all tiers thereof.

However, when such damage or loss is caused by CONTRACTOR, CONTRACTOR shall bear damages up to Rs [●] (*To be decided, depending on total value & scope*)

7.2.3 Damage to the PLANT

The CONTRACTOR shall be responsible for loss or damage to the PLANT (including without limitation all goods, EQUIPMENT, MATERIALS for incorporation therein) sustained at any time until the

a) PRELIMINARY ACCEPTANCE of PLANT or the issuance of a conditional PRELIMINARY ACCEPTANCE CERTIFICATE (as envisaged under clause 20.8 of SCC), whichever is earlier; and b) Upon PRELIMINARY ACCEPTANCE or the issuance of a conditional PRELIMINARY ACCEPTANCE CERTIFICATE (as envisaged under clause 20.8 of SCC), whichever is earlier but before FINAL ACCEPTANCE of PLANT, when loss or damage results from any cause or operation described in Sub-clause 27.1 a) or b) of GCC which is not caused by OWNER or any person directly or indirectly employed by OWNER, persons acting on OWNER's behalf, OWNER's other contractors, suppliers, and all tiers thereof, or which is not caused by an Excepted Risk (as defined below), and consequently

CONTRACTOR shall repair or replace such lost or damaged PLANT (including without limitation all goods, EQUIPMENT, MATERIALS for incorporation therein), free of cost. Notwithstanding the foregoing, CONTRACTOR shall be responsible for loss or damage to the PLANT caused by OWNER's personnel working under direct instruction of CONTRACTOR during PRE-COMMISSIONING/COMMISSIONING, except in the event of gross negligence or wilful misconduct by OWNER's personnel, and consequently, CONTRACTOR shall repair or replace such lost or damaged PLANT (including without limitation, all goods, EQUIPMENT, MATERIALS for incorporation therein), free of cost.

Upon PRELIMINARY ACCEPTANCE of PLANT or the issuance of a conditional PRELIMINARY ACCEPTANCE CERTIFICATE (as described in Sub-clauses 20.8 of SCC), whichever is earlier, when the PLANT is under the care and custody of OWNER, CONTRACTOR shall remain liable to repair or replace lost or damaged Parts at CONTRACTOR's own expense, only when the damage or loss is caused by CONTRACTOR or any person directly or indirectly employed by CONTRACTOR, Person acting on CONTRACTOR's behalf SUBCONTRACTORS, suppliers, and all tiers thereof, in the course of operations carried out by CONTRACTOR or any person directly or indirectly employed by CONTRACTOR, persons acting on CONTRACTOR's behalf, CONTRACTOR's SUB-CONTRACTORS, suppliers, and all tiers thereof, for the purpose of any testing, defect rectification or other activities after PRELIMINARY ACCEPTANCE of PLANT carried out or supervised by the

CONTRACTOR or any SUB-CONTRACTOR for the purpose of complying with their obligations under the CONTRACT.

Notwithstanding anything to the contrary in the CONTRACT, if the PLANT (including without limitation all goods, EQUIPMENT, MATERIALS for incorporation therein) sustains any loss or damage which is:

- i) the direct or indirect consequence of any risk for which coverage is not available in the insurance market, namely war, nuclear holocaust, etc (these risks being referred to as “Excepted Risks”), or
- ii) for which CONTRACTOR is not expressly responsible pursuant to the preceding paragraphs of this clause 7.2.3,

CONTRACTOR shall repair or replace such PLANT (including without limitation all goods, EQUIPMENT, MATERIALS for incorporation therein) at the expense of OWNER at a price to be agreed between CONTRACTOR and OWNER. In case of any disagreement between OWNER and the CONTRACTOR the same shall be settled in accordance with clause 37.0 of GCC.

7.2.4 Injury to THIRD PARTY Persons and Damage to THIRD PARTY Property

For the purpose of this clause,

“THIRD PARTY” shall mean any person or entity which is not:

- i) Directly or indirectly employed by the OWNER and CONTRACTOR,
- ii) Persons acting on OWNER’s and CONTRACTOR’s behalf,
- iii) OWNER’s other contractors, suppliers, and all tiers thereof
- iv) CONTRACTOR’s SUB-CONTRACTORS, suppliers, and all tiers thereof.

CONTRACTOR shall hold harmless and indemnify OWNER from and against any and all actions, suits, claims, demands, costs, charges and expenses in respect of loss of or damage to THIRD PARTY property, and injury to or death of any THIRD PARTY, including environmental incidents to the extent that such loss, damage, injury or death is caused by the negligence or breach of duty of CONTRACTOR or any person directly or indirectly employed by the CONTRACTOR, persons acting on CONTRACTOR’s behalf, CONTRACTOR’s SUB-CONTRACTORS, suppliers, and all tiers thereof.

OWNER shall hold harmless and indemnify CONTRACTOR from and against all actions, suits, claims, demands, costs, charges and expenses in respect of loss of or damage to THIRD PARTY property, and injury to or death of any THIRD PARTY, including environmental incidents to the extent that such loss, damage, injury or death

is caused by the negligence or breach of duty of OWNER or any person directly or indirectly employed by the OWNER, persons acting on OWNER's behalf, OWNER's other contractors, suppliers, and all tiers thereof. Notwithstanding the above, in case of dispute regarding indemnification for THIRD PARTY claims, procedure as per clause 37.0 of GCC shall apply.

Notwithstanding anything to the contrary in the CONTRACT, this Clause 7.2.1 shall survive the termination or expiration of the CONTRACT.

7.2.5 CONTRACTOR Indemnification for Taxes

It is specifically understood that CONTRACTOR hereby accepts and assumes exclusive liability for and save and hold OWNER harmless from and against of all Taxes arising from the performance of WORK, and all such Taxes shall be deemed to be included in TOTAL CONTRACT PRICE.

7.2.6 Payment of Amounts under this Clause

Except to the extent covered by insurance, all amounts payable by CONTRACTOR to OWNER under this Clause shall be deducted from TOTAL CONTRACT PRICE or any other amounts owed by OWNER to CONTRACTOR here under. If such amounts payable by OWNER to CONTRACTOR are less than the amounts payable by CONTRACTOR under this Clause, CONTRACTOR shall be liable to OWNER for such excess and shall pay such amount to OWNER immediately upon demand.

7.2.7 Permits and Certificates

CONTRACTOR shall procure, at its expense, all necessary permits, certificates and licenses to be obtained in the name of the OWNER and/or CONTRACTOR required by virtue of all applicable laws, regulations, ordinances and other rules in force at the place where any of the works is to be performed and approvals from Statutory Authorities as stated in clause 56.1 of GCC. CONTRACTOR further agrees to hold OWNER harmless from liability or penalty which might be imposed by reason of any asserted or established violation of such laws, regulations, ordinances or other rule. OWNER shall provide the necessary permits for CONTRACTOR's personnel to undertake any work in India in connection with CONTRACT. For avoidance of doubt, as per clause 1.3 of GCC, Statutory fees paid to Government Authorities or Regulatory bodies for Licenses / permits obtained by CONTRACTOR in OWNER's name, shall be borne by OWNER.

7.2.8 Lien

CONTRACTOR agrees to indemnify and hold harmless OWNER against all labourer's material, man's and/or mechanic's liens arising from its work and shall keep the premises of OWNER free from all such claims, liens and encumbrances.

8.0 PERFORMANCE BANK GUARANTEE

8.1 Within 30 days after receipt of CONTRACT by CONTRACTOR, the CONTRACTOR shall furnish to the OWNER security in the form of a bank guarantee for faithful completion of Project, as per terms and conditions of the Contract, issued by OWNER'S approved list of Banks for an amount equivalent to 10% of TOTAL CONTRACT PRICE valid throughout the DEFECTS LIABILITY PERIOD plus six months claim period.

Notwithstanding the foregoing, if the DEFECTS LIABILITY PERIOD is extended with respect to any part of the PLANT in accordance with clause 54.10.3 of GENERAL CONDITIONS OF CONTRACT hereto, the CONTRACTOR shall arrange for the Bank Guarantee to remain valid until the expiration of the extended DEFECTS LIABILITY PERIOD with respect to such part of the PLANT for a sum equivalent to the estimated and mutually agreed price of that repaired / replaced part subject to a maximum of 5% of TOTAL CONTRACT PRICE.

8.2 The proceeds of Performance Bank Guarantee shall be appropriated by the OWNER as compensation for any loss resulting from the CONTRACTOR's failure to complete their obligations under the CONTRACT without prejudice to any of the rights or remedies the OWNER may be entitled to as per terms and conditions of the CONTRACT.

8.3 The Performance Bank Guarantee shall be denominated in the currency/currencies of the CONTRACT.

8.4 The format for Performance Bank Guarantee is attached as Appendix-1 of SCC. The Performance Bank Guarantee shall be retained by OWNER during the currency of CONTRACT as indicated above, or till settlement of all the accounts thereof whichever is later. In case of any dispute or differences not settled within the validity of bank guarantee CONTRACTOR shall arrange to get the bank guarantee extended for the period asked for by OWNER with at least 60 days prior notice by OWNER. In case bank guarantee is not extended for the period as asked for by the OWNER at the latest 30 days prior to the expiry of the Bank Guarantee, the OWNER shall have the sole discretion to invoke Bank Guarantee in whole or part. The above PBG shall

be deemed to be security for the faithful performance of the CONTRACT and for the purpose of section 74 of the Indian Contract Act, 1872 and for the extension of that section.

The CONTRACT shall be deemed to be bond given by the CONTRACTOR for the performance of essential duty. In the event of breach of any of the terms and conditions of the contract OWNER shall have the right to draw from the Performance Bank Guarantee whole or part of the value of Performance Bank Guarantee. The amount so drawn shall not in any way affect any remedy to which OWNER may otherwise be entitled or any liability incurred by CONTRACTOR under the CONTRACT or any law for the time being in force relating thereto or bearing hereupon. This Performance Bank Guarantee shall be returned after CONTRACT has been successfully completed and certificate to this effect has been issued by OWNER. It shall be lawful for OWNER if any differences or dispute is likely to arise to defer payment of the Performance Bank Guarantee or any portion thereof which may be due for release until such differences and dispute has been finally settled or adjusted. Performance Bank Guarantee amount shall not bear any interest.

9.0 CONTRACT AGREEMENT

- 9.1 On final acceptance of the bid, the bidder shall be informed about it and thereafter a CONTRACT agreement shall be finalised between the OWNER and the BIDDER.
- 9.2 The CONTRACT will be signed in quadruplicate, two copies each for the CONTRACTOR and OWNER. All expenses for the preparation and stamping of CONTRACT shall be borne by the CONTRACTOR.

10.0 MANNER OF EXECUTION OF CONTRACT

- 10.1 All documents as per Clause 2.0 of GCC shall be included in the CONTRACT document and detailed specifications be inserted as mutually agreed between OWNER and CONTRACTOR.
- 10.2 Every page of the CONTRACT agreement shall be initialed by the Authorized representatives of OWNER and CONTRACTOR under the Seal of their respective Companies.
- 10.3 The CONTRACT agreement shall be prepared on stamp paper of appropriate value as per law.

- 10.4 The CONTRACTOR shall present the above CONTRACT so prepared in four copies along with proper power of attorney and other requisite material on the day of signing the agreement.
- 10.5 Two signed copies shall be returned to CONTRACTOR while the other two including the original shall be retained by OWNER.
- 10.6 Notwithstanding anything mentioned in any other clause, any conditions imposed from time to time by Government of India shall be followed by the CONTRACTOR.

11.0 EFFECTIVENESS AND JURISDICTION OF CONTRACT

- 11.1 The CONTRACT shall be considered as having come into force from the EFFECTIVE DATE OF THE CONTRACT.
- 11.2 The laws applicable to this CONTRACT shall be the laws in force in India from time to time.

12.0 ASSIGNMENT OR SUBLETTING OF CONTRACT AND SUB-CONTRACTING

- 12.1 Neither CONTRACTOR nor OWNER shall assign CONTRACT or any part of it or any share of interest therein, without the prior written consent of the other party.
- 12.2 CONTRACTOR shall not subcontract the whole or any part of WORK without the prior written consent of OWNER provided that CONTRACTOR may subcontract any part of WORK to any of its affiliates, his agents or employees in which event CONTRACTOR shall remain fully responsible to OWNER for the work performed by such affiliates.
- 12.3 Sub-Contracts and Purchase Orders

12.3.1 General

All vendors, suppliers, consultants 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 "SUBCONTRACTORS"/ "VENDORS", and any such SUBCONTRACTS, purchase orders and similar purchase forms and arrangement entered into by or on behalf of CONTRACTOR with SUB CONTRACTORS/VENDORS are herein referred to as "SUBCONTRACTS" provided that none of OWNER's CONTRACTORS or SUBCONTRACTORS shall be deemed to be a SUBCONTRACTOR 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 finalised and approved by the OWNER in the FINAL PROPOSAL. 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, consultant or SUBCONTRACTOR.

12.3.2 Approval of Major SUB-CONTRACTOR/VENDOR

12.3.2.1 The vendor list for procurement of EQUIPMENT and the list of SUB-CONTRACTORS shall be as attached in the FINAL PROPOSAL. Any changes to such list of VENDORS/SUBCONTRACTORS shall require the prior approval of OWNER. CONTRACTOR shall provide name, address, fax number, email id and name of contact person of major VENDOR/SUBCONTRACTORS for use in future, to OWNER.

12.3.2.2 The review, approval and consent by OWNER as to the agreed SUB-CONTRACTOR's/ VENDOR List or as to CONTRACTOR's entering into any SUB-CONTRACT / PURCHASE ORDER shall not relieve CONTRACTOR of any of its duties, liabilities or obligations under this CONTRACT and CONTRACTOR shall be liable hereunder to the same extent as if any such Subcontract had not been entered into.

12.3.2.3 a) CONTRACTOR shall provide to OWNER such information concerning the SUB-CONTRACTORS as OWNER may from time-to-time reasonably request, contractor 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 32.0 herein, CONTRACTOR shall forthwith deliver to OWNER a copy of each SUBCONTRACT.

b) CONTRACTOR shall supervise and direct the work of all SUB-CONTRACTORS / VENDORS and shall be responsible for all design; engineering; procurement; manufacturing; transportation; delivery; fabrication; construction; commissioning; start-up and testing means, erection; operation, maintenance, repair; methods; techniques; sequences and procedures of; and for co-coordinating the work of SUB-CONTRACTORS / VENDORS by following all Quality, SHE & Sustainability related procedure at each relevant stage at activity.

c) If CONTRACTOR fails to correct, or commence to correct and execute the correction with due diligence of deficient or defective work performed by any SUB-

CONTRACTOR / VENDOR within seven days, after receipt by CONTRACTOR of a notice from OWNER with respect thereto, 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.

d) CONTRACTOR shall require all SUB-CONTRACTORS/VENDORS to perform the SUBCONTRACTS in accordance with the relevant requirements of the CONTRACT including FINAL PROPOSAL, all APPLICABLE LAWS and APPLICABLE PERMITS, Prudent Utility Practice, Good Engineering Practices, the requirements of the Request for Proposal, and all Warranties of SUB-CONTRACTORS/VENDORS and Manufacturers and all insurance policies relating to the PLANT or the WORK.

e) CONTRACTOR shall be solely responsible for timely payment to each SUBCONTRACTOR / VENDOR 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 that, such services, equipment, construction equipment materials and supplies and the like have been or will be received, inspected and approved and that such services have been or will be properly performed.

f) In performing the duties incidental to its responsibilities hereunder, CONTRACTOR shall issue to the SUB-CONTRACTORS/VENDORS such directives and impose such restrictions as may be required to obtain such compliance herewith and with the terms of the SUBCONTRACTS.

12.3.2.4 Sub-Contractor/Vendor and Manufacturer Warranties

a) CONTRACTOR shall, for the protection of OWNER, obtain from all SUB-CONTRACTORS, vendors and manufacturers of equipment all available Guarantees and Warranties on equipment and other items used in connection with the performance of the WORK or incorporated in the PLANT (other than minor items), and such Guarantees and Warranties shall not be amended, modified or otherwise discharged without the prior written consent of OWNER. Such warranties shall be in the name of CONTRACTOR and any subsisting Warranties shall stand transferred in the name of the OWNER on submission of the FINAL ACCEPTANCE CERTIFICATE. The CONTRACTOR undertakes that the Vendor's/ Supplier's

acceptance of the transfer of warranty is furnished to the OWNER within Two (2) months of issuance of Purchase Order by CONTRACTOR. The CONTRACTOR shall deliver to OWNER un-priced copies of all Purchase Orders providing for such guarantees and warranties.

- b) On FINAL ACCEPTANCE, OWNER shall be entitled to receive all benefits and proceeds (including damages and rebates) paid by or on behalf of any person in respect of any claim made by OWNER pursuant to any Guarantee or Warranty transferred to OWNER. Neither CONTRACTOR nor its SUB-CONTRACTORS/VENDORS, 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 or services relating to the PROJECT or the WORK.
- c) 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 herein above.
- d) CONTRACTOR shall require all SUB-CONTRACTORS/VENDORS to release and waive any and all rights of recovery against OWNER including its affiliates, subsidiaries, employees, successors, permitted assigns, insurers and underwriters.
- e) OWNER shall not be deemed by virtue of the CONTRACT to have any contractual obligation to or relationship with any SUB-CONTRACTOR/VENDOR.

12.3.2.5 Review and Approval Not Release of CONTRACTOR's Liability:

The review, approval and consent of duties, liabilities SUB-CONTRACTORS list or as to CONTRACTOR entering into any SUB-CONTRACT with any approved SUB CONTRACTOR or as to any WORK done or supply made or services provided by any such approved SUB-CONTRACTOR/VENDOR 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.

- 12.3.3** All WORK performed or EQUIPMENT supplied by SUB-CONTRACTOR/ VENDOR shall be pursuant to an appropriate SUB-CONTRACT, PURCHASE ORDER or similar agreement which shall, as appropriate, contain provisions that:

- a) Preserve and protect all the rights of OWNER here under for WORK to be performed or EQUIPMENT to be supplied under PURCHASE ORDER or SUB-CONTRACT.
- b) Require that such WORK be performed or EQUIPMENT be fabricated, supplied and installed in strict accordance with the applicable requirements of this CONTRACT.
- c) Obligate such SUB-CONTRACTOR/VENDOR to consent to and be bound by those obligations under this CONTRACT which by their terms are intended to also obligate such SUB-CONTRACTOR/VENDOR, including the provisions of this Clause.
- d) Require such SUB-CONTRACTOR/VENDOR to provide and maintain adequate insurance consistent with requirements for companies of similar size and performing similar services. Permit the assignment of such SUB-CONTRACT/PURCHASE ORDER by CONTRACTOR to OWNER
- e) Include a price list (which shall be binding to the extent reasonably feasible for a period of (6) six months from the date of such PURCHASE ORDER or SUB-CONTRACT) covering all commissioning and two years spare and replacement parts relating to the subject matter of such PURCHASE ORDER or SUB-CONTRACT.

12.3.4 Contractor Responsible for Work

CONTRACTOR is responsible for WORK, and that the performance thereof conforms in all respects to the requirements of this CONTRACT, regardless of any failure of any SUBCONTRACTOR / VENDOR to perform or any disagreement between any SUBCONTRACTOR / VENDOR or between any SUB-CONTRACTOR / VENDOR and CONTRACTOR.

The CONTRACTOR shall furnish such information relative to its SUB-CONTRACTOR/VENDOR (including copies of un-priced SUB-CONTRACT or PURCHASE ORDER) as OWNER may request.

12.3.5 Damages

CONTRACTOR shall agree to hold all SUB-CONTRACTOR/VENDOR, including all persons directly or indirectly employed by them, responsible for any damages due to breach of CONTRACT or any negligent act and to diligently endeavour to effect recoveries in such damages subject to Sub-clause 7.2 of GCC.

13.0 STANDARDS

The goods and services supplied under this CONTRACT shall conform to the standards mentioned in the technical specifications, or such other standards which ensure an equal or higher quality. When no applicable standard is mentioned, the goods and services shall conform to the latest standards issued by an authority/recognised institution in the country of origin of the goods.

14.0 INSTRUCTIONS AND DIRECTIONS

The MATERIALS described in CONTRACT are to be supplied according to the standards, data sheets, tables, specifications and drawings attached hereto and/or enclosed with the CONTRACT itself and according to all conditions both general and specific enclosed with the CONTRACT, unless any or all of them shall have been modified or cancelled in writing as a whole or in part.

All instructions and orders to CONTRACTOR shall, excepting what is herein provided, be given by OWNER/ CONSULTANT

All the work shall be carried out under the direction of and to the satisfaction of the OWNER. All communications including technical/ commercial clarifications and/ or comments shall bear reference to the CONTRACT.

Invoice for payment against CONTRACT shall be addressed to OWNER.

The CONTRACT number shall be shown on all invoices, communications, packing lists, containers, and bills of lading etc. by the Contractor.

15.0 INSPECTION, TESTING AND EXPEDITING

15.1 The OWNER or his representatives shall have their right to inspect and/or to test the goods to conform to the specifications laid down in the CONTRACT. The SPECIAL CONDITIONS OF CONTRACT and/ or the technical SPECIFICATIONS shall specify what inspections and test the

OWNER requires and where they are to be conducted. The OWNER shall notify the CONTRACTOR in WRITING of the identity of any other representatives retained for this purpose. Expediting of some critical supply by OWNER's representative in no way relieves the CONTRACTOR of his obligation under the terms and conditions of this CONTRACT.

15.2 The inspections and tests may be conducted on the premises of the CONTRACTOR or his SUB-CONTRACTOR at point of completion and/or at the good's final destination. When conducted on the premises of the CONTRACTOR or his

SUBCONTRACTOR, all reasonable facilities and assistances including access to drawings and production data shall be furnished to the inspector at no charge to the OWNER.

15.3 CONTRACTOR shall not be entitled to any extension to the GUARANTEED COMPLETION DATE due to any possible delay in the approval or testing phase as well as for any possible delay in the remittance of necessary certificates unless such delay is not attributable to the CONTRACTOR.

15.4 Participation or presence of OWNER or their representatives at any tests or their failure to be present at or to witness any tests to be undertaken pursuant here to shall not in any way or manner relieve or release the CONTRACTOR from any of its warranties, guarantees or other obligations under the CONTRACT.

15.5 Copies of all test results/report of the tests shall be furnished promptly by the CONTRACTOR to the OWNER.

16.0 KICK OFF MEETING, PLANNING AND PROGRESS MONITORING

16.1 Kick-Off Meeting

16.1.1 Contract Kick-Off Meeting

Within 3 weeks of Effective Date, Contractor shall organise a meeting with the following topics:

- Project presentation to personnel involved in the Project,
- Introduction of Owner and Contractor organisation,
- Project execution strategy
- Subcontracting strategy,
- Presentation of contractor 's schedules,
- Any other subject as necessary.

16.1.2 Engineering Discipline Kick Off Meeting

Upon Effective Date, Contractor shall organise a meeting for each of the engineering discipline involved in the Work to address the following topics:

- Review of applicable Specifications,
- Detailed review of engineering deliverables,
- Definition of priorities and area of concerns,
- Decide protocol for Drawings/Documents submission,

- Any other topic as necessary

This meeting shall take place at the Engineering Design Center or at a mutually agreed location at the start of Engineering.

16.1.3 Site Kick-Off Meeting

This meeting shall be held, as closely as possible, to Site at the start of works on Site. Its purpose is to:

- Introduce the persons who are responsible for the Project and their responsibilities,
 - Present the organisation of the worksite:
 - Workforce, management, working hours, subcontractors, etc.
 - Safety measures,
 - Finalise the operating procedures:
 - Key stakeholders at site,
- Communication of documents and correspondence,
 - Review of plans and various documents,
 - Progress reporting and meeting protocol,
- Quality Assurance / Quality Control,
- Work acceptance procedures (pre-commissioning and commissioning check lists, certificates),
- Any other topic as necessary

16.2 Planning and Progress Monitoring

16.2.1 Project Planning

The entire Project Management shall be done by using Oracle Primavera P6 management software, considering all the realistic project data, dates and contract stipulated periods of performances. Any deviation to this shall have to be approved by Owner. The Contractor shall submit his project planning package within 45 days of Effective Date. Within 7 days of Effective Date, the Contractor shall submit the list of major activities planned till submission of planning package.

The planning package shall contain all the project milestones to be achieved from date of Effective Date till proposed date of completion. The Planning Package shall include the following but not limited to

- a) Project Execution Plan
- b) Planning & Scheduling Procedure

- c) Progress Measurement Procedure
- d) Overall Project Baseline Schedule (P6) Level 3
- e) Project Weight Factors for Engineering, Procurement & Construction
- f) Document Control Index & Material Control Index
- g) Procurement Register
- h) Fabrication & Erection Activity Register
- i) S Curves for Overall Project and discipline wise S Curves
- j) Manpower deployment plan
- k) Equipment deployment schedule
- l) Formats for Weekly & Monthly Reports
- m) Any other report required by EIC

Planning Package shall be reviewed and approved by Owner. No change shall be made in the base line without specific consent of Owner.

16.2.1.1 Time Schedule Network/Bar Chart

- a) As part of Planning Package, CONTRACTOR shall submit to OWNER, his time schedule regarding the documentation, supply and manufacture of EQUIPMENT and MATERIALS as well as information of his SUBCONTRACTS to be placed with their parties, including the dates on which CONTRACTOR intends to issue such SUB CONTRACTS. A complete activity-wise time schedule shall be furnished by the CONTRACTOR to meet the completion time quoted in months from the EFFECTIVE DATE OF CONTRACT.
- b) The time schedule shall be in the form of a network or a bar chart clearly indicating all main or key events regarding documentation, supply of raw materials, manufacturing, testing, delivery, erection & commissioning.
- c) The original issue and subsequent revisions of CONTRACTOR's time schedule and or SUB-CONTRACTORS' time schedules shall be sent in four copies plus soft electronic version to OWNER.
- d) The time schedule network/bar chart shall be updated fortnightly using the latest 'Project Management software', i.e. Primavera (latest version), and internet enabled acceptable to the OWNER. CONTRACTOR shall provide online access to authorized persons of OWNER or persons acting on behalf of OWNER to their time schedule network and all necessary user licenses will be procured by CONTRACTOR for such OWNER representatives (2 users).

16.2.2 Progress Monitoring

16.2.2.1 Monthly Monitoring:

- i) CONTRACTOR shall submit monthly progress report by 5th of every month, wherein the actual status of activities shall be mapped against the base line to indicate both the original schedule and present status of project.
- ii) The report shall indicate original activity time, actual time and variance of each milestone. A commentary to be furnished indicating the reasons for variation of critical path, the critical activities, the reasons thereof and remedial / additional measures proposed to be taken to bring back the project on to the original critical path and any assistance needed from the Owner.
- iii) The progress shall be expressed in percentages shown in the progress trend chart with computation of total progress by summation of Design / Engineering / Procurement/ Construction. The overall progress shall be reported against planned progress.
- iv) Any hindrances which may affect the work / Critical path may be notified to the Owner in advance. The status of critical activities which may affect the critical path needs to be identified at least a week in advance and initiate corrective actions under intimation to the Owner. Any corrective actions by Owner also needs to be anticipated and informed at least a week in advance to provide sufficient time for corrective actions.
- v) The monthly report shall also generate, using primavera, one month look ahead plan (to be submitted along with the current month and should highlight the milestone dates). In the subsequent month, if any of the activity in the look ahead plan could not be achieved; same needs to be highlighted, indicating the reason for the same and remedial action proposed.
- vi) Any revision in time schedule on account of changes / decisions by Owner, to be brought out clearly on the Project critical path in the subsequent monthly report.

16.2.2.2 Weekly and Daily Progress Reports

- i) The format for weekly and daily progress reports shall be mutually discussed by the contractor with the project group and decided separately.
- ii) Project review meeting frequency shall be mutually discussed and decided, which needs to be attended by the EIC of Owner and senior person in charge of the project from the Contractor.
- iii) Distribution matrix of progress reports shall be provided by EIC.

16.2.2.3 Rate of Progress

- i) CONTRACTOR shall monitor progress of all the activities and submit free of cost monthly progress report about various aspects of the Works to the OWNER. The periodicity of such reports may be changed by the Owner on mutual agreement between both parties.
- ii) Extracts of the progress report to be termed as "Executive Summary" shall be submitted in 02 copies along with 02 copies of monthly progress report.
- iii) OWNER or his representatives shall have the right to inspect CONTRACTOR's premises to evaluate the actual progress of work on the basis of CONTRACTOR's time schedule documentation.
- iv) Irrespective of such inspection, CONTRACTOR shall advise OWNER at the earliest possible date of any anticipated delay in the programme indicating the reasons thereof and corrective measures proposed thereto.
- v) The manner and speed of execution and maintenance of the Works are to be in accordance with the Contract. Should the rate of progress of the Works or any part of them at any time falls behind or is found to be too slow to ensure completion of the Works by the stipulated time or extended time for completion, the EIC shall so notify the Contractor in writing. The Contractor shall reply to the written notice giving details of the measures he proposes to take to expedite the progress so as to complete the Works by the prescribed time. The Contractor shall not be entitled to any additional payment for taking such steps. If at any time it should appear to the EIC that the actual progress of Works does not conform to the approved programme the Contractor shall
- vi) produce at the request of the EIC a revised programme showing the modification to the approved programme necessary to ensure completion of the Works within the time for completion.
- vii) The submission to and approval by the EIC of such programme as the furnishing of such particulars shall not relieve the Contractor of any of his duties or responsibilities under the Contract.
- viii) In case during execution of Works the progress falls behind schedule, Contractor shall deploy extra manpower, Constructional Plant and Equipment, resources to make up the progress. Programme for deployment of extra manpower/Constructional Plant and Equipment resources shall be submitted to the Owner for its review and approval which approval shall not be unreasonably

withheld. All time and cost effect in this respect shall be borne, by the Contractor unless otherwise expressly provided in the Contract. viii) In the event that the delay is caused by a delay in the completion of sub-contracted equipment, CONTRACTOR shall submit details together with un-priced copies of the appropriate orders and agreements entered with such SUB-CONTRACTORS.

- ix) Notwithstanding the above, in case progress on the execution of CONTRACT at various stages including supply of critical MATERIALS, is not as per phased time schedule and is not satisfactory in the opinion of the OWNER which shall be conclusive or if the CONTRACTOR shall neglect to execute the CONTRACT with due diligence and expedition or shall contravene the provisions of the CONTRACT, OWNER may give notice of the same in writing to the CONTRACTOR as per clause 32.0 of GCC calling upon him to make good the failure, neglect or contravention complained of. Should the CONTRACTOR fail to comply with such notice within the period of 30 days, the provisions of clause 32.0 of GCC shall apply.
- x) The time for completion and phased time schedule shall be subject to and in accordance with the provision of Sub-Clauses xi) and xii) below.
- xi) Neither OWNER nor CONTRACTOR shall be considered in default in performance of their obligations if such performance is prevented or delayed by FORCE MAJEURE conditions as stated in Clause 33.0.
- xii) Should the CONTRACTOR's preparation for the commencement of the work or progress of work be unduly and unreasonably delayed by the CONTRACTOR for reasons directly & solely attributable to him, the OWNER at the CONTRACTOR's risk and cost reserves the right to terminate the CONTRACT as per the provisions under clause 32 of GCC.

17.0 CONTRACTOR TO INFORM HIMSELF FULLY

17.1 Contractor to Inform Himself

17.1.1 The CONTRACTOR shall be deemed to have carefully examined the specification thoroughly and to have removed any doubt he may have had as to the meaning of the Specification and in addition to have fully informed himself as to the SITE and local conditions affecting the carrying out of the CONTRACT and to have made due allowance in the offer.

- a) Should the CONTRACTOR encounter during the execution of the WORKS cables and/or pipes and/or other materials not depicted in any of the drawings

and/or specifications and/or documents furnished by the OWNER before the date of submission of the FINAL PROPOSAL by CONTRACTOR, the cost of removal and rerouting (if required) shall be borne by CONTRACTOR, while the costs to be sustained for the material necessary for re-routing shall be borne by the OWNER.

- b) Should the CONTRACTOR during the execution of the WORKS find an abnormal and unexpected item (such as caves and/or mines and/or rocks and/or archaeological artefacts), which are not evident from the soil investigation report furnished by the OWNER before the date of submission of the FINAL PROPOSAL by CONTRACTOR, the costs for removal of such underground impediments shall be borne by the OWNER (Also refer Clause 29.1.1 of GCC). All such items unearthed or excavated by the contractor shall be deposited with the Owner.

If such occurrence is found affecting the critical path of the overall contract and there is a significant impact on Project Schedule due to such unusual underground obstructions not envisaged, OWNER shall consider granting a reasonable extension of time commensurate with the removal of such obstructions on a case-to-case basis.

17.2 Discrepancies in Documents

17.2.1 If the CONTRACTOR finds any discrepancies between the Specification, drawings or Schedules he shall immediately refer them to the OWNER for decision. Figured dimensions on the drawings shall be followed. Dimensions shall not be scaled unless permission is given in WRITING by the OWNER.

17.2.2 Any information otherwise obtained not in any way relieve the CONTRACTOR of his from the OWNER shall responsibility to fulfil his obligations under the CONTRACT.

18.0 SUITABILITY OF PLANT FOR INTENDED PURPOSE

18.1 It is a condition of the CONTRACT and the CONTRACTOR warrants that the PLANT will be suitable in all respects for the purpose mentioned or inherent in the specification.

18.2 Without limiting the generality of the foregoing clause, the CONTRACTOR shall ensure before complying with any direction, that compliance by the CONTRACTOR with that direction will not render the plant unsuitable in any respect for the aforesaid purposes or otherwise prevent the CONTRACTOR from carrying out the CONTRACT in accordance with the terms thereof.

18.3 The CONTRACTOR shall give notice to the OWNER within fifteen (15) days after receipt of any requirement or direction which he considers will render the PLANT unsuitable in any respect or is not in accordance with the meaning and intent of the CONTRACT or otherwise prevent the CONTRACTOR from carrying out the CONTRACT as aforesaid and submit to the OWNER, a proposal or proposals for modifying the requirement or direction. Failure to file an objection within the allotted Time will be considered as acceptance of the OWNER's decision and the decision shall become final and binding.

19.0 FEES FOR ROYALTIES AND PATENT RIGHTS

Payment Due to be Included in TOTAL CONTRACT PRICE

All payments for royalties, patent rights and fees due to or payable for or in connection with any matter or thing used or required to be used in performance of the CONTRACT or to be supplied under the CONTRACT whether payable in one sum or by instalments or otherwise, shall be included by the CONTRACTOR in the prices named in the CONTRACT and shall be paid by CONTRACTOR to whom such payments may be due or payable.

20.0 DESIGN RESPONSIBILITY AND MANAGEMENT

20.1 The CONTRACTOR shall carry out, and in accordance with the CONTRACT be responsible for, the development of the Design, including but not limited to Process Design, Basic Engineering, Detailed Engineering, etc. The OWNER shall have the right to be informed of the Design Development to enable review of the engineering at all stages.

20.2 The CONTRACTOR holds itself, its designers and design SUB-CONTRACTORS as having the experience and capability necessary for Design. The CONTRACTOR undertakes that the designers shall be available to attend discussions with the OWNER at all reasonable time during the execution of the CONTRACT.

20.3 The contractor shall prepare all Contractor's documents. Unless otherwise stated in the Contract or allowed on a case-by-case basis, the Contractor's Documents shall be written in English. The Contractor's documents shall comprise the technical documents specified in the Contract, documents required to satisfy all regulatory approvals.

20.4 Contractor's drawings and documents, as specified in contract scope of work shall be submitted for Owner review. The Contractor is required to submit only those Documents that are specified as requiring review.

20.5 Unless otherwise stated in the Contract, each review period shall not exceed 21 days, calculated for the Date on which the Owner receives Contractor's documents stated to be ready for review. If the Contractor is not notified of the review status of a Contractor's Document within the review period, such document is deemed to have been reviewed by the Owner and approved.

20.6 If the contractor's Documents are acceptable to the Owner, they will be returned marked "Reviewed by the Owner" with the date noted. The Owner may, within the review period, give notice to the Contractor that a Contractor's Document fails (to the extent stated and as exactly identified) to comply with the Contract. If the Contractor receives such notice and the Contractor's document does in fact fail to comply with the Contract, it shall be rectified and resubmitted for review. Owners' review of Contractor's drawings & documents do not relieve the contractor of his responsibility in the design & Engineering of the equipment and plant.

20.7 If the Contractor wishes to modify any Contractor's Document that has previously been submitted for review, the Contractor shall immediately give notice to the Owner. Thereafter, the Contractor shall submit revised Contractor's Documents to the Owner.

20.8 If errors, omissions, ambiguities, inconsistencies, inadequacies or other Defects are found in the Contractor's Documents at any time by any party, they and the Works shall be corrected by the Contractor at the Contractor's expense.

20.9 AS-BUILT DRAWINGS

20.9.1 The CONTRACTOR shall prepare, and keep up to date, a complete set of records of the execution of the WORKS, showing the exact as-built locations, sizes and details of the WORKS as executed. A preliminary copy shall be supplied to the OWNER before PRECOMMISSIONING/COMMISSIONING.

20.9.2 In addition, the CONTRACTOR shall supply to the OWNER prior to PRELIMINARY ACCEPTANCE, the final as-built drawings of the PLANT/WORKS in quantities and format stated in GCC Clause 1.10.

20.10 TRAINING, OPERATION AND MAINTENANCE MANUALS

20.10.1 The CONTRACTOR shall carry out the training of OWNER's Personnel in the operation and maintenance of the WORKS to the extent specified in the CONTRACT.

20.10.2 At least three months prior to COMMISSIONING, unless otherwise agreed, the CONTRACTOR shall supply to the OWNER preliminary operation and maintenance manuals, in sufficient details for the OWNER's personnel to operate and maintain the WORKS under the CONTRACTOR's supervision.

20.10.3 Final operation and maintenance manuals will be handed over prior to PRELIMINARY ACCEPTANCE, in quantities and format stated in GCC Clause 1.10.

21.0 TOTAL CONTRACT PRICE

Unless otherwise stated in the Special Conditions of the Contract:

21.1 TOTAL CONTRACT PRICE for the scope of the work (as mentioned in the clause 1 of GCC) and in accordance with all terms, conditions, stipulations, specifications and requirements, is inclusive of the cost/fees of CONTRACTOR's obligations as given below briefly but not limited to the following:

- a) All process license(s) in CONTRACTOR's scope
- b) Basic Engineering and Detailed Engineering
- c) Supply of all Plant, Equipment, Bulk Materials, Catalysts, Chemicals, Lubricants, etc.
- d) Supply of commissioning spares
- e) Civil and Structural works,
- f) Custom Clearance, Port Handling and onward dispatch to SITE and forwarding charges, if applicable,
- g) Freight up to SITE,
- h) Unloading, storage at SITE, Site Assembly, Erection, PRE-COMMISSIONING and COMMISSIONING until PRELIMINARY ACCEPTANCE OF PLANT.
- i) Insurance
- j) All taxes, duties, Cess, royalties, rents as applicable in India and outside India for execution of work under CONTRACT including Works Contract Tax, any tax to be deducted at source under VAT Act, Income tax Act, labour cess, if any,
- k) Inspection and expediting charges
- l) Project management and overheads, including expenses for relevant contractor personnel to attend various meeting initiated by owner.

- m) Guarantee test runs and handing over of PLANT to OWNER.
- n) All other costs, expenses and outgoings of the CONTRACTOR not otherwise expressly set forth herein but necessary, required or incidental to the full, complete and proper performance and discharge of the CONTRACTOR's obligations under and in accordance with the CONTRACT including completion of the PLANT in all respects and overheads of the CONTRACTOR.

- 21.2 OWNER shall pay to CONTRACTOR a lump-sum fixed TOTAL CONTRACT PRICE for the due and faithful performance of CONTRACTOR's obligations under the CONTRACT. TOTAL CONTRACT PRICE provided for in this Clause covers entire consideration payable to CONTRACTOR for all obligations of CONTRACTOR. The TOTAL CONTRACT PRICE is fixed and firm and not subject to any escalation during the contract period unless and otherwise specified in the Contract documents.
- 21.3 TOTAL CONTRACT PRICE is inclusive of cost of all travel, accommodation, living costs and all other expenses of management and personnel of CONTRACTOR, SUBCONTRACTOR, VENDOR and their agents for travelling to and from plant SITE and other places/countries as may be necessary for the proper performance of CONTRACTOR's responsibilities under CONTRACT and shall also include all costs and expenses incurred in attending such meetings in connection with CONTRACT as OWNER may reasonably require.
- 21.4 TOTAL CONTRACT PRICE is inclusive of cost of all CONTRACTOR's EQUIPMENT, MATERIALS, services, etc. required to complete WORK under CONTRACT.
- 21.5 The lump sum price quoted by the CONTRACTOR in his bid with additions and deletions as may be agreed upon before signing of the CONTRACT, for the entire scope of the work, e.g. Carrying out Basic Engineering, Detailed Engineering, Conducting HAZOP Study and incorporating its recommendation in the Project, Supply of PLANTS and associated facilities, EQUIPMENT, Machinery, accessories, auxiliaries, spares and other related items, manufacturing, packing, supplying, arranging comprehensive insurance, primary protection and testing of individual items and assembly where necessary, construction, erection, testing, PRE-COMMISSIONING and COMMISSIONING, PERFORMANCE AND GUARANTEE TEST RUNS as per CONTRACT specifications, supply of final DRAWINGS & DOCUMENTS etc. on LSTK basis shall be treated as the TOTAL CONTRACT PRICE.
- 21.6 The price quoted shall be firm and fixed without any escalation whatsoever on any account except the statutory variations in Taxes levied by the Government of India from date of Bid submission up to PRELIMINARY ACCEPTANCE and otherwise specified in the CONTRACT.

- 21.7 All taxes, duties, licence fees, royalties and other local taxes, labour Cess and such levies as may be applied to the CONTRACT both in CONTRACTOR's country and in India, including Custom Duty, Excise duty, Service Tax, VAT, Works Contract Tax, Sales Tax, on bought out items, octroi, and corporate income tax in respect of the performance of the CONTRACT as well as income tax on the personnel deputed by the CONTRACTOR to India in connection with the CONTRACT, are to the account of the CONTRACTOR except as stated in "change in legislation clause"
- 21.8 The prices indicated for spare parts in the item wise lists shall be fixed and not subject to any escalation for a minimum period of 6 months after the date of PRELIMINARY ACCEPTANCE CERTIFICATE (Refer SCC Clause 20.8).
- 21.9 It is clearly understood that tax or duty exemptions, subsidies and/or other fiscal incentives of any kind granted to the PROJECT by the State or Central Govt. on application by the OWNER (as per eligibility under extant Industrial Policies, Notifications, etc or available otherwise), subsequent to the submission of BID (or not appropriately envisaged by the CONTRACTOR in his BID due to any reason whatsoever) having a net impact on TOTAL CONTRACT PRICE, shall be availed by the CONTRACTOR, acting on behalf of the OWNER, on a best-endeavour basis to the maximum extent feasible (based on certifications obtained by the OWNER from the relevant State/Central Govt. Authority, as required) and duly passed on to the OWNER along with supporting documentary evidence. For this purpose, the CONTRACTOR shall be required to furnish an undertaking to pass-on the financial benefits that actually accrue as a result of availing of the said tax or duty exemptions, subsidies and/or other fiscal incentives, failing which the OWNER shall be at liberty to realize the presumptive accruals from the CONTRACTOR's monthly or final bill.

22.0 DEDUCTIONS FROM TOTAL CONTRACT PRICE

All costs, damages or expenses which the OWNER may have paid for which, under the CONTRACT, the CONTRACTOR is liable, will be claimed by the OWNER. All such claims shall be billed by the OWNER to the CONTRACTOR regularly as and when they all due. Such claims shall be paid by the CONTRACTOR within Thirty (30) days from the date of the receipt of the corresponding bills and if not paid by the CONTRACTOR within the said period without a valid reason, the OWNER may then deduct the amount from any bill due or becoming due by him to the CONTRACTOR under the CONTRACT or may be recovered by action of law or otherwise, if the CONTRACTOR fails to satisfy the OWNER of such claims.

23.0 RECOVERY OF VALUE OF MATERIALS SUPPLIED BY OWNER

In case some material is supplied on chargeable basis by the OWNER to the CONTRACTOR on his written request, OWNER shall recover delivered cost of material, which has been supplied by the OWNER to CONTRACTOR by deducting from the TOTAL CONTRACT PRICE (Also refer Clause 52.11 of GCC).

24.0 PAYMENT TERMS

24.1 The payment to CONTRACTOR for the performance of the WORKS under the CONTRACT will be made by OWNER as per the framework & conditions specified herein in Clause 16 of SPECIAL CONDITIONS OF CONTRACT.

24.2 Schedule of Payment

The CONTRACTOR shall submit billing schedule, along with price break-up, cost center wise for review and approval by OWNER. Cost Centres/Sub-Cost Centre are named according to their general scope of work. The apportioned amount for each Cost Centre/Sub-Cost Centres generally reflects the actual / representative cost for that particular Cost Centre/Sub-Cost Centre and may be further distributed amongst various Milestones included in that particular Cost Centre/Sub-Cost Centre, separately by the Bidder and included in the Priced Bill of Quantities Billing Schedule. The payment to the Contractor shall be made for the work done by him on completion of various milestones under different Cost Centres as indicated in the Bill of Quantities and/or Billing Schedule. The CONTRACTOR shall submit progressive bills once every month based on the billing schedule duly certified by OWNER with related documents.

24.3 Due Date for Payment

- a) OWNER will make progressive payments as and when the payment is due as per the terms of payment set forth in the CONTRACT. Payment will become due and payable by OWNER within 30 days from the date of receipt of CONTRACTOR'S bill/invoice by OWNER provided the documents submitted are complete in all aspects and are submitted as per billing schedule.
- b) In the event of the OWNER objecting to any portion of the WORK covered by the said bill / invoice, such objection shall be communicated to the CONTRACTOR within 15 (fifteen) days from the date of receipt of bill/invoice by the OWNER. The OWNER shall make payments for undisputed amounts of the bill/invoice within 30 days from the receipt of CONTRACTOR'S bill/invoice.

Payments for amount objected by the OWNER shall be made by the OWNER within 30 (thirty) days of removal of cause of such objection.

- c) Final payment to the CONTRACTOR by the OWNER will not be made while any such disputed claim, as explained in point "b" above, remains unsettled. In the event any apparatus or equipment or any part thereof furnished by the CONTRACTOR is in dispute, held to constitute infringement, and its use is enjoined, the CONTRACTOR shall, at his option, and at his own expense, either procure for the OWNER the right to continue use of the said apparatus, equipment or part thereof, replace it with non-infringing apparatus or equipment or modify it, so that it becomes non infringing. This Clause to be read in conjunction with Clause 32.2 of the GCC

25.0 TAXES, PERMITS, ROYALTIES and LICENCES

The CONTRACTOR shall be liable and pay all taxes, duties, levies, lawfully assessed against the OWNER or the CONTRACTOR in pursuance of the CONTRACT as per existing laws as applicable at the time of Bid. The CONTRACTOR shall be solely responsible for all taxes, duties, Cess, Royalties, Rents, fees that may be levied on the CONTRACTOR's turnover & profit or on the earnings of any of his employees or personnel engaged by him and shall hold the OWNER indemnified and harmless against any claims that may be made against the OWNER in this behalf. The OWNER does not undertake any responsibility whatsoever regarding any taxes levied on CONTRACTOR and/or his personnel by Centre/State/Local Authorities. TDS Certificate (in original) will be issued by the OWNER to enable the CONTRACTOR to take Tax Credit in its home country.

CONTRACTOR shall be responsible to pay in the name and on behalf of OWNER, all indirect taxes and duties that may be assessed against the OWNER and to the extent attributable to the CONTRACTOR under the CONTRACT. Provided however, if any taxes, duties, including interest and penalties thereon are imposed on the OWNER for any reasons attributable to the CONTRACTOR, the same shall be borne by the CONTRACTOR. Further, OWNER shall reimburse the taxes and duties within the ceiling mentioned below.

OWNER will extend requisite support to the CONTRACTOR with necessary documentation to prove the claim under Sale in Transit, Sale in course of Import, etc. under the Central Sales Tax Act 1956 and the State VAT Act, should such propositions be challenged at assessment stage. OWNER will not indemnify the CONTRACTOR

against any such plausible demand. OWNER shall, if applicable, deduct VAT-TDS (WCT-TDS), only on the value of intrastate transactions and no such TDS will be deducted on inter-state transactions in the course of imports and services (labour charges) in line with the extant rules.

The CONTRACTOR to provide the details of material procured locally and consumed in the Contract to adhere with the requirement of deducting TDS & WCT on intrastate transactions, ad valorem.

Service Tax under Reverse Charge Mechanism and Entry Tax, wherever applicable, is included in the Schedule of Prices and are included in Overall ceiling of taxes and duties applicable on the CONTRACT. Service Tax under Reverse Charge Mechanism and Entry Tax, wherever applicable, shall be paid by OWNER to the respective Government Authorities. The CONTRACTOR shall specifically give the list of items on which Entry Tax has been considered.

The CONTRACTOR shall give the details of base price of materials & services exclusive of all taxes for executing the CONTRACT and also the details of taxes separately, (VAT, CST, WCT, Custom Duty, Excise Duty, Entry tax, labour Cess, Royalties, rent, fees etc.) and Services (Total Service tax including service tax payable under Reverse Charge Mechanism, R&D cess wherever applicable, etc.) with a separate ceiling for Services and for Supplies at overall PLANT level.

25.1 Import Licence

If applicable, OWNER shall obtain Essentiality Certificate for import of capital goods for the project at concessional rates, to cover the complete scope of work defined earlier, including spares, under this CONTRACT. CONTRACTOR shall furnish all the necessary information, technical data, etc. and assist and cooperate with OWNER for preparing the application for Essentiality Certificate. CONTRACTOR shall also, if necessary, accompany and take part in discussions necessary with government authorities in this respect at CONTRACTOR's own cost.

25.2 For CONTRACTORS who have to bring equipment and material from outside state of site will have to obtain necessary registrations and take appropriate steps as required under State Laws and pay entry tax, if applicable.

25.3 Unless otherwise specified, the CONTRACTOR shall pay all tonnage and other royalties, rents and other payments or compensation (if any) for getting stone, sand, gravel, clay, earth, bricks or other materials required for the WORKS or any temporary works.

26.0 PACKING, FORWARDING AND SHIPMENT

- 26.1 CONTRACTOR shall give complete despatch information concerning the weight, size, content of each package including any other information the OWNER may require.
- 26.2 CONTRACTOR, wherever applicable, shall after proper painting pack and crate all equipment in such a manner as to protect it from deterioration and damage during rail and road transportation to the site and storage at the site till the time of erection. CONTRACTOR shall be held responsible for all damages due to improper packing.
- 26.3 The CONTRACTOR shall notify the OWNER of the date of each shipment from his works, and the expected date for arrival at the site for the information of the OWNER. The CONTRACTOR will be responsible for arranging any requirement of over dimensional, special rail/road wagon/trailor for transporting.
- 26.4 The CONTRACTOR shall also give all shipping information concerning the weight, size and content of each package including any other information the OWNER may require. The size of the largest packages shall be according to limitations of obstructions on road like overhead cables, bridges etc. Maximum overall dimensions and weights beyond which consignments are categorized as “Over-dimensional Consignments” (ODC) and/or “Over-weight Consignments” (OWC), are mentioned below:
- a) For road transport - 49tonnes; 18m long x 2.6m wide x 3.8m high
 - b) For rail transport-
 - 13.716m x 2.845m x 2743mm
 - Top width at max. height 0.610 m
 - Height of max. width 2.133 m
 - Weight 54 Tonne

Contractor shall be required to conduct route survey, if any, for ODC & OWC consignment at his own cost prior to shipment.

- 26.5 The CONTRACTOR shall prepare detailed packing lists of all packages and containers, bundles and loose materials forming each and every consignment dispatched to the site. The CONTRACTOR shall further be responsible for making all necessary arrangements for loading, unloading and other handling, right from works till the SITE and also till the EQUIPMENT is erected, tested and commissioned. The CONTRACTOR shall be solely

responsible for proper storage and preservation of all equipment & machineries etc.

- 26.6 CONTRACTOR will find out list of all wood & other packing material banned in India for packing imported consignment and ensure its non-use by foreign suppliers, shipping agents, etc.

27.0 INSURANCE

- 27.1 Before commencement of the execution of LSTK works/system/sub-system, unless otherwise stated in the Special Conditions of Contract, it shall be obligatory on the part of the CONTRACTOR to take in the joint name of CONTRACTOR and OWNER comprehensive transit insurance for imported and indigenous goods, Transit-cum-Storage Erection or its equivalent and third party liability insurance policies with reputed underwriters to cover All Risks whatsoever during the whole period starting with dispatch of goods from CONTRACTOR's warehouses / Ex works in foreign country to CIF port of shipment for imported goods and EXW at Contractor's works for indigenous goods and shall further cover for performing services in India for transportation, loading, unloading, assembly, erection, testing till the issuance of PRELIMINARY ACCEPTANCE CERTIFICATE and thereafter the aforementioned Transit-cum-Storage Erection policy shall provide an Extended Maintenance Cover for a period of 12 months insuring loss or damage to the PLANT and resulting from:
- a) any cause occurring prior to PRELIMINARY ACCEPTANCE of PLANT or the issuance of a conditional PRELIMINARY ACCEPTANCE CERTIFICATE (as envisaged under Sub-clause 20.8 of SCC), whichever is earlier and
 - b) any testing, defect rectification or other activities after PRELIMINAR ACCEPTANCE of PLANT carried out or supervised by the CONTRACTOR or any SUB-CONTRACTOR for the purpose of complying with their obligations under the CONTRACT; but excluding coverage which is not available in the insurance market, namely war, nuclear holocaust, etc.(such risks being referred to as "Excepted Risks"), The deductible from any insurance claim shall be borne and paid by the Party whoever is liable for the damage under the CONTRACT. However, if the deductible from any insurance claim is to be borne by the OWNER, the deductible shall be reimbursed to the CONTRACTOR through a CHANGE ORDER. The CONTRACTOR shall submit a claim in accordance with the procedure stipulated in the policy and makes best endeavours to substantiate the same. Also, CONTRACTOR shall take insurance cover for loss or damage caused by CONTRACTOR or any person directly or indirectly

employed by the CONTRACTOR, persons acting on CONTRACTOR's behalf, CONTRACTOR's SUB-CONTRACTORS, suppliers, and all tiers thereof to OWNER's existing property on or in the vicinity of the SITE for token value of Rs. [●] (*To be decided, depending on total value & scope*) to take care of unforeseen eventualities during interconnection with existing facilities by CONTRACTOR which may, for any reason, not be covered under OWNER's existing insurance policy (ies).

27.2 CONTRACTOR shall be fully responsible for pursuing and settling all claims under the underwriters. Unless otherwise agreed the CONTRACTOR, as policyholder, shall represent the insured parties in all matters relating to the policy or policies. The CONTRACTOR shall not give any release or compromise any claim affecting the interest of the OWNER without the prior consent of the OWNER. In the event of accident, injury, damage or loss likely to form a claim under the above insurance policies, CONTRACTOR shall, as quickly as possible submit the insurance claims to underwriters under intimation to OWNER. CONTRACTOR shall also keep OWNER fully informed about progress of each such case. CONTRACTOR shall undertake immediate repair and replacement of the equipment lost in transit, storage, assembly, erection, and COMMISSIONING of PLANT pending settlement of claim thereafter by the underwriters.

27.3 The CONTRACTOR at his cost shall arrange, secure and maintain all insurance as may be pertinent to the works and obligatory in terms of law to protect his interest and interest of OWNER, against all perils detailed herein. The Form and the limit of such insurance as defined herein together with the under-writer in each case shall be acceptable to the OWNER. However, irrespective of such acceptance, the responsibility to always maintain adequate insurance coverage including third Party liabilities during the period of contract shall be as of CONTRACTOR alone. The CONTRACTOR'S failure in this regard shall not relieve him of any of his contractual responsibilities and obligations. The insurance covers to be taken by the CONTRACTOR shall be in the joint names of OWNER and the Contractor. The CONTRACTOR shall, however, be authorised to deal directly with insurance company or companies and shall be responsible in regard to maintenance of all insurance covers.

27.4 All insurance including marine insurance is to be covered from IRDA approved insurance company registered in India. There should be a single cover for marine cum inland transit, storage and erection.

However adequacy, credibility and maintenance of Insurance policies is sole responsibility of CONTRACTOR and CONTRACTOR shall keep the OWNER indemnified against any such failure.

All insurance covers shall be taken by CONTRACTOR in joint name of CONTRACTOR and OWNER. Alternatively, the CONTRACTOR has the option to take separate Insurances as

1. Marine Cargo Insurance for transit of all imported and indigenous goods from Ex Works (Supplier's / CONTRACTOR's works) to SITE.

2. Erection and All Risk (EAR) Insurance

3. Third Party Liability Insurance

27.5 Any loss or damage to the equipment during handling, transportation, storage, erection, putting the equipment into satisfactory operation and all activities to be performed till the successful completion of trial operation of the plant shall be to the account of the CONTRACTOR subject to Sub-clause 7.2 of GCC. The CONTRACTOR shall be responsible for reference of all claims and make good the damages or loss by way of repairs and/or replacement of the equipment, damaged or lost. The transfer of title shall not in any way relieve the CONTRACTOR of the above responsibility during the period of CONTRACT. The CONTRACTOR shall provide the OWNER with copies of all insurance policies and documents taken out by him in pursuance of the CONTRACT. Such copies of documents shall be submitted to the OWNER immediately after such insurance coverage. However, adequacy, credibility and maintenance of Insurance policies is the sole responsibility of CONTRACTOR and CONTRACTOR shall keep the OWNER indemnified against any such failure. License /facilities, to the extent it remains the responsibility of the OWNER, in respect of supplies to be made by the foreign CONTRACTOR from outside India required for purposes of replacement of equipment lost in transit and /or during erection and /or during storage shall be made available by the OWNER. CONTRACTOR shall however, be required to follow the procedure as may be laid down by the OWNER to facilitate him arranging such license /facilities. The perils required to be covered under the insurance shall include, but not be limited to fire and allied risks, miscellaneous accidents (erection risks) workman compensation risks, loss or damage in transit, theft, pilferage, riot and strikes and malicious damages, civil commotion, weather conditions, accidents of all kinds, war risks (during ocean transportation only) etc. The scope of such insurance shall be adequate to cover the replacement/reinstatement cost of the equipment for all risks till the equipment is taken over by the OWNER. The insurance policies to be taken should be on replacement value basis and/or incorporating escalation clause. Notwithstanding the extent of insurance cover and the amount of claim available from the underwriters, the CONTRACTOR shall be liable to make good the full replacement/rectification of

all equipment/materials and to ensure their availability as per project requirements without additional financial liability to the OWNER. The workman compensation policy taken by the SUB-CONTRACTOR of the CONTRACTOR shall be passed on to the OWNER.

- 27.6 All cost on account of insurance premiums covered under the CONTRACT will be to the CONTRACTOR's account and will be included in the TOTAL CONTRACT PRICE, except for the premium for 6-months Continuity Cover of the CONTRACTOR's Erection All Risk(EAR) Policy to be equally shared between the CONTRACTOR and the OWNER as provided under Sub-clause 20.8 of SCC. It is expressly understood that a) should the situation provided under Sub-clause 20.8 not arise; or b) should the period for which the PLANT is operated by OWNER between issuance of a conditional PRELIMINARY ACCEPTANCE CERTIFICATE and PRELIMINARY ACCEPTANCE of the PLANT be less than 6 months, that is, 6-months period of said Continuity Cover is not fully or partially utilized, a refund of the premium for the unutilized portion of the Continuity Cover on a pro-rata basis, shall be tried to obtain by the CONTRACTOR as per the terms and conditions of the policy and the refund amount so obtained, shall also be shared equally between the CONTRACTOR and the OWNER.

Such Continuity Cover premium including applicable taxes shall be paid by the CONTRACTOR and reimbursed by the OWNER within 30 days from receipt of invoice from the CONTRACTOR along with the confirmation letter from the Insurer indicating the premium for such Continuity cover has been paid.

The policy(ies) of insurance aforesaid shall also cover risk due to "acts of terrorism" for a sum assured equal to the TOTAL CONTRACT PRICE with a loss limit of Rs. 10,000 million (Rupees Ten thousand million) till PRELIMINARY ACCEPTANCE of PLANT or the issuance of a conditional PRELIMINARY ACCEPTANCE CERTIFICATE (as envisaged under Sub-clause should 20.8 of SCC), whichever is earlier.

- 27.7 Irrespective of single or separate insurances, the CONTRACTOR shall take the same in the joint name of CONTRACTOR and OWNER, with CONTRACTOR as Primary Beneficiary and OWNER as Joint Beneficiary, to cover all risk including marine cum erection insurance (MCE), workmen compensation / Employees State Insurance (ESI) under ESI Act 1948 for CONTRACTOR's personnel, fire risk policy etc. till handing over of PLANT to OWNER duly commissioned and tested. However, for CONTRACTOR's EQUIPMENT, CONTRACTOR can be the sole beneficiary.

- 27.8 The CONTRACTOR shall be fully responsible for pursuing and settling all claims with the underwriters, except for claims made under the Continuity Cover for any damage or loss to

the PLANT operating under the care and custody of the OWNER as provided under Subclauses 20.8 of SCC for which OWNER shall be fully responsible. For the avoidance of doubt, claims under the Continuity Cover for damage or loss to the PLANT during testing and DEFECT rectification carried out or supervised by the CONTRACTOR, as provided under Sub-clause 20.8 of SCC, shall be pursued and settled with the underwriters by the CONTRACTOR, for which the CONTRACTOR shall be fully responsible. In the event of accident, injury, damage or loss likely to result in a claim under the above insurance policies, the CONTRACTOR (or OWNER in respect of specific claims under the Continuity Cover as elaborated above) shall promptly submit such details as are necessary for settling such claims by underwriters and shall also provide information and assistance necessary to settle the claim. The CONTRACTOR and OWNER shall keep each other fully informed about progress of each such case. (Also refer Clause 52.2.1. f).ii of GCC)

28.0 GUARANTEES

28.1 It shall be a condition of the CONTRACT and the CONTRACTOR shall guarantee that the PLANT shall achieve the requirement as set forth in CONTRACTOR's FINAL PROPOSAL.

28.2 The CONTRACTOR shall guarantee that the Plants, Equipment and machineries will be new and in accordance with the CONTRACT documents and free from defects in design, material and workmanship and shall be guaranteed for a period of Twelve (12) calendar months commencing immediately upon PRELIMINARY ACCEPTANCE or the issuance of a conditional PRELIMINARY ACCEPTANCE CERTIFICATE (as envisaged under Sub-Clause of 20.8 of SCC), whichever is earlier.

The CONTRACTOR's shall replace any defective parts in the equipment of his own manufacture or those of his SUB-CONTRACTOR under normal use and arising from faulty design, materials and/or workmanship provided always that such defective parts are not repairable at the SITE and are not in the meantime essential in the commercial use of the PLANT. Such replaced defective parts shall be returned to the CONTRACTOR unless otherwise arranged. No repairs or replacement shall normally be carried out by the OWNER when the plant is under COMMISSIONING and under the supervision of the CONTRACTOR's supervisory engineers or during the guarantee period.

28.3 In the event of an emergency where, in the judgement of the OWNER, delay would Causes serious loss or damage, repairs or adjustments may be made by the OWNER or a third party chosen by the OWNER without advance notice to the CONTRACTOR

and the cost of such work shall be paid by the CONTRACTOR. In the event such action is taken by the OWNER, the CONTRACTOR will be notified promptly and he shall assist wherever possible in making the necessary corrections except for the work carried out by OWNER or a third party chosen by the OWNER. This shall not extinguish the CONTRACTOR's liability under the terms and conditions of the CONTRACT.

28.4 The cost of any special or general overhaul rendered necessary during the guarantee period due to defects in the PLANT or defective work carried out by the CONTRACTOR shall be borne by the CONTRACTOR.

28.5 The acceptance of the equipment by the OWNER shall in no way relieve the CONTRACTOR of his obligation under this clause.

28.6 In the case of those defective parts which are not repairable at site but are essential for the commercial use of the equipment and machineries, the CONTRACTOR shall mutually agree to a programme of replacement or renewal which will minimize interruption to the maximum extent, in the operation of the equipment and machineries.

28.7 At the end of the DEFECTS LIABILITY PERIOD or the extended DEFECTS LIABILITY PERIOD, the CONTRACTOR's liability terminated. In respect of goods supplied by the SUBCONTRACTORS to the CONTRACTOR where a long guarantee (more than 12 months) is provided by such CONTRACTORS, the OWNER shall be entitled to the benefit of such longer guarantees.

28.8 During the guarantee period, the CONTRACTOR shall provide if required by the OWNER the services of operation engineers to advise the OWNER for such period and in such number as may be mutually agreed upon. The CONTRACTOR's operation engineers shall also train the OWNER's personnel, act as a liaison between the OWNER and the CONTRACTOR, assist the OWNER in ordering and obtaining spare parts, generally monitoring operation and maintenance and trouble shooting and supervising repair work under guarantee.

28.9 The provisions of Clause 46 including the cost of transport, insurance etc. shall be implemented at the CONTRACTOR's expenses.

28.10 The provisions contained in clause 46 will not be applicable in following circumstances:

- a) If after handing over of the PLANT the OWNER has not operated the equipment according to generally approved industrial practices and in accordance with the conditions of operation specified and in accordance with operation manuals if any;

b) In cases of normal wear and tear of the parts to be specifically mentioned by the CONTRACTOR in the offer.

28.11 Guarantees for Time of Completion

The CONTRACTOR shall guarantee the COMPLETION DATE calculated from the EFFECTIVE DATE OF THE CONTRACT, for the purpose of determining PRICE DISCOUNT on account of delay in completion. No discount will be levied on account of delay in achieving the GUARANTEED COMPLETION DATE for reasons not attributable to the CONTRACTOR.

28.12 Performance Guarantees

CONTRACTOR shall guarantee the performance of PLANT as specified in the CONTRACTOR's FINAL PROPOSAL & as stated in CONTRACT.

28.13 Design and Vendors'/ Sub-Contractors' Guarantees

28.13.1 CONTRACTOR shall guarantee the design and engineering work carried out by him against mistakes, errors, defective specifications, inadequacy and other such items which lead to the supply of inadequate PLANTS and Facilities. In case of detection of such mistakes, errors, deficiencies etc. the CONTRACTOR shall redo the design and/or engineering work to overcome all such mistakes, errors, deficiencies etc. at no extra cost to OWNER.

28.13.2 CONTRACTOR shall be responsible for all the items of the EQUIPMENT procured by him from VENDORS/ SUB-CONTRACTORS. Further, CONTRACTOR shall replace or repair any item of EQUIPMENT which is demonstrated to be defective under normal operating conditions within the DEFECTS LIABILITY PERIOD.

29.0 PRICE DISCOUNT AND INCENTIVE PROVISIONS

29.1 Price discount in event of delay in Completion of contract

29.1.1 The CONTRACTOR agrees that the work shall be commenced and carried on at such points, and in the order of precedence and at such times and seasons as may be directed by the OWNER in accordance with the schedule for the completion of work as outlined in the CONTRACT. The CONTRACTOR declares that he has familiarized himself with the site and rights of way, ground conditions, with all the local conditions, and with all the circumstances which may or are likely to affect the performance and completion of the work and that he has allowed for such conditions in the preparation of this schedule except for abnormal situations mentioned in 17.1.1b) of GCC. The progress of work shall be checked at regular monthly intervals and the percentage

progress achieved shall be commensurate with the time elapsed after the award of the CONTRACT.

29.1.2 However, it is not incumbent upon the EIC to notify the CONTRACTOR when to begin or to cease or to resume work, nor to give early notice of the rejection of a faulty work, nor in any way to superintend so as to relieve the CONTRACTOR of responsibility of any consequence of neglect or carelessness by him or his subordinates.

29.1.3 The time stipulated in the CONTRACT for the execution of the WORKS and achievement of the GUARANTEED COMPLETION DATE shall be of utmost importance for the CONTRACT. In the event the CONTRACTOR fails to achieve the GUARANTEED COMPLETION DATE then the **OWNER** shall be entitled for **Price Discount for Delay** in accordance with the provisions more specifically contained in the **Special Conditions of Contract Clause 16.4**. The starting date and percentage for discount calculation shall be as prescribed in the **Special Conditions of Contract Clause 16.4**.

29.2 Incentive for early completion

Incentive, if any, shall be calculated as specified in Clause 16.4 of the SCC.
[However, it must be clearly understood that the incentive or bonus for early completion is optional and would be applicable for specific projects where time is of utmost importance as prescribed in bid documents]

29.3 For Failing to Meet Works Cost Guarantee

CONTRACTOR shall guarantee overall Works Cost. In the event Works cost is exceeded, provisions of Clause 20.7 of SCC shall apply.

30.0 OVERALL CEILING ON TOTAL LIABILITY

30.1 The maximum overall liability of the CONTRACTOR to the OWNER shall be limited to the TOTAL CONTRACT PRICE, excluding liabilities for extra cost incurred due to Termination of Contract for CONTRACTOR'S default and carrying out balance work at the risk and cost of CONTRACTOR, re-engineering, make good, mechanical warranty and patent infringement as per relevant clauses of CONTRACT.

30.2 No such ceiling limit shall apply in respect of:

- (i) any liability pursuant to Contractor's indemnify obligations under the contract; (ii) any loss resulting from Fraud, willful misconduct or unlawful acts or omissions of Contractor, its officials, suppliers, and sub-contractors.

31.0 TIME EXTENSION OF CONTRACT

31.1 No necessity for an extension of time is anticipated, but if untoward or extra ordinary circumstances, as defined in Clause 33.0 of GCC, should arise beyond the control of the CONTRACTOR, which in the opinion of the OWNER should entitle the CONTRACTOR to a reasonable extension of time, such extension may be granted but shall not operate to relieve the CONTRACTOR of his obligations.

31.2 The Contractor shall closely monitor the progress of the Works and give written notice to the Engineer-in-Charge as soon as it can foresee or ought reasonably to have foreseen any delay and/or a delay to the achievement of any dates mentioned or milestones suggested in the agreed Completion Schedule.

Any notice given pursuant to this clause shall as precisely as possible state the likely period of delay to the achievement of any dates mentioned or milestones suggested in the Completion Schedule and specify whether the Contractor considers that it is or may become entitled to an extension of time for the completion of the Works. Following service of a notice pursuant to this clause, the Contractor must supply the Engineer-in-Charge with such further supporting documentation and information as the Engineer-in-Charge may require so as to support its claim for extension of time for the completion of Works.

After it has given notice under this clause, the Contractor shall as soon as reasonably practicable, submit by further written notice to the Engineer-in-Charge, stating the following: (i) full and detailed particulars of the cause and actual extent of the delay to the completion of the Works or to the achievement of any dates mentioned or milestones

suggested in the Completion Schedule; or

in case where a circumstance has a continuing effect or where the Contractor is at any time unable to determine whether the effect of a circumstance will actually cause delay to the completion of the Works or to the achievement of any dates mentioned or milestones suggested in the Completion Schedule, a statement to that effect with reasons and interim written particulars (including details of the likely consequences of the circumstance on the progress of execution of the Works and an estimate of the likelihood of and likely extent of the delay); the Contractor shall also submit to the Engineer-in-Charge further interim written particulars at intervals of not more than fourteen (14) days until the actual delay caused (if

any) is ascertainable, when he shall thereafter within fourteen (14) days submit to the Engineer-in-Charge full and detailed particulars of the cause and actual extent of the delay; (iii) for approval, details of the documents that the Contractor proposes to present in support of its claim for extension of time for completion of Works so as to demonstrate its entitlement; (iv) for approval, details of the measures the Contractor has adopted or proposes

to adopt to avoid or reduce the effects of such circumstance upon the completion of the Works and the timely achievement of any dates mentioned or milestones suggested in the Completion Schedule.

(v) details of any adverse effect of the ability of the Contractor to meet the contractual requirements; and

(vi) details of measures which it has agreed and discussed with any Subcontractor to reprogramme or adjust the performance of that Subcontractors' works or services.

31.3 The Contractor shall not be entitled to an extension of time in respect of any cause of delay nor for any period of delay, which by the exercise of reasonable endeavours could be avoided or reduced (to the extent that such could have been reduced). The onus of proving that the Contractor has exercised all reasonable endeavours, and that despite such endeavours, the delay could not be avoided or reduced, shall in all cases rest with the Contractor in this respect. Upon receipt of notice from Contractor pursuant to Clause 31.2 and where the CONTRACT is delayed at any time in the commencement or during the progress of the WORK by any act, delay or neglect of the OWNER or his employees, or by any other contractor utilized by the OWNER or by FORCE MAJEURE, the time duration in the form of 'Permission to work' shall be extended by the Engineer-in Charge in WRITING for a reasonable period as may be necessary in the opinion of Engineer-in-Charge upon application from the CONTRACTOR immediately on occurrence of such special circumstances but not later than 10 working days and not towards the end of the CONTRACT period.

With such Permission to Work, the Project Manager may notify the Contractor to increase labour force, the number of shifts, overtime operations, and additional days of work per week etc., all without additional cost to Owner and without changing the Scheduled Completion Date. Any such Permission to Work shall never be construed as extension of time.

The contractor shall continue to put efforts including extra manpower & other resources to recover the delay till scheduled completion period. At the end of scheduled contract period,

contractor shall submit summation of all such occurrence including the efforts put to recover the delay and final delay analysis with request to extend the completion period as a result of all such occurrence where execution of permission to work has been granted. Engineer-in-charge may grant further 'Permission to work' to complete the balance work leading to

'Preliminary Acceptance Certificate' pending final decision on 'Extension of time'. Price Discount for delay as elaborated in SCC Clause 16.4 will accordingly be applicable beyond the extended time period, if granted by owner. Cost compensation for such delay (excluding FORCE MAJEURE conditions) shall be as per clause 5.9 of SCC.

Upon an extension of the time for completion of the Work or any part of the work or any operation(s) involved therein pursuant to this clause, the extended date/time of completion shall be deemed to be the relative date of completion in the Completion Schedule.

31.4 OWNER shall have the right to suspend the WORK in whole or in part for such time as may be necessary in order that WORKS shall be well and properly executed. In such events, suitable extension of time shall be granted to CONTRACTOR. However, should the cumulative period of suspension exceed 90 days or a single continuous suspension of more than 30 days during the scheduled duration of CONTRACT, the CONTRACTOR shall be compensated as mutually agreed in addition to extension of time, provided the suspension is caused due to reasons attributable to OWNER, and happens at the phase of project where the contractor has fully mobilized its manpower, sub-contractors, equipment, tools and tackle and is likely to incur substantial costs during idling period due to suspension or work.

Contractor shall provide complete data and information as asked by owner to enable owner to reasonably assess the compensation to the Contractor. No indirect cost like overheads, Finance costs etc. shall be considered for compensation to Contractor.

31.5 The mere fact that the Owner shall not have terminated the Contract or that the Owner has granted Permission to Work to the Contractor, for the time being, to continue with the work for its completion shall not prejudice the full rights and remedies available to the Owner under the Contract arising out of the delayed completion, including the right of Price Discount for Delay, damages and/or termination. Such permission(s) shall unless specifically stated to be an extension of time under Clause 31, shall not be construed as extension(s) of time, and shall merely constitute an indication or intimation, as

the case may be, of the Owner's willingness, for the time being, to accept the delayed completion, subject to its rights under the Contract.

31.6 No assurance, representation, promise or other statement by any of the Owner's Personnel in relation to extension of time or Permission to Work shall be binding upon the Owner or shall constitute an extension of time or Permission to Work, as the case may be, unless the same has been communicated to the Contractor in writing by the Engineer-in-charge.

31.7 Mere agreement or prescription of a revised milestone in Completion Schedule by the Engineer-in-Charge or any other Owner Personnel at variance with the approved Completion Schedule, shall not constitute an extension of time or Permission to Work in terms of the Contract so as to relieve the Contractor of all or any of his/its liabilities under the Contract, nor shall it constitute a waiver by the Owner of any of its rights under the terms of the Contract, but shall be deemed as a guidance to the Contractor for better organising his work on a recognition that the Contractor has failed to organise his work and/or to perform the same within the time specified in the Completion Schedule or subsequent approvals.

32.0 TERMINATION OF CONTRACT

32.1 Proceedings and Procedure on Default by Contractor

32.1.1 If the CONTRACTOR neglects to execute the WORK or part of the work or defaults in the performance or observance of any conditions, terms or the progress of the WORK is unduly and unreasonably delayed in the opinion of the OWNER, or neglects to carry out any order, instruction, direction or determination which the OWNER is empowered to give or make under the CONTRACT and which is given or made in WRITING to the CONTRACTOR, the OWNER may, by notice in WRITING (which shall specify with reasonable particularity the neglect, default or refusal on the part of the CONTRACTOR) require the CONTRACTOR:

- i) To give reasons for such neglect, default or refusal
- ii) To put forward his proposals for
 - a) Rectifying such neglect, default or refusal as the case may be and
 - b) Completing the CONTRACT.

32.1.2 If within 30 days after the posting of the notice addressed to the CONTRACTOR at his address last known to the OWNER, the CONTRACTOR fails to comply with the notice or if the opinion of the OWNER, the CONTRACTOR's reasons or proposals are not satisfactory then the OWNER, without prejudice to any other rights that he may have under the CONTRACT against the CONTRACTOR may either:

- a) Take over the work remaining to be completed wholly or partly out of the hands of the CONTRACTOR or any other person in whose hands or possession the work or any part of it may be, at the risk and cost of the CONTRACTOR; or
- b) Terminate the CONTRACT and encash the Bank Guarantee and recover balance claims, if any, from available unpaid moneys with OWNER.

32.2 Duration of suspension of payment due to CONTRACTOR:

Without prejudice to other payments due to the CONTRACTOR, if the OWNER suspends specific payment linked to the default and other portions of the WORKS directly connected with the default due to CONTRACTOR under this clause such suspension of payment may be continued until the default has been rectified.

32.3 Work taken out of the hands of the CONTRACTOR.

32.3.1 Employment of other contractors:

If the OWNER takes action under sub-clause 32.1.2(a), he may complete the work or any part of it by contracting with or employing any person or persons to execute further and complete work or any part of it and to provide all equipment, materials and labour as may be necessary for such further execution and completion. If practicable further execution and completion shall be carried out in accordance with the specification and at prices obtained under competitive conditions.

The OWNER may also take possession of and permit such person or persons to use for the purposes of the CONTRACT only such materials, tools and equipment and all other things on or about the SITE which are the property of the CONTRACTOR as are requisite and necessary for such further execution and completion, and the CONTRACTOR shall have no right to any compensation or allowance in respect thereof.

On the completion of such work, all tools and equipment and the surplus of the materials so taken possession of shall be handed over to the CONTRACTOR but without payment or allowance for the fair wear and tear they may have sustained in the meantime. If the CONTRACTOR fails to make good such deficiency such of the tools, equipment and materials as are necessary to make good the deficiency may

be sold and a sufficient part of the monies received retained by the OWNER and applied in payment of such deficiency.

In addition, the OWNER shall be entitled:

- a) To take possession of and remove from the CONTRACTOR's premises within a reasonable period anything (including but without limiting the generality thereof any design, drawings, specification, material or other goods) the property which is vested in the OWNER pursuant to the CONTRACT.
- b) To full particulars of any sub-contract made by the CONTRACTOR with any person for the execution of any portion of the WORKS and to peruse and copy an instrument (including but without limiting the generality thereof any agreement, letter or other paper) relating to any such SUB-CONTRACT made by the CONTRACTOR with any person for the execution of any portion of the WORKS.

32.3.2 Extra cost to the OWNER of completing work for deduction

Prior to the issue of PRELIMINARY ACCEPTANCE CERTIFICATE, the OWNER shall ascertain the cost of the work to the OWNER comprising payments to the CONTRACTOR and costs incurred by the OWNER in carrying out of the work taken out of the CONTRACTOR's hands. Such amount shall not include any extra cost due to departures from the specification unless such departures were necessitated by the CONTRACTOR's default. Should the amount so certified be greater than the amount which would have been paid to the CONTRACTOR, if the whole of the work had been carried out by him, the difference between the two amounts shall be deducted from any monies which may then be or thereafter become due to the CONTRACTOR or which may have been deposited by him as security under the CONTRACT, and if such monies be less than the amounts to be deducted the deficiency shall be a debt due by the CONTRACTOR to the OWNER and which may be recovered as provided in subclause 32.3.1 of this clause by Arbitration as per clause 38.0 of GCC in both, such payment of excess amount shall be independent of Mutually Agreed Damages for delay if the completion of WORKS is delayed.

32.4 Preservation of rights of the OWNER

No action taken by the OWNER under sub clause 32.2 and 32.3 of this clause shall vitiate the CONTRACT or shall operate to the prejudice of the right of the OWNER to recover from the CONTRACTOR or to deduct from any monies which may be or may

become due to the CONTRACTOR all sums of money which may be or may become due to the OWNER under the CONTRACT as damages, penalties or otherwise.

32.5 Should the OWNER decide to terminate the CONTRACT under sub-clause 32.1.2(b) of this clause, he may do so under notice in WRITING as from the date of such notice, and the termination shall be without prejudice to any right that may have occurred to the OWNER or to the CONTRACTOR under the CONTRACT.

32.6 Termination of Contract on Account of OWNER's Convenience

32.6.1 The OWNER, may, by written notice sent to the CONTRACTOR, terminate the CONTRACT, in whole or in part, at any time for his convenience. The notice of termination shall specify that termination is for the OWNER's convenience, the extent to which performance of work under the CONTRACT is terminated and the date upon which such termination becomes effective.

32.6.2 The jobs that are complete and ready for handover, within 30 days after the CONTRACTOR's receipt of notice of termination shall be paid by OWNER at the CONTRACT terms and prices. For the remaining jobs, the OWNER may opt:

- a) To have any portion completed at the CONTRACT terms and prices; and/or
- b) To cancel the remainder and pay to the CONTRACTOR an agreed amount for partially completed jobs and for materials and parts previously procured by the CONTRACTOR, in which event such goods shall be the property of the OWNER.

32.6.3 Termination for Insolvency

OWNER may at any time terminate CONTRACT giving written notice to CONTRACTOR, without compensation to CONTRACTOR, if CONTRACTOR becomes bankrupt or otherwise insolvent, provided that such termination will not prejudice or affect any right of action or remedy which has occurred or will accrue thereafter to OWNER.

32.7 Surviving Obligations

Termination of this CONTRACT (a) shall not relieve CONTRACTOR of its obligations with respect to the confidentiality as set forth in this CONTRACT, (b) shall not relieve CONTRACTOR of any obligation hereunder which expressly or by implication survives termination hereof, and (c) except as otherwise provided in any provision of this CONTRACT expressly limiting the liability of CONTRACTOR, shall not relieve CONTRACTOR of any obligations or liabilities for loss or damage to the OWNER arising out of or caused by acts or omissions of CONTRACTOR prior to the effectiveness of such termination or arising out of such termination, and shall not

relieve CONTRACTOR of its obligations as to portions of SERVICES already performed or of obligations assumed by CONTRACTOR prior to the date of termination, except as otherwise agreed by OWNER in WRITING. Notwithstanding to what is stated herein, in the event of Termination of this Contract, the CONTRACTOR shall procure and transfer and/or assign the license/s or IP rights compliant with its scope defined in Clause 3 of SCC without any additional cost, charges or expenses. For the avoidance of doubt, it is hereby clarified that any termination, howsoever occurred, shall not release the CONTRACTOR from fulfilling its obligations under this Article.

33.0 FORCE MAJEURE

33.1 Neither CONTRACTOR nor OWNER shall be considered in default in the performance of their obligations under CONTRACT, as long as such performance is prevented or delayed for reasons such as acts of God, severe earthquake, typhoon or cyclone (except monsoon), floods, lightening, land slide, fire or explosions, plague or epidemic, strikes of a whole National category of workers and concerted act of workmen or other industrial disturbances (lasting more than 14 consecutive calendar days), lockouts (lasting more than 10 consecutive calendar days), sabotage, blockade, war, riots, invasion, act of foreign enemies, hostilities (whether war be declared or not), civil war, rebellion, revolution, insurrection or military or usurped power of confiscation, trade embargoes, destruction or requisition by order of any Government or any Public Authority, provided notice of any such cause is given forthwith and in any event not later than one week (7) days of the happening of the event by the party claiming the benefit of this Clause to the other. The notice shall specify the matter constituting FORCE MAJEURE explaining to what extent contractual obligations will thereby be prevented or delayed and the further period for which it is estimated that such prevention or delay will continue. CONTRACTOR shall provide justificatory documents countersigned by the local Chamber of Commerce. Notwithstanding the foregoing, FORCE MAJEURE shall not include:

- (a) weather conditions reasonably to be expected for the climate in the geographic area of the contract SITE and suppliers shops including but not limited to the monsoon season,
- (b) the occurrence of any manpower or material shortages unless such a shortage is itself caused by an event of FORCE MAJEURE, or
- (c) any delay, default or failure (direct or indirect) in obtaining materials, or

(d) in any SUBCONTRACTOR/VENDOR or worker performing any WORK or any other delay, default or failure (financial or otherwise) attributable to SUB-CONTRACTOR/Vendor/worker, unless such delay, default or failure results from any act, event or condition which would, with respect to such SUB-CONTRACTOR/VENDOR/ worker, constitute an event of force majeure.

33.2 If the CONTRACTOR suffers delay in the due execution of the contractual obligations due to delays caused by FORCE MAJEURE as defined above, the agreed time of completion of job covered by this CONTRACT or the obligation of the CONTRACTOR shall be extended by a period of time on account of force majeure conditions, provided that on the occurrence of any such contingency, the CONTRACTOR reports within 7 days to the OWNER in WRITING, the cause of delay and likely duration of cause of delay with requisite documentary evidence. 33.3 The decision of the OWNER, whether there is FORCE MAJEURE condition or not and whether extension of time shall be granted or not, shall be final.

33.4 Should one or both the parties be prevented from fulfilling the contractual obligations by a state of FORCE MAJEURE lasting continuously for a period of 6 weeks, the two parties shall consult each other regarding the future implementation of the CONTRACT. The mere shortage of labour, materials or utilities shall not constitute FORCE MAJEURE unless caused by circumstances which are themselves FORCE MAJEURE.

33.5 CONTRACTOR and OWNER shall endeavour to prevent, overcome or remove the causes of FORCE MAJEURE.

33.6 No ground for exemption can be invoked if CONTRACTOR has failed to give timely notice by registered letter and subsequently supported it by documentary evidence.

33.7 Delay or non-performance by a party hereto caused by the occurrence of any event of FORCE MAJEURE shall not:

a) Constitute a default or breach of the CONTRACT,

Or

b) Give rise to any claim for damages or additional cost or expense occasioned thereby, if such delay or non-performance is caused by the occurrence of any event of FORCE MAJEURE. FORCE MAJEURE events are not payable under any circumstances, save as set out in Subclause 33.9.

33.8 Nothing contained in clause 33 of GCC shall affect the right of the CONTRACTOR to receive payments falling due and payable during the continuance of FORCE

MAJEURE. 33.9 In case of suspension of WORK for a continuous period of more than Two Hundred Forty (240) DAYS due to FORCE MAJEURE condition, the OWNER reserves the option to provide the CONTRACTOR either a right to terminate the CONTRACT, or alternatively, to reimburse the CONTRACTOR all reasonable costs incurred due to suspension of WORK during the FORCE MAJEURE period.

34.0 NO WAIVER OF RIGHTS

34.1 Neither the inspection by the OWNER or any of their officials, employees, or agents nor any order by the OWNER for payment of money or any payment for or acceptance of, the whole or any part of the WORKS by the OWNER nor any extension of time, nor any possession taken by the OWNER shall operate as a waiver of any provision of the CONTRACT, or of any power herein reserved to the OWNER or any right to damages herein provided.

34.2 No waiver of any breach in the CONTRACT shall be held as a waiver of any subsequent breach.

35.0 BANKRUPTCY AND LIQUIDATION OF CONTRACTOR OR BUSINESS UNDER RECEIVERSHIP:

If the CONTRACTOR becomes insolvent or bankrupt, or have a receiving order made against him, or compound with his creditors, or being a corporation commence to be wound up not being a member's voluntary winding up for the purpose of reconstruction or carry on his business under a receiver for the benefit of his credit, the CONTRACTOR shall within fourteen (14) days notify the OWNER accordingly. On the occurrence of any of the happenings stated in the first sentence of this clause, the OWNER shall be at liberty to:

a) Determine the CONTRACT forthwith by notice in WRITING to the CONTRACTOR or to the receiver or liquidator or to any person in whom the CONTRACT may have become vested, and act in the manner provided in clause 32.1 (proceedings or default) or, b) Give to such receiver, liquidator or other person in WRITING the option for a period of one month of carrying out the CONTRACT subject to his providing a guarantee for the due and faithful performance of the CONTRACT up to the CONTRACT value of the work for the time being remaining unexecuted and subject to his taking all reasonable steps to prevent stoppage of the work. In the event of stoppage of the work, the period of the option under this clause shall be fourteen (14) days only.

36.0 CERTIFICATE NOT TO AFFECT RIGHT OF OWNER AND LIABILITY OF CONTRACTOR

No interim payment certificate of the OWNER nor any sum paid by the OWNER nor any extension of time or permission to work for execution of the WORKS granted by the OWNER shall affect or prejudice the rights of the OWNER against the CONTRACTOR or relieve the CONTRACTOR of his obligations for the due performance of the CONTRACT or be interpreted as approval of the WORK done or of the equipment furnished and no certificate shall create liability on the OWNER to pay for alterations, amendments, variations, or additional works not ordered, in WRITING, by the OWNER or discharge the liability of the CONTRACTOR for the payment of damages whether due, ascertained or certified or not or any sum against the payment of which he is bound to indemnify the OWNER nor shall any such certificate nor the acceptance by him of any sum paid on account or otherwise affect or prejudice the rights of the CONTRACTOR against the OWNER.

37.0 SETTLEMENT OF DISPUTES

Any and all disputes or differences arising out of or in connection with this CONTRACT or any breach thereof (the “**Dispute**”) which cannot be settled by friendly negotiation and agreement between the Parties shall be subject to conciliation. Both Parties shall nominate representative(s) who shall jointly appoint a Conciliator who shall try to settle the Dispute between the Parties.

38.0 ARBITRATION

38.1 If after 30 (thirty) days of Conciliation, the Parties have failed to reach an amicable settlement on a Dispute, the Dispute shall be referred to and finally resolved by arbitration. The Dispute shall be referred to a sole Arbitrator, to be jointly appointed by the Parties, under the Arbitration and Conciliation Act, 1996, (as amended from time to time) which Rules are deemed to be incorporated by reference into this Clause. The seat and venue of arbitration shall be Mumbai, India *[or as mutually agreed by the Parties]* the language to be used in arbitral proceeding shall be in English. Subject to Arbitration above, the Courts in *[Mumbai]* shall have exclusive jurisdiction.

38.2 It is agreed between the Parties that the WORK shall be continued by CONTRACTOR during the arbitration proceedings unless otherwise directed in writing by OWNER or

unless the matter itself is such that WORK cannot practically be continued until the decision of the arbitrator is obtained and CONTRACTOR shall remain liable and bound in all respects under the CONTRACT.

39.0 GOVERNING LAWS, LANGUAGE AND MEASURES

This CONTRACT shall be governed and construed in accordance with the Law of India, without reference to conflict of law principles. The governing language for all communication, notices, Technical Information, etc. pertaining to CONTRACT shall be English. Any literature, correspondence, documents etc., shall be considered only if its accompanied by English translation. For the purpose of interpretation English translation shall govern and be binding on all Parties. The metric system of measurement shall only be used exclusively in the execution of CONTRACT.

40.0 RELEASE OF INFORMATION

The CONTRACTOR shall not communicate or use in advertising, publicity, sales releases or in any other medium, photographs or other reproduction of the WORKS under this CONTRACT or descriptions of the SITE, dimensions, quantity, quality, or other information, concerning the work unless prior written permission has been obtained from the OWNER.

41.0 COMPLETION OF CONTRACT

Unless otherwise terminated under the provisions of any other relevant clause, this CONTRACT shall be deemed to have been completed at the expiry of the guarantee period as provided for under the clause entitled guarantee.

42.0 ENFORCEMENT OF TERMS

The failure of either party to enforce at any time any of the provisions of this CONTRACT or any rights in respect thereto or to exercise any option herein provided, shall in no way be construed to be a waiver of such provisions, rights or options or in any way affect the validity of the CONTRACT. The exercise by either party of any of its rights herein shall not preclude or prejudice either party from exercising the same or any other right it may have hereunder.

43.0 OWNER'S DECISION

43.1 In respect of all matters which are left to the decision of the OWNER including the granting or withholding of the certificates, the OWNER shall, if required to do so, by the CONTRACTOR, give in WRITING a decision thereon.

43.2 In each case involving a financial commitment the written APPROVAL of the OWNER alone shall be binding.

43.3 In matters of difference of opinion on a decision passed by the OWNER to the CONTRACTOR stipulations of Clause 37.0 shall govern.

44.0 CO-OPERATION

44.1 Co-operation with OWNER

- a) The CONTRACTOR and OWNER shall co-operate with each other in the discharge of their respective obligation under the CONTRACT with the aim of satisfactory completion of the PLANT and the WORKS in accordance with the CONTRACT.
- b) The parties shall deal fairly, openly and in good faith with each other. Each party shall disclose information which the other might reasonably need to order to exercise its rights and to perform its obligations under the CONTRACT. In particular, each party shall promptly disclose full information to the other concerning any matter which will or may prevent the PLANT and WORKS being completed in accordance with the CONTRACT. The parties shall work together in a manner consistent with their respective obligations under the CONTRACT to resolve or mitigate any such problem.
- c) OWNER shall be at liberty to object to employment of any person at SITE and the objection shall be communicated in WRITING and CONTRACTOR shall make immediate arrangements for removal of such person/s.

44.2 Cooperation with other contractors

- a) The CONTRACTOR shall not object to the execution of the work by other contractors or tradesmen and offer them every facility and access for the execution of their several works simultaneously with CONTRACTOR's work. CONTRACTOR shall at all time provide sufficient fencing, notice boards, lighting and watchmen to protect and warn the public and guard the works and in default there of OWNER may provide such facilities at CONTRACTOR's cost.
- b) The CONTRACTOR shall agree to cooperate with the OWNER and other CONTRACTORS and freely exchange with them such technical information as

is necessary to obtain the most efficient and economical design and to avoid unnecessary duplication of efforts. The OWNER shall be provided with three (3) copies of all correspondence addressed by the CONTRACTOR to other SUB-CONTRACTORS in respect of such exchange of technical information.

45.0 SUSPENSION OF WORK

- 45.1 The OWNER reserves the right to suspend and reinstate execution of the whole or any part of the WORK without invalidating the provisions of the CONTRACT with reasonable prior notice depending on the prevailing circumstances. Orders for suspension or reinstatement of the WORKS will be issued by the OWNER to the CONTRACTOR in WRITING. The time for completion of the WORKS will be reviewed for execution for reasonable period considering the duration of the suspension and a reasonable re-mobilization period to be mutually agreed between the CONTRACTOR and OWNER.
- 45.2 During the period of suspension, the CONTRACTOR shall at his own cost properly protect and secure the work and materials included in his scope.
- 45.3 If such suspension of WORK as per above Clause 45.1 by OWNER and / or suspension of WORK as per Clause 45.4 by CONTRACTOR delays or is likely to delay the progress of WORK or the carrying out of WORK under CONTRACT resulting in additional expenses or increased liability to CONTRACTOR, the OWNER shall pay to the CONTRACTOR all reasonable expenses, mutually agreed between OWNER and CONTRACTOR, arising from suspension of the work by an order in WRITING of the OWNER provided that such suspensions of work is more than a cumulative period of ninety (90) days or a single continuous suspension of more than 30 days and provided that such suspension is not due to some fault on the part of the CONTRACTOR or a SUB-CONTRACTORS.
- 45.4 In the event OWNER fails to make payment against a clear and undisputed invoice within a period of one hundred eighty (180) days from the date of receipt of invoice, the CONTRACTOR shall be entitled to suspend the WORK after giving seven (7) days prior written notice to the OWNER.
- 45.5 If the suspension under Clause 45.1 is for reasons of FORCE MAJEURE as defined in clause 33.0 or by reason(s) of the default or failure on the part of the CONTRACTOR or is for the purpose of ensuring safety of the WORK(S) or any part thereof or is necessary for the proper execution of the WORK(S) or is for reason(s) of weather affecting the safety or quality of the WORK(S) or materials (the reasons for the

suspension stated by the ENGINEER-INCHARGE / OWNER in any notice of suspension as aforesaid, inclusive as to existence or default or failure on the part of the CONTRACTOR, if so stated in the notice, being final and binding upon the CONTRACTOR), the CONTRACTOR shall not be entitled to claim compensation for any loss or damage sustained by the CONTRACTOR by virtue of any suspension as aforesaid, notwithstanding that, consequent upon such suspension, the machinery, equipment and/or labour of the CONTRACTOR or any part thereof shall be or become or be rendered idle and notwithstanding that the CONTRACTOR shall be liable to pay salary, wages or hire charges and expenses thereof or therefor.

45.6 In the event of such termination being upon a suspension consequent to a default or failure by the CONTRACTOR, the CONTRACTOR shall not be entitled to any damage, compensation, loss of profit or other compensation whatsoever in addition to payment for the completed supplies made and completed works done in accordance with the terms of the CONTRACT.

46.0 REPLACEMENT OF PARTS & MATERIALS DEFECTIVE / DAMAGED / LOST DURING TRANSIT / ERECTION & COMMISSIONING

46.1 If during the progress of the WORKS, the OWNER shall decide and inform in WRITING to the CONTRACTOR that the CONTRACTOR has manufactured any PLANT or part of the PLANT unsound or imperfect or has furnished any PLANT inferior to the quality specified, the CONTRACTOR on receiving details of such defects or deficiencies shall at his own expense, within seven (7) days of his receiving the notice or otherwise within such time as may be reasonably necessary for making it good, proceed to alter, re-construct or remove such WORK and furnish fresh EQUIPMENT up to the standards of the specifications. In case the CONTRACTOR fails to do so, the OWNER may on giving the CONTRACTOR seven (7) days' notice in WRITING of his intentions to do so, proceed to remove the portion of the WORKS so complained of and at the cost of the CONTRACTOR perform all such WORK or furnish all such EQUIPMENT provided that nothing in this clause shall be deemed to deprive

the OWNER of or affect any rights under the CONTRACT which the OWNER may otherwise have in respect of such defects and deficiencies.

46.2 The CONTRACTOR's full and extreme liability under this clause shall be satisfied by the payments to the OWNER of the extra cost, of such replacement procured including erection as provided for in the CONTRACT, such extra cost being the ascertained difference between the price paid by the OWNER for such replacements

and the CONTRACT price portion for such defective PLANTS and repayments of any sum/ paid by the OWNER to the CONTRACTOR in respect of such defective PLANT.

- 46.3 If the MATERIAL/EQUIPMENT or any portion thereof is damaged or lost during transit and handling, storage, erection, commissioning at site, the replacements of such MATERIAL/ EQUIPMENT shall be effected by the CONTRACTOR within a reasonable time to avoid unnecessary delay in the COMMISSIONING of the EQUIPMENT and without waiting for realisation of cost of damages from the insurance company if the cost of the said item is more than excluded in the insurance, appointed by him for this purpose. This will not alter the schedule of commissioning & guarantee tests in any way.

47.0 DEFENCE OF SUITS

- 47.1 If any action in Court is brought against the OWNER or an officer or agent of the OWNER for the failure, omission or neglect on the part of the CONTRACTOR to perform any acts, matters, Covenants or things under the CONTRACT, or for damage or injury caused by the alleged omission or negligence on the part of the CONTRACTOR, his agents representatives or his SUB-CONTRACTORS or in connection with any claim based on lawful demands of SUBCONTRACTORS, workmen, suppliers or employees, the CONTRACTOR shall in all such cases indemnify and keep the OWNER and/ or his representative harmless from all losses, damages, expenses or decrees arising out of such action (Also refer Clause 28.10 of GCC).
- 47.2 CONTRACTOR and OWNER shall jointly undertake to defend any action brought against the OWNER as aforesaid in Sub-clause and CONTRACTOR shall bear all costs related thereto.
- CONTRACTOR shall further hold OWNER harmless from any damages or other sums that may become payable by OWNER under a final judgment or settlement. Further, the OWNER shall have the right to be represented therein by counsel of its own selection and at its own expense.
- 47.3 Neither CONTRACTOR nor OWNER shall settle or compromise any suit or action without the written consent of the other Party, if such settlement or compromise obliges the other to make any payment or part with any property or assume any obligations or surrender any rights or to be subjected to any injunction by reason of such settlement or compromise.

48.0 CONTRACTOR'S RESPONSIBILITIES

- 48.1 In consideration of payment by the OWNER, the CONTRACTOR shall regularly and diligently carry out and complete the WORKS in accordance with the CONTRACT.
- 48.2 All work carried out by the CONTRACTOR shall be carried out with sound workmanship and materials, safety and in accordance with good engineering practice, applicable Legislation and codes and shall be to the reasonable satisfaction of the ENGINEER-IN-CHARGE.
- 48.3 The CONTRACTOR shall set out the PLANT by reference to points, lines and levels of reference provided to him by the ENGINEER-INCHARGE. The CONTRACTOR shall consider Highest Flood Level (HFL) and Highest Hi-Tide Level of last 50 years for deciding the level of plant, maximum rainfall (last 50 years) for deciding the surface drain design, maximum wind speed (last 50 years) and earthquake zone qualification at site for structural design.
- 48.4 The PLANT/WORKS as completed by the CONTRACTOR shall in every respect comply with the requirements defined in the Specification or any other provision of the CONTRACT.
- 48.5 If any time during the performance of the CONTRACT the CONTRACTOR is of the opinion that a change to the WORKS or the design or method of operation of the PLANT.
- a) is necessary to eliminate a potential defect in the PLANT or a specific hazard to any person or party in the performance of the WORKS or in the operation of the PLANT which has occurred or would otherwise occur; or
 - b) Would improve operating or life cycle costs of the PLANT; or
 - c) Would otherwise be beneficial to the OWNER; the CONTRACTOR shall bring the matter to the attention of the ENGINEER-INCHARGE stating the reasons for his opinion and where appropriate submit his proposals for a Variation in accordance with Clause 5 of SPECIAL CONDITIONS OF CONTRACT.
- 48.6 The CONTRACTOR shall at all times have and maintain adequate resources available for the proper and timely execution of the WORKS, including financial resources, and competent, appropriately experienced and physically capable staff and labour whether employed by the CONTRACTOR, any SUB-CONTRACTOR or third parties.
- 48.7 The CONTRACTOR shall provide and maintain records as specified in the CONTRACT. Unless otherwise agreed, the CONTRACTOR shall, at intervals of not more than one calendar month, report to the Engineer-In-Charge on the progress of the WORKS,

supporting his reports with appropriate Documentation including any revisions to the approved programme.

48.8 The CONTRACTOR shall maintain, and cause SUB-CONTRACTORS to maintain, a quality assurance system as specified in the CONTRACT. The existence of such a quality assurance system shall not relieve the CONTRACTOR from any of his other duties, obligations or liabilities under the CONTRACT. The CONTRACTOR shall also prepare and implement a validation plan, if such a requirement is specified in the CONTRACT. Health, Safety and Environment (HSE) CONTRACTOR shall comply with the HSE requirements detailed in the GCC and elsewhere in bidding documents. The CONTRACTOR shall follow the OWNER safety manual, as provided, as well as safety standard for work and protection as per Indian Standards (BIS). The CONTRACTOR shall also be responsible to comply with the code requirements of Occupational Safety & Health Administration (OSHA), ISO-14000 Series and other domestic and international practices. In case of conflict between the requirements of the various specifications and/or the requirements specified in the bid document, the more stringent requirement shall be followed.

CONTRACTOR shall comply at minimum with the following, but not limited to:

- a) CONTRACTOR shall take all necessary measures to protect the work and workmen against accident and occupational diseases. CONTRACTOR shall observe and comply with all Governmental safety regulations as well as OWNER's and accepted industry safety practices as required for this work.
- b) CONTRACTOR shall establish a Safety & Health Committee. This committee shall consist of contractors' management, supervisor and representation from subcontractors. This committee shall function as a body to eliminate all the potential hazards on workplaces and reinforce the safety activities at site.
- c) CONTRACTOR shall develop and submit a method statement for all work activities including actions to be taken to minimize HSE impact.
- d) CONTRACTOR shall within 30 days of commencement of Contract and also once every three months thereafter submit a safety report, to OWNER's HSE Manager with a copy to the EIC.
- e) CONTRACTOR shall conduct HAZOP study during the engineering stage of the plant. The HAZOP shall be facilitated by a qualified HAZOP third party consultant not connected with the project.
- f) CONTRACTOR shall provide one competent full time qualified safety manager. Additionally, for every 400 workmen at site, there shall be one qualified safety officer.

Besides, Safety Managers & officers, Safety Stewards shall be deployed at site at a rate of 1 per 50 employees.

- g) CONTRACTOR shall be responsible for the safety of its sub-contractors and work crews and for ensuring that all equipment, materials, tools and procedures remain in compliance with job requirements.
- h) CONTRACTOR shall be responsible for providing CONTRACTOR & its Sub-Contractors employees at site the appropriate Personal Protective Equipment (PPE) including but not limited to Eye/face protection, safety footwear, proper gloves, full body double lanyard safety harnesses, hearing protection and safety helmets. CONTRACTOR shall also provide additional PPE, if instructed for safe execution of the job. CONTRACTOR employees should be trained in the proper use and maintenance of PPE. CONTRACTOR's Safety Manager shall ensure that PPE are correctly used and maintained in good condition. All PPE shall conform to the latest relevant Indian standards.
- i) CONTRACTOR shall take environmental protection measures as mentioned in the ESIA report and the conditions laid down in environmental clearances obtained by the OWNER.
- j) CONTRACTOR shall not employ child labour nor encourage bonded labour to ensure compliance with human rights policy and related requirements.
- k) CONTRACTOR shall report all incidents and environmental releases, regardless of severity, to the OWNER's HSE Manager in writing.
 - i) In the event of a workplace accident, injury, or illness, the most important immediate actions shall be to provide medical assistance to those who may need it and to ensure the safety of others that may be affected or acting as emergency responders.
 - ii) The OWNER's HSE Manager shall be immediately notified by fastest means possible of any accident which involves the following:
 1. Death from any cause whatsoever.
 2. A fractured skull, pelvis, arm, thigh or spine, forearm or leg.
 3. A dislocated shoulder.
 4. The amputation of an arm or hand, or of one or more fingers of the same hand, or of a leg or a foot.
 5. The loss of sight of an eye.
 6. Any other serious bodily injury, including internal bleeding or burns or asphyxia where such injury is likely to endanger life, cause permanent incapacity, or temporary incapacity of 5 days or more.

- iii) Contactor shall document all accident investigations using the Accident Investigation Report. All required reports shall be completed and copies provided within 24 hours to the OWNER.
- iv) In case of death, the CONTRACTOR shall be responsible for immediately notifying the nearest Indian police station so that they can make the proper investigation in accordance with the law. Also, the CONTRACTOR shall immediately notify the Labor Officer of the Federal Ministry of the area in which the death occurred.
- l) CONTRACTOR shall provide medical facilities to his staff and workmen at site. One first aid center at site with Ambulance & Para medical staff in attendance is required to be kept operational at all working hours. Additionally, contractor shall enter into MOU with one general hospital/ nursing home, with facility to treat head injury / other serious injuries, which shall attend to any injured staff of contractor / sub- contractor on credit to be paid by CONTRACTOR.
- m) The CONTRACTOR shall submit to the OWNER HSE Manager a method statement or Construction Plan (CP) for each construction activity planned to complete the scope of work. These CPs shall be reviewed by the OWNER HSE Manager who shall determine the need for a Job Safety Analysis (JSA).
- n) All site personnel from CONTRACTOR including his Sub-contractors at site shall undergo a Safety Orientation at the beginning of their deployment. This orientation shall be mandatory to obtain a Gate Pass to enter the site. The CONTRACTOR shall submit the names of new employees to receive the training, 24 hours in advance, OWNER shall then schedule the training and advise the CONTRACTOR of the training time and venue.
- o) CONTRACTOR shall ensure that appropriate training is provided to workmen at periodic intervals. CONTRACTOR shall properly document and make available for verification all training information, records, and certificates.
- p) CONTRACTOR shall certify that all operators of mobile equipment such as forklifts, cranes, boom lifts, buses, etc., have been trained and/or certified on the proper operation of the equipment. Copies of this training and certification shall be maintained on the project site by the CONTRACTOR and forwarded to OWNER HSE Manager upon request. Mobile crane operators shall be qualified on each specific crane (type & rating) that they are assigned to operate through a testing and qualification procedure recognized by OWNER.

- q) CONTRACTOR involved with operations, such as those involving hazardous waste, Chemicals etc., shall describe the medical and exposure monitoring procedures and their proposed compliance methods in HSE Action Plan.
- r) OWNER may conduct safety Audits at any stage of project execution and before taking over the Plant. The audit shall be based on a protocol that covers elements which can affect safety during execution or the safe operation of the works in the CONTRACTOR's scope of work. The protocol shall cover documentation, process hazard analysis, fire detection and suppression system, life-saving appliances and escape routes, operating procedures, pre-start-up safety review, safe work practices, safety and shut down devices, management of change, assurances of quality and mechanical integrity, emergency response control, investigation of accidents, personnel protective equipment. Audit can be conducted by the OWNER's personnel or any agency appointed by the OWNER. CONTRACTOR shall accord full access to site and provide all relevant information and shall comply with the observations and recommendations of the audit

49.0 PHOTOGRAPHIC RECORD OF PROGRESS

The CONTRACTOR shall furnish digital photographs of the work done in his shop/site along with monthly progress report (Refer Clause 16.2.2 of GCC). Photographs shall be taken when and are indicated by the Engineer-In-charge. Adequate number of photographs shall be submitted indicating various stages of manufacture and erection. Each photograph shall contain the date, the name of the CONTRACTOR and the title of the view taken. OWNER also desires to have complete Video film of all major components during fabrication and erection. Before utilizing any photographs for publicity, CONTRACTOR shall obtain prior approval of OWNER.

50.0 SPARES

All the necessary commissioning spares shall be included in the scope of the CONTRACT. The contractor bid shall include separate price for spare parts for 2 years trouble free operation. These prices shall be valid for a minimum period of 6 months after the date of PRELIMINARY ACCEPTANCE CERTIFICATE (Refer SCC Clause 20.8). The OWNER reserves the right to finalise the exact quantities of the additional Supplier-recommended spare parts and effect price adjustments on the basis of the unit rates quoted by the Supplier plus insurance, freight, taxes and duties at actuals and nominal procurement overheads as mutually agreed between the OWNER and CONTRACTOR. The mandatory spares, commissioning spare parts

and additional Supplier-recommended spares, if any, opted by the OWNER shall be delivered at the SITE and handed over to OWNER prior to PRELIMINARY ACCEPTANCE of the PLANT.

51.0 CORRESPONDENCE

51.1 All correspondence from the CONTRACTOR to the OWNER shall be as per the correspondence distribution schedule. All communications including technical-commercial clarification and/or comments shall be addressed to OWNER and shall always bear reference to CONTRACT.

Correspondence on technical and commercial matters shall be dealt with in separate letters and each copy of the letter shall be complete with all Annexure, if any.

51.2 Any notice to the CONTRACTOR under the terms of the CONTRACT shall be served by registered mail/Speed Post, fax or courier.

51.3 Any notice to the OWNER shall be served from the CONTRACTOR's Principal office in the same manner.

51.4 Any written order or instruction of OWNER or his duly authorised representative, communicated to authorised representative of the CONTRACTOR at site office shall be deemed to have been communicated to the CONTRACTOR at his legal address.

51.5 A notice shall be effective when delivered or on date of the notice, whichever is later.

52.0 MATERIALS AND EQUIPMENT

52.1 Materials

52.1.1 CONTRACTOR shall supply, to the OWNER, all MATERIALS required for incorporation in the permanent works as determined by the CONTRACTOR, within the scope of work, to be necessary to establish, commission and operate (so far as concerns mandatory spares) the PLANT/ Unit delivered on CIF/CFR/CPT/CIP basis at Indian port of CONTRACTOR's choice in respect of imported materials and delivered ex-factory at the price of materials specified in the Price Schedule. It is hereby clarified that the said contract shall include a contract for the sale and supply within the price of materials (and any recoveries in respect thereof under any policy of insurance) of all materials required for the replacement of any defective materials and any materials lost, damaged or destroyed during transit, storage, fabrication, erection or otherwise prior to the issue of PRELIMINARY ACCEPTANCE CERTIFICATE.

52.1.2 Invoices

CONTRACTOR's / Supplier's invoices shall be raised as detailed below:

- a) Supplier's invoices in respect of materials covered within the scope of supply under Clause 52.1.1 shall be made out by the Supplier in favour of the OWNER or CONTRACTOR and the materials shall be consigned to the OWNER. Where the CONTRACTOR is the Supplier, the invoices shall be drawn by the CONTRACTOR as the Supplier.

The CONTRACTOR shall submit a valid document under the prescribed law to enable the OWNER to claim CENVAT credit / input tax credit. The release of payment of the indirect tax cost indicated in the bid is subject to submission of prescribed documents to enable the OWNER to avail credit. Non-submission of such documents or submission of defective documents would entitle the OWNER to deduct the tax amount from the amount due to the CONTRACTOR.

- b) It is hereby clarified that the CONTRACTOR's responsibility shall be limited to providing valid documents. The OWNER shall, irrespective of the fact that whether items / equipment / services are eligible for CENVAT / input tax credit benefits as per extant tax laws / rules or the OWNER not availing the CENVAT/ input tax credit benefits for whatever reasons, upon submission of valid documents pay to the CONTRACTOR the indirect tax amounts so claimed.

The Supplier's invoices for imported materials shall include the cost of all pre-delivery tests, third party inspections, Packing and forwarding charges etc.

- c) The Supplier's invoices for indigenously supplied materials shall include all pre-delivery tests, third party inspections, Packing and forwarding charges etc.
- d) The invoices for indigenously and imported supplied materials shall also include the taxes, duties and other levies on the supply which are reimbursable by the OWNER. Reimbursement shall, however, be subject to the satisfaction of the conditions and provision of the documents required to qualify for the reimbursement.

52.1.3 The CONTRACTOR shall be responsible at his own cost and initiative within the scope of services, to take delivery of the materials from the port of delivery in India in respect of imported materials and from the factory or ware-house or other place(s) of delivery in respect of indigenous materials and to transport these to the OWNER's designated CONTRACTOR's stockpiles, godowns or other places of storage approved by the ENGINEER- IN-CHARGE for all materials consigned to OWNER, and to transport the same from said godowns or place(s) of storage after

obtaining release from OWNER to the work site for installation and incorporation in the permanent WORKS.

52.1.4 The work of delivery and transportation of materials shall include (but not be limited to) the following:

- a) Clearance of the goods through custom and port clearance including filing of all custom manifests, bills of entry, and custom declarations and other documents as may be required for the clearance of the goods from customs or port authorities, for which purpose the OWNER shall, from time to time, grant to the CONTRACTOR or the CONTRACTOR's designate(s), such authority (ies) as may be reasonably required by the CONTRACTOR in this behalf.
- b) Stevedoring, clearing, forwarding and handling services as required for clearing, forwarding and handling imported and indigenous materials and consignments including payment at CONTRACTOR's cost of any demurrage, wharfage, port, charges, siding charges, retention charges, detention charges or other charges whatsoever and howsoever designated or levied by any railway, air-port, ship and/or other authorities for or in connection with the loading, unloading or detention of any materials or vessels or other means of transport beyond the free period or unloading, clearance, retention or detention or loading, as the case may be, provided by the relevant authority (ies) or carrier(s) in this behalf.
- c) All works and operations necessary to lift and to remove the material from port, warehouse, railway or other siding, factory or other places of delivery, loading, handling, transporting, and unloading and safely stacking, placing or storing the same at approved godowns, yards or other place(s) of storage including lashing or otherwise securing or protecting the same in transit and during and in storage.
- d) Supply, procurement, mobilization, and deployment of all labour thereof, equipment & machinery necessary for lifting, loading, handling, removing, transporting, unloading, stacking or securing the materials.
- e) Transit and storage insurance of all materials for the full replacement value thereof delivered at site.
- f) All acts, deeds, matters or things required to fulfil all local, municipal and other statutory authorities with respect to the transportation of any materials through

or into any State into any State, municipal, local or other barriers or limits or for the import of the materials or any of them within the limits of such barrier, including payment of octroi or other local toll, terminal and/or entry or other taxes payable on the passage or entry of the materials through or within any local limits, for which purpose the OWNER shall give the CONTRACTOR and/or CONTRACTOR's designate(s) any and all authority(ies) as may be reasonably required in this behalf.

If Road Permits, Entry Permits, Transit Permits or the like for the transportation of any materials is to be obtained in the name of the OWNER, the OWNER shall at the request of the CONTRACTOR sign and provide such documents as are required to be furnished by the OWNER to obtain the Permit(s).

- g) All other acts, deeds, matters and things whatsoever ancillary, auxiliary or incidental to the above including but not limited to the grading of the site and/or creation of temporary approaches and ramps etc. as may be required.

52.2 General Provision with regard to Materials

52.2.1 The CONTRACTOR shall, within the scope of work, undertake the following activities and responsibilities with respect to and in addition and without prejudice to the activities and responsibilities under Clause 52.1 and associated clauses there under in respect of materials:

- a) The CONTRACTOR shall in taking delivery, ensure compliance of any condition for delivery applicable to deliveries from the concerned authority or carrier, and shall be exclusively responsible to pay and bear any detention, demurrage or penalty or other charges payable by virtue of any delay or failure by the CONTRACTOR.
- b) The CONTRACTOR shall maintain a day-to-day account of all materials consigned to OWNER indicating the daily receipt(s), consumption(s) and balance of each material and category thereof. Such account shall be in the format, if any, prescribed by the ENGINEER-IN-CHARGE and shall be supported by all documents necessary to verify the correctness of the entries in the account.
- c) All materials shall be taken delivery of, held, stored and utilised by the CONTRACTOR as Trustee of the OWNER, in such a manner that OWNER's eligibility for tax credit benefit is fully protected.

- d) All materials, including materials in respect of which licenses / release orders / permits / authorization have been accorded in the name of the OWNER shall, without prejudice to the responsibility/liability of the CONTRACTOR in respect thereof, vest in the OWNER at the time when it / they would have ordinarily vested in the OWNER on a direct delivery to the OWNER, and the CONTRACTOR shall be deemed to be acting on behalf of the OWNER and as an agent of the OWNER in respect of deliveries taken by the CONTRACTOR.
- e) The CONTRACTOR shall at all times be exclusively responsible for any and all losses, damages, deterioration, misuse, wastage, theft, or other application or misapplication or disposal of the materials.
- f) The CONTRACTOR shall take out, at his own cost and keep in force at all times, during transit, handling, storage, and erection up to completion in all respect of the WORKS, policy(ies) with Insurance Company(ies) approved by the OWNER for the full replacement value of the MATERIALS at SITE against the risks hereinafter specified. Such policies shall be in the joint names of the OWNER and the CONTRACTOR
- (i) Notwithstanding anything provided herein, the CONTRACTOR's liability for damage to the PLANT shall be as per clause 7.2.3 of GCC.
- (ii) Subject to clause 27.9 of GCC, it shall be the exclusive responsibility of the CONTRACTOR to lodge and pursue any or all claims in respect of the insurance aforesaid.
- (iii) The CONTRACTOR shall, as a condition to the certification of any Running Account Bill, satisfy the OWNER/ ENGINEER-INCHARGE of the existence of one or more policy(ies) of insurance, covering the materials for all insurable risk including but not limited to, any loss or damage commencing from the supplier's ware house in handling, transit, storage and during erection, theft, pilferage, riot, civil commotion, force majeure (including earth quake, flood, storm, cyclone, tidal wave, lightening and other adverse weather conditions), accidents of kinds, fire, and explosion. The policy(ies) of insurance aforesaid shall cover risk due to "acts of terrorism" for a sum assured equal to the TOTAL CONTRACT PRICE with a loss limit of Rs. [•] million (To be decided based on complexity & nature of work & contract) till PRELIMINARY ACCEPTANCE of PLANT or the issuance of a conditional PRELIMINARY ACCEPTANCE CERTIFICATE (as envisaged under Sub-clause should 20.8 of SCC), whichever is earlier. In case Insurance cover for any specific risk indicated above, is not available in the Insurance market, liability for the same shall be excluded from the CONTRACTOR's scope.
- g) Notwithstanding anything herein provided and notwithstanding the transference of all risks in respect of the MATERIALS to the CONTRACTOR, the ownership in respect of the material shall pass to the OWNER at whichever is the earlier of the following:
- (i) upon delivery to the SITE

(ii) when CONTRACTOR becomes entitled to payment in respect of such MATERIALS and such payment has been made Whenever ownership of MATERIALS passes to the OWNER prior to delivery to the SITE, the CONTRACTOR shall arrange for the MATERIALS to be marked as the OWNER's property and ensure that they are stored and handled appropriately.

52.3 Bills of Materials

52.3.1 The CONTRACTOR shall furnish to the OWNER a detailed Bill of Materials specifying the materials, which on preliminary determination made by the CONTRACTOR, will be required to be incorporated in the permanent works in order to establish the WORKS/ Unit and to operate the PLANT/Unit (to the extent of the mandatory spares), including construction materials.

52.3.2 Each item entered in the Bill of Materials shall be priced, so far as possible, in conformity with the details given in this behalf in the priced bid. The Bill of Materials and said price break-up therein and in the price bid are intended only to form a basis for the purpose of approval of billing schedule and calculating 'on account payments' and for calculating payments due to the CONTRACTOR under Clause 32.0 of GCC upon cancellation of CONTRACT, and for no other purpose.

52.3.3 The OWNER shall review or cause to be reviewed the prima facie adequacy, sufficiency, validity and/or suitability of the materials listed in the Bill of Materials for the works for which they are intended, and of the prices indicated in the Bill of Materials in respect thereof. Such review shall be performed in conjunction with the design, engineering, specification and other technical reviews to be done by the OWNER and all provisions applicable thereto with reference to critical drawings shall be applicable to the review of the Bill of Materials.

The priced Bill of Materials as approved by the OWNER shall constitute the Bill of Materials envisaged in the contract documents. However, no such approval shall, in any manner, absolve the CONTRACTOR of his full responsibility under the CONTRACT to sell and supply to the OWNER at and within the price of materials quoted in the Price Schedule, all materials required for the permanent incorporation in the works and which are required to establish, commission and operate (to the extent of mandatory spares) the PLANT/ Unit in accordance with the CONTRACT and the specifications, complete in all respects including spares, tools, tackles and testing equipment, so far as included within the scope of supply, whether or

not any particular material is actually included within or omitted in the Bill of Materials and whether or not the price thereof is included in the price indicated in the Bill of Materials and whether or not the price thereof is in conformity with the price thereof indicated in the Bill of Materials. The review and approval of the Bill of Materials and the prices therein are intended only for the satisfaction of the OWNER that the priced Bill of Materials, prima-facie covers the materials required to be supplied by the CONTRACTOR within the scope of supply.

- 52.3.4 The Bill of Materials shall be subject to amendment in both items and prices in so far as necessary consequent upon major change in quantity of bulk materials on completion of detail design or any amendment in any relevant related technical particulars, and upon any amendment, the amended Bill of Materials as approved by the OWNER, shall thereafter constitute the Bill of Materials as envisaged in the CONTRACT documents, provided that unless the amendment results from a CHANGE ORDER and/or agreed variation, no such amendment shall anyway impose any liability on the OWNER to pay customs and other import duties in excess of the customs and other import duties payable on the value of imported materials as indicated in the Price schedule but for such amendment.

52.4 Supply of Materials

- 52.4.1 The CONTRACTOR shall supply the MATERIALS required to be supplied within the CONTRACTOR's scope of supply for incorporation in the permanent works in accordance with and to meet the requirements in quality, quantity and other particulars of the descriptions, specification's, plans, drawings, designs and other documents applicable thereto, and the CONTRACTOR shall be deemed to have undertaken that all materials selected, procured and supplied by the CONTRACTOR within the scope of supply shall be of the best quality and workmanship and shall be capable of producing the designed desired results and to perform the designed and desired functions to meet the contractual requirements in all respects for the project.
- 52.4.2 The CONTRACTOR shall undertake and complete the supply of materials within the scope of supply to meet the scheduled progress and requirements of the WORK within the scope of work.
- 52.4.3 Within 30 (thirty) days from the EFFECTIVE DATE OF CONTRACT, the CONTRACTOR shall submit to the OWNER for approval in respect of each work or groups of work, a detailed Delivery Schedule intended for monitoring and controlling

by OWNER in Graphical or other suitable form giving dates of starting and finishing the various supplies relating to the WORK, providing sufficient margin to cover for contingencies. The ENGINEER-IN-CHARGE and the CONTRACTOR shall thereafter, within 14 (Fourteen) days, settle the Delivery Schedule so as to achieve the GUARANTEED COMPLETION DATE.

- 52.4.4 All MATERIALS shall be deemed to have been accepted only when the material is received at the project SITE and accepted by the ENGINEER-IN-CHARGE. Such acceptance shall however, be subject to the terms and conditions hereof, including the right of rejection and/or replacement as elsewhere herein specified.
- 52.4.5 If the CONTRACTOR fails to submit to the OWNER a Delivery Schedule as envisaged above or if the ENGINEER-INCHARGE and the CONTRACTOR shall fail to agree upon the Delivery Schedule as envisaged above, then the ENGINEER-IN-CHARGE shall in consultation with the CONTRACTOR so far as reasonably feasible prepare the Delivery Schedule as best he can and the dates of delivery as fixed by the ENGINEER-IN-CHARGE shall be final and binding upon the CONTRACTOR except as herein otherwise expressly provided. The ENGINEER-IN-CHARGE shall issue the Delivery Schedule so prepared to the CONTRACTOR, and the provisions of Clause 52.4.3 hereof shall apply thereto as though it was an approved Delivery Schedule.
- 52.4.6 Any reference in the CONTRACT documents to the “approved Delivery Schedule” or to the “Delivery Schedule” shall mean the approved Delivery Schedule specified in Clause 52.4.3 above or the Delivery Schedule prepared and issued by the ENGINEER-IN-CHARGE as specified in Clause 52.4.5 above, whichever shall be in existence.
- 52.4.7 Within 7 (Seven) days of the occurrence of any act, event or omission which, in the opinion of the CONTRACTOR, is likely to lead to delay in the commencement or completion of delivery of any particular material or of all material and is such as would entitle the CONTRACTOR for an extension of the time specified in this behalf in the Delivery Schedule(s), the CONTRACTOR shall inform the ENGINEER-IN-CHARGE in WRITING of the occurrence of the act, event or omission and date of commencement of such occurrence. Thereafter, if even upon the cessation of such act or event or the fulfilment of the omission, the CONTRACTOR is of opinion that an extension of time specified in the Delivery Schedule related to particular material(s) or in relation to all materials is necessary, the CONTRACTOR shall within 7 (Seven) days after the cessation or fulfilment as aforesaid make a written request to the

ENGINEER-INCHARGE for extension of the relative time specified in the Delivery Schedule and the ENGINEER-INCHARGE may at any time, prior to completion of the work, extend the relative time of completion in the Delivery Schedule for such period(s) as he considers necessary, if he is of opinion that such act/event/omission constitutes a ground for extension of time in terms of the CONTRACT and that such act/event/omission has in fact resulted in insurmountable delay to the CONTRACTOR. The opinion/decision of the ENGINEER-IN-CHARGE in this behalf and as to the extension necessary shall, subject to the provisions of Clause 52.4.8 hereof, be final and binding upon the CONTRACTOR.

52.4.8 Notwithstanding the provisions of Clause 52.4.7 hereof, the OWNER may at any time after the completion of the work in all respects at the request of the CONTRACTOR made by way of appeal either against a decision of the ENGINEER-IN-CHARGE taken under Clause 52.4.7 or against the ENGINEER-IN-CHARGE's refusal to take a decision under the said clause, if satisfied of the existence of any ground(s) justifying the delay/omission, extend the date of delivery of any materials for such period(s) as the OWNER may consider necessary, and the decision of the OWNER as to the existence or otherwise of any grounds justifying the extension and as to the periods of extension, if any necessary, shall be final and binding upon the CONTRACTOR.

52.4.9 Subject as elsewhere herein or in the CONTRACT documents, otherwise expressly provided, only the existence of FORCE MAJEURE circumstances as defined in Clause 52.4.10 hereof, shall afford the CONTRACTOR a ground for extension of time for delivery of materials, and specifically without prejudice to the generality of the foregoing:

- i) Inclement or unforeseen weather, strike or lock-out (except as provided in Clause 52.4.10), shutdown, third party breach, delay in payment or commercial hardship shutdown or idleness or other impediment in progress or completion of the supply or work due to any reason whatsoever shall not afford the CONTRACTOR a ground for extension of time or relieve the CONTRACTOR of his/its full obligations under the CONTRACT.
- ii) No delay whatsoever in the supply of any material by the CONTRACTOR or any of the CONTRACTOR's vendors, suppliers or SUB-CONTRACTORS shall anyway entitle the CONTRACTOR to any extension of time for completion.

52.4.10 “FORCE MAJEURE” shall mean an event beyond the control of the

CONTRACTOR and not involving the CONTRACTOR’s fault or negligence and not foreseeable as per Clause 33.0 of GCC.

52.4.11 No assurance, representation, promise or other statement by any personnel, Engineer or representative of the OWNER regarding the extension of time for the supply by the CONTRACTOR of any material within the CONTRACTOR’s scope of supply shall be binding upon the OWNER or shall constitute an extension of time for the supply of any material(s) within the provision of Clause 52.4.7 or Clause 52.4.8 hereof, unless the same has been communicated by the ENGINEER-IN-CHARGE to the CONTRACTOR in WRITING under Clause 52.4.7 or under Clause 52.4.8.

52.4.12 Make of Materials

- i) All EQUIPMENT and MATERIALS to be supplied under this CONTRACT shall be from approved vendors as indicated in the FINAL PROPOSAL or as otherwise approved by the ENGINEER-IN-CHARGE / OWNER.
- ii) Where the makes of materials are not indicated in the Bidding document, the CONTRACTOR shall obtain list of vendors from OWNER, evaluate them along with his own list of vendors and shall furnish details of proposed makes and supplies and supply the same after obtaining the OWNER’s/ ENGINEER-IN-CHARGE’s approval.

52.5 Certificate of Verification and Good Condition

52.5.1 The CONTRACTOR shall, before supply of material covered within the scope of supply, at his own risks, costs and initiative, undertake or cause to be undertaken all tests, analysis and inspections as shall be required to be undertaken with regard to the materials under the specifications and any codes, practices, orders and instructions with respect thereto. 52.5.2 On arrival of the material at site the CONTRACTOR shall give written notice thereof to the ENGINEER-IN-CHARGE or Inspection Agency notified by the OWNER in this behalf, to inspect the materials, and shall keep in readiness for inspection, the materials and the relevant tests results, reports and certificates hereto.

52.5.3 Notwithstanding any other provisions in the contract documents for analysis or tests of materials and in addition thereto, the CONTRACTOR shall, if so required by the ENGINEER-IN-CHARGE or Inspection Agency in writing at his own risks and costs prepare a ‘Quality Assurance Plan’ QAP for complete quality check stage wise or

before dispatch and submit to ENGINEER-IN-CHARGE for comments ahead of manufacturing of equipment or other bulk material.

CONTRACTOR will ensure that QAP is followed completely, and reports prepared, for review by OWNER, or its representative inspection agency or witness the compliance if they so desire.

52.5.4 If on Inspection or proof, analysis or tests as aforesaid the ENGINEER-IN-CHARGE or Inspection Agency nominated by the OWNER in this behalf is prima facie satisfied that the material received is in conformity with the material requirements of the Bill of Materials and description given in the shipping documents and in the CONTRACTOR's invoice in this behalf and that the test reports/results/certificates given in respect thereof are prima facie in conformity with the relevant result/reports/certificates required in respect thereof in terms of the specifications and/or relevant codes and practices, and that the material appears to be prima facie in good order and condition, the ENGINEER-IN-CHARGE shall issue to CONTRACTOR, a Certificate of Verification and Good Condition in respect of such material, and this shall constitute the Certificate of Verification and Good Condition elsewhere envisaged in the CONTRACT documents.

52.5.5 Such certificate is only intended to satisfy the OWNER that prima facie the material supplied by the CONTRACTOR is in order and shall not anyway absolve the CONTRACTOR of his/its full responsibility under the CONTRACT in relation thereto, including in relation to specification fulfilment and/or performance or other guarantees.

52.5.6 Notwithstanding that any area(s) or source(s) has/have been suggested by the OWNER to the CONTRACTOR from which any material for incorporation in the WORKS can be obtained, the CONTRACTOR shall independently satisfy himself of the suitability, accessibility and sufficiency of the source(s) of supply suggested by the OWNER with the intent that any suggestion as aforesaid shall not anyway relieve the CONTRACTOR of his full liability in respect of the suitability and quality of the material(s) obtained from said source(s) and the CONTRACTOR shall obtain material(s) therefrom and incorporate the same within the permanent works entirely at his own risks and costs in all respects, with the intent that any such suggestion by the OWNER shall only be by way of assistance to the CONTRACTOR and shall not entail any legal responsibility or liability upon the OWNER.

52.6 Materials in the Contractor's Scope of Supply

52.6.1 The OWNER does not warrant or undertake the provisions of any materials and the CONTRACTOR shall not imply, by conduct, expression or assurance or by any other means, any promise or obligation on the part of the OWNER in his respect understood by the CONTRACTOR.

52.7 Shipping and Other Documents

Imported Supplies:

52.7.1 Without prejudice to any other obligations of the CONTRACTOR under the CONTRACT, and in addition to any other documents required to be furnished by the CONTRACTOR under the CONTRACT, the CONTRACTOR shall, in respect of all items and materials imported into India, obtain and furnish within 7(seven) working days to the OWNER, at his own cost and initiative, the following documents (hereinafter for the sake of brevity collectively referred to as the "the said documents") according to the provisions of the following clauses, namely :

- i) Signed Invoice(s).
- ii) Clean Bill of Lading.
- iii) Packing lists including weights.
- iv) Certificate of origin
- v) Quality Certificate and/or Inspection /Test Report by Supplier and Inspection Certificate by 3rd Party as per QAP approved by owner / ENGINEER-IN-CHARGE or waiver certificate issued by owner / ENGINEER-IN-CHARGE.
- vi) Insurance Certificate covering "All Risks".
- vii) Any other document(s) or literature required for Custom clearance; and
- viii) Phytosanitary Certificate for packing material as per international norms

52.7.2 The Bill of Lading shall be drawn to show the OWNER's concerned project as the consignee, or otherwise as instructed by the OWNER, and shall clearly indicate the Contract Number specified in this behalf by the OWNER, the description of the items/materials giving the dimensions, quantities, weights, and all other details required for Customs clearance of the consignment, and/or as may be specified by the OWNER from time to time in this behalf.

- 52.7.3 The Bill of Lading shall show the gross freight amount and shall either indicate or be accompanied by the carrier's statement of charges and shall carry all other particulars necessary to bind the carrier.
- 52.7.4 The CONTRACTOR shall not less than 7(seven) clear days before the contemplated date of shipment, inform the ENGINEER-IN-CHARGE of the contemplated date of relative shipment of the item(s) or material(s) and of the contemplated date of arrival thereof in India.
- 52.7.5 In addition, within 7(Seven) working days of the date of shipment, the CONTRACTOR shall dispatch, by Air Courier, according to the instructions of the ENGINEER-IN- CHARGE in this behalf, 3 (Three) sets/copies of the said documents.
- 52.7.6 The CONTRACTOR shall also, within 48 (Forty-Eight) hours of shipment, send intimation of shipment by fax or scanned copy by email to the addresses of the OWNER and/or PROJECT MANAGER specified on this behalf.
- 53.7.7 The Invoice shall be drawn in the name of the OWNER and shall state the quantity and detailed description of each item supplied reflecting the value of each item/material and the basis of delivery as CIF.
- 52.7.8 The description of each item/material indicated in the Invoice and the Bill of Lading shall conform to the description of the item/material as given in the relative Import License(s)/Permit(s) issued to the OWNER on this behalf.
- 52.7.9 The Invoice and Bill of Lading shall also indicate on the face of it, the Number, date and validity of the Import License (if the Import License has been revalidated, Number and date of re-validation) against which the Import is being made.
- 52.7.10 Invoice(s) referred to with reference to the said documents are intended merely to comply with customs and Import formalities and will not create any obligation for payment thereof or against unless specifically as provided elsewhere in the CONTRACT.
- 52.7.11 The OWNER reserves the right to vary the said list of documents by addition thereto or subtraction there from and to vary applicable instruction(s) from time to time.

52.8 Packing and Forwarding

52.8.1 Imported Supplies

- a) The CONTRACTOR wherever applicable, shall, after proper painting, pack and crate all materials for shipment in a manner suitable for export to a tropical, humid climate in accordance with internationally accepted export practices and in such a manner so as

to protect them from damage and deterioration in transit by road, rail and/or sea and during storage at the site till the time of erection. Without prejudice to any other liabilities or obligations of the CONTRACTOR, the CONTRACTOR shall be responsible for all damage(s) to the materials due to improper packing.

- b) The CONTRACTOR shall notify the OWNER and ENGINEER-IN-CHARGE of the date of each shipment from the port of embarkation as well as of the expected date of arrival of such shipment at the designated port of arrival only for the OWNER's / ENGINEER-INCHARGE's information.
- c) The CONTRACTOR's notification shall give complete shipping information concerning the weight, size and content of each package and such other information as the OWNER may require.
- d) The packing material used should be duly certified by a Phytosanitary Certificate issued as per international norms and accompanied by a certificate of country of origin. In case, MOC of any catalyst, chemicals, adsorbents or other items like radioactive source, nucleonic devices, etc. falls under dangerous goods classification, the declaration and all required documents for the custom clearance shall be in the CONTRACTOR's scope and CONTRACTOR shall indemnify the OWNER of any risk/litigation arising out of the same.

52.8.2 Indigenous Supplies

- a) The CONTRACTOR shall, wherever applicable, after proper painting, pack and crate all items in such a manner as to protect them from deterioration and damage during rail and road transportation to the site and during storage at the site till the time of erection. Without prejudice to any other liabilities or obligations of the CONTRACTOR, the CONTRACTOR shall be responsible for all damage(s) due to improper packing.

Contractor shall take special care in packing and crating of fragile items like switchgear, instrument, electrical & instrument panels where even minor corrosion or accumulation of corrosion product is detrimental in satisfactory performance of the item for intended use.
- b) The CONTRACTOR shall notify OWNER/ ENGINEER-IN-CHARGE of the date of each shipment from the works and expected date of arrival at the site for the information of OWNER/ ENGINEER-IN-CHARGE.

- c) The CONTRACTOR's notification shall also give all shipping information concerning the weight, size and content of each packing and such other information as the OWNER/ ENGINEER-IN-CHARGE may require.
- d) Three copies of the following documents shall be sent to the OWNER/ ENGINEER-IN-CHARGE within 3 (three) days from the date of shipment:
 - Invoice
 - Packing List including weights
 - Supplier's Quality Certificate / Test Certificate
 - Railway Receipt/Lorry Receipt
 - Insurance Certificate or copy of MCE Policy
 - Third Party Inspection Release Note or Inspection Certificate as per QAP approved by OWNER/ ENGINEER-IN-CHARGE or waiver certificate issued by OWNER / ENGINEER-IN-CHARGE.

52.9 Equipment

52.9.1 The CONTRACTOR shall be exclusively responsible to arrange for importation into India in its own name on drawback or re-export or other basis all equipment, tools and tackle etc., if any, required to be imported into India for the purposes of the WORK and to pay and bear the customs, import and other duties and levies (if any) payable thereon or in respect thereof, and will be solely responsible for the timely and proper compliance of all applicable terms and conditions and formalities relative thereto.

52.9.2 The CONTRACTOR shall within 28 (Twenty Eight) days from the date of receipt of Acceptance of Bid, furnish to the ENGINEER-IN-CHARGE a list of the said equipment which he proposes to import into India on a draw-back/re-export basis for the purposes of the work, together with complete details thereof. The OWNER may without obligation or responsibility, furnish to the Import Licensing Authorities in India its recommendations relative to import of such equipment which the OWNER considers necessary for the work and extend help if necessary.

52.10 Miscellaneous Imports

52.10.1 The CONTRACTOR shall be exclusively responsible at his own costs and initiative to arrange for importation into India, to import into India, to pay Custom duties and Port and other charges and levies, to clear from Customs and to transport to job site all consumables, spares for the CONTRACTOR's equipment and other materials and things whatsoever not covered under the OWNER's obligation.

52.10.2 Any obligation undertaken or recommendation, facility or assistance provided by the OWNER to the CONTRACTOR for or in relation to the importation of any equipment or material whatsoever into India by or on behalf of the CONTRACTOR pursuant to the provisions hereof or otherwise shall be without any responsibility or liability whatsoever upon the OWNER and without right in the CONTRACTOR to raise any claim or demand or to seek extension of time on account of any delay or failure on the part of the OWNER or any delay or failure by the CONTRACTOR in obtaining Import License(s) and/or permits for importation thereof into India.

52.10.3 All materials and equipment Imported into India by or on behalf of the CONTRACTOR for and in connection with the WORK shall be utilised only for and relative to the performance of the WORK covered by the CONTRACT.

52.10.4 Upon completion of the works, the CONTRACTOR shall within the scope of work remove from the job site all the equipment and temporary works remaining thereon.

52.10.5 All EQUIPMENT, MATERIALS and temporary works shall at all times be and remain at the risk of the CONTRACTOR to the extent of CONTRACTOR's liability for damage to the PLANT as per clause 7.2.3 of GCC.

52.11 MATERIAL AND EQUIPMENT SUPPLIED BY THE OWNER

Only under special circumstances and at the sole discretion of the owner, the OWNER may supply certain proprietary materials or as requested by the CONTRACTOR (Clause 23.0). The supply of equipment and materials to the CONTRACTOR shall be on the following terms and conditions:

- a) It shall be the responsibility of the CONTRACTOR at his own risks and costs to take delivery of the materials from the stores, factory, rail head or other designated collection point, and to arrange for its loading, transportation to job site and unloading at the job site or other place of storage.
- b) The CONTRACTOR shall inspect the equipment and materials at the time of taking delivery thereof and satisfy himself of the quality, quantity and condition thereof prior to taking delivery and the OWNER shall not be liable for any claims or complaints whatsoever in respect of quality, quantity or conditions of the equipment or materials once the CONTRACTOR has taken delivery thereof, except for established latent defects which could not be determined at the time of delivery.
- c) The CONTRACTOR shall on receiving and opening the packing cases or other packaging of equipment and material on behalf of the OWNER, verify and tally

the actual contents with the packing list and bring any discrepancies to the notice of the ENGINEER-IN-CHARGE. The CONTRACTOR shall also sort out and segregate and handover to the OWNER's stores, the Instruction Manuals, Operation and Maintenance Manuals, Special Maintenance Tools, Erection Spares, Commissioning Spares, and Maintenance Spares and other extras, if received with the equipment/ materials.

- d) The CONTRACTOR shall furnish to the ENGINEER-IN-CHARGE sufficiently in advance a detailed statement showing its requirement of all types and quantities of equipment and materials agreed to be supplied by the OWNER, indication of the time when relative types and quantities thereof shall be required by him for the works so as to enable the OWNER to verify the quantities of materials specified by the CONTRACTOR and to enable the OWNER to make arrangements for supply thereof.

53.0 UTILITIES, CONSUMABLES, LAND AND OTHER TEMPORARY FACILITIES

- a) It shall be the responsibility of the CONTRACTOR to procure, arrange and provide within the scope of work explicitly defined in Clause 3.2 of SCC, all utilities, consumables, land and other temporary facilities necessary for performance of the WORK including (but not limited to) water (including inhibited / de-ionized water for hydrostatic testing, if any), power and any additional land at or about the job site(s) required for the CONTRACTOR's field office(s), camps, godown(s), workshops and residential accommodation for CONTRACTOR's staff, quarry rights, borrow areas and access roads to or about the job site(s) and CONTRACTOR's offices, camps, godown(s), workshops, accommodations, and temporary works and facilities whatsoever.
- b) The OWNER does not warranty or undertake the provisions of any facility aforesaid or otherwise whatsoever to the CONTRACTOR or assistance in obtaining, procuring the same or other assistance whatsoever for or in the performance or testing the work(s) and the CONTRACTOR shall not imply by conduct, expression or assurance or by any other means any promise or obligation on the part of the OWNER contrary to the provisions hereof, and any such promise or obligation understood by the CONTRACTOR shall not be binding upon the OWNER.
- c) Any assistance which the OWNER renders to the CONTRACTOR, in terms hereof or otherwise relative to the work by provision of any facility, water, power, transportation, tools, vessels, vehicles, construction and/or testing equipment

and machinery, provision of land for quarries or borrow areas or for CONTRACTOR's Office, godown(s), workshop(s) or accommodations and/or access road(s) or otherwise howsoever in the performance or testing of the work(s), shall be, without any attendant obligation upon the OWNER or liability on the OWNER for any failure, omission, delay or refusal in providing or continuing to provide the same, and shall not for any cause afford a basis of defense to the CONTRACTOR for any breach by the CONTRACTOR of any of his obligations under the Contract or a ground for extension of time for completion.

- d) The CONTRACTOR shall be and remain at all times exclusively responsible within the scope of work to provide all utilities, consumables, permits, licenses, easements and facilities and other items and this whatsoever required for or in connection with the work, including but not limited to those indicated by expression or implication in the bid documents and/or other contract documents or howsoever otherwise as shall be or may from time to time be necessary for or in connection with the work
- e) The supply of the first charge of oils, greases, lubricants, first charge of proprietary solvent & specialty chemicals, corrosion inhibitors, promoters, activators, anti-foam compounds, desiccants, adsorbents, molecular sieves, catalysts, resins, activated carbon, inert (alumina) balls / tiles / lumps, filter media, etc required in various sections / units of subject Plants as well as Offsite facilities are included in the CONTRACTOR's scope.

53.1 POWER SUPPLY

- 53.1.1 Without prejudice to the provisions of Clause 53 hereof and following clauses thereunder, as and when adequate power supply becomes available for the site, the OWNER may, at its discretion provide for supply of power to the CONTRACTOR for the work from the OWNER's convenient & nearest substation, from which source the CONTRACTOR shall at his own cost and initiative make arrangements for temporary distribution of power to CONTRACTOR's work(s) at the site.
- 53.1.2 All arrangements for the distribution of power from source aforesaid and the work relative thereto shall be made, performed and/or installed in conformity with Indian Electricity Act and other applicable Laws and Regulations governing the supply and transmission, distribution of electricity and shall be subject to prior approval by the EIC.

53.1.3 The OWNER shall recover from the CONTRACTOR for the power consumed by the CONTRACTOR from the OWNER's source(s) of supply the cost thereof to the OWNER as determined by the OWNER in this behalf from time to time. The amount due to the OWNER in respect of such power supplied shall, without prejudice to any other mode of recovery available to the OWNER, be deductible from the Running Account / Final Bill(s) of the CONTRACTOR and/or any monies due or becoming due to the CONTRACTOR from time to time.

53.1.4 The CONTRACTOR shall provide at his own cost suitable electric meters certified by State Electricity Board or other authority approved by the ENGINEER-IN-CHARGE for measurement of the power units supplied to the CONTRACTOR for determination of the amount due thereon to the OWNER. Such meters shall be under the custody and control of the OWNER.

53.1.5 In the event of failure or defect or non-provision of meter(s), power charges shall be calculated on the consumption determined by the ENGINEER-IN-CHARGE (whose decision shall be final both as regards the existence of a defect or failure and as regards the power consumed) and shall be based on source capacity utilised @ 14 hours/day.

53.2 WATER SUPPLY

53.2.1 Without prejudice to the provisions of Clause 53.0 hereof and the following clauses thereunder in the event of the OWNER having adequate source of water supply at the site available for distribution, the OWNER may at its discretion provide water to the CONTRACTOR for the work from the OWNER's source of supply. The CONTRACTOR shall, at CONTRACTOR's own cost and initiative provide suitable pumping installations and piping for the transportation of water to and distribution at the CONTRACTOR's place or work.

53.2.2 Such installations, pipes and other equipment shall be laid out/installed by the CONTRACTOR only with the prior approval of the Engineer-in-Charge so as not to interfere with the layout and progress of the other construction work at the site and access to or about the job site.

53.2.3 The CONTRACTOR shall forthwith on completion of the work or earlier determination of the Contract or during the execution of the work(s), if so required by the Engineer-in-Charge, on grounds of hindrance or obstruction caused thereby or other cause whatsoever at his/ its own cost and initiative remove or re-

route, as the case may be, any installation, pipes and/or other equipment put up or erected by the CONTRACTOR for the transportation and/or distribution of water, and fill any trenches, ditches or other excavations done by the CONTRACTOR for the purpose thereof and restore the site to the same condition in which it was prior to the installation.

53.2.4 The OWNER shall recover from the CONTRACTOR, for water supplied to the CONTRACTOR from OWNER's source of supply at the cost thereof to the OWNER as determined by the OWNER in this behalf from time to time. The amount due to the OWNER in respect thereof shall (without prejudice to any other mode of recovery available to the OWNER) be deductible from the Running Account and Final Bill(s) of the CONTRACTOR and/or payments due or becoming due to the CONTRACTOR from time to time.

53.2.5 The CONTRACTOR shall provide at his own cost and initiative suitable water meters approved by the ENGINEER-IN-CHARGE for measurement of the water units supplied to the CONTRACTOR for determination of the payments due in this behalf to the OWNER. Such meters shall be under the custody and control of the OWNER.

53.2.6 In the event of failure or defect or non-provision of meters, water charges will be calculated on the consumption determined by the Engineer-in-Charge (whose decision shall be final both as regards the existence of a defect or failure and as regards the water consumed) and shall be based on size of pipelines / pressure and consumption @ 14 hours/day.

53.3 LAND

53.3.1 Without prejudice to the provision of Clause 53.0 hereof and following Clauses there under, the OWNER may at its discretion and convenience, if it has sufficient available land at its disposal, provide land to the CONTRACTOR near or about any job site, for the construction of the CONTRACTOR's field office(s), godown(s), workshop(s), assembly yard, residential accommodation and/or temporary works or any of them required for/or in connection with the execution of the works.

53.3.2 The CONTRACTOR shall at his own cost and initiative construct temporary buildings or other accommodation or works necessary and make suitable arrangement for water and power supply thereto and for provision of sanitary, drainage and de-watering arrangements in respect thereof in accordance with plans/designs, layouts previously approved by the Engineer-in-Charge in this behalf.

53.3.3 Any land provided by the OWNER to the CONTRACTOR within the provisions

hereof shall be strictly on a license basis, and shall not create any right, title or interest whatsoever in the CONTRACTOR therein or in respect thereto.

53.3.4 Notwithstanding anything herein provided, the OWNER reserves the right at any time during the pendency of the work to call upon the CONTRACTOR to vacate the land or any part thereof on giving 7 (Seven) days' written notice to the CONTRACTOR in this behalf.

54.0 MEASUREMENTS, CERTIFYING INSPECTIONS AND PAYMENTS

54.1 Final Measurements

54.1.1 Within 15 (fifteen) days from the date of issue of Final Test Certificate in respect of the WORK, or of any portion of the WORKS, section, group or job site, as the case may be, Final Measurements for the WORKS covered by the Final Test Certificate shall be jointly taken by the ENGINEER-IN-CHARGE and the CONTRACTOR as herein provided.

54.1.2 If the CONTRACTOR fails to apply to the ENGINEER-IN-CHARGE for Final Measurements within 15 (fifteen) days from the date of relative Final Test Certificate as specified in Clause 54.1.1, the ENGINEER-IN-CHARGE shall notify the CONTRACTOR in WRITING of the date(s) for Final Measurements, and require the CONTRACTOR to be present on date(s) so notified.

54.2 Mode of Measurement

54.2.1 Mode of measurement shall be mile-stone based or actual measurement of works as agreed during finalisation of Billing Schedule. In case of actual measurement following system will be broadly followed. All measurements shall be recorded in the metric system and shall be taken in accordance with the procedures set forth or provided for in the Schedule of Rates, Specifications and other CONTRACT Documents.

54.2.2 Where the mode of measurement is not provided for in the CONTRACT Documents in respect of any item of work, it shall be measured in accordance with the Indian Standard Specification (latest edition) and in the event of such item not being covered by Indian Standard Specifications, it shall be measured in accordance with the method of measurement in this behalf specified by the ENGINEER-IN-CHARGE, whose decision in this regard shall be final and binding upon the CONTRACTOR.

54.2.3 All measurements shall be taken jointly by the ENGINEER-INCHARGE and the CONTRACTOR or their respective representatives. The CONTRACTOR or his

authorized representative shall be entitled to remain present at all times when joint measurements are being taken.

54.2.4 Despite due intimation, if the CONTRACTOR omits or fails to be present to witness joint measurements, the measurements shall be taken in the presence of the ENGINEER-INCHARGE and the measurements so recorded and signed by the ENGINEER-IN-CHARGE as correct, shall be final and binding upon the Parties.

54.2.5 Except in cases covered by Clause 54.2.4, in all other cases measurements shall be signed and dated on each page by the CONTRACTOR / CONTRACT MANAGER and ENGINEER-INCHARGE or his representative.

54.3 Certifying Inspections

All provisions referred to in Clauses 54.1 to 54.2, in respect of Mode of Measurement, shall apply to all inspections required to be made in order to qualify the CONTRACTOR for any payment(s) under the CONTRACT and any reference in the said clauses to measurements shall, for the purpose of this clause, be deemed to be a reference to certifying inspections and any reference therein to the measurement book shall, for the purpose of this clause, be deemed to be a reference to the certifying inspection book.

54.4 Final Bill

54.4.1 On the basis of the TOTAL CONTRACT PRICE provided in the CONTRACT, the CONTRACTOR shall prepare a Final Bill in the prescribed form with reference to the total supplies covered by the scope of supplies and shall prepare a separate Final Bill with reference to the total services covered by the scope of services. Such Bill shall be prepared by applying the price of materials specified in Price Schedule in respect of supplies broken up with respect to the indigenous materials and with respect to imported materials (including plant, parts and components) in accordance with the break-up of the Price of Materials given the Price Schedule and the various formats there under, and by applying the price of services specified in the Price Schedule in respect of works/services broken up with respect to the various heads of services/works in accordance with the break-up of the Price of services given the Price Schedule and the various formats there under. Additions claimed to the TOTAL CONTRACT PRICE or reductions there from resultant upon any CHANGE

ORDER(S) shall be separately indicated in the Final Bill with reference to the relative CHANGE ORDER(S).

- 54.4.2 The Final Bill shall, in addition to the payment entitlements arrived at according to the provisions of Clause 54.4.1 hereof separately state, include therein all claims of the CONTRACTOR if any with full particulars of the nature of such claim, grounds on which it is based and the amount claimed.
- 54.4.3 The Final Bill drawn in accordance with Clause 54.4.1 shall be submitted (in a form approved by the OWNER) together with the PRELIMINARY ACCEPTANCE CERTIFICATE to the ENGINEER-IN-CHARGE for certification, who shall certify the Final Bill, if drawn in accordance with Clause 54.4.1. After certification of the ENGINEER-IN-CHARGE, the Final Bill shall be submitted in quadruplicate (or in such other number of copies as the OWNER may prescribe) accompanied by the PRELIMINARY ACCEPTANCE CERTIFICATE to the OWNER for payment.
- 54.4.4 All monies payable under the CONTRACT for WORKS to be performed and MATERIALS to be supplied up to and including successful completion and final tests and commissioning of the system and performance tests shall become due and payable to the CONTRACTOR only after submission to the OWNER of the Final Bill prepared in accordance with the provisions of Clause 54.4.1 hereof and associated provisions there under accompanied by the PRELIMINARY ACCEPTANCE CERTIFICATE in respect of the WORKS.
- 54.4.5 Payments of the amount(s) due on the Final Bill to the extent certified by the ENGINEER IN-CHARGE, shall be made within 84 (Eighty Four) days from the due date as specified in Clause 54.4.4 hereof, subject to the deductions provided in Clause 54.4.6.
- 54.4.6 All payments due to the CONTRACTOR on the Final Bill shall be subject to deduction of “on account” payments and other amounts due from CONTRACTOR to the OWNER, tax deductions as provided for in Clause 54.7.2 and associated clauses there under, and any other deduction provided for herein or agreed to between the parties or required to be made under any law, rule or regulation having the force of law for the time being applicable, or elsewhere provided for in the CONTRACT documents.

54.5 Price Schedule

54.5.1 The remuneration determined due to the CONTRACTOR as provided for in Clause 54.4.1 hereof shall constitute the entirety of the remuneration and entitlement of the CONTRACTOR in respect of the WORK under the CONTRACT, and no further or other payment whatsoever shall be or become due or payable to the CONTRACTOR under the CONTRACT.

54.5.2 Without prejudice to the generality of the provisions of Clause 54.5.1 hereof, the Price Schedule and TOTAL CONTRACT PRICE shall be deemed to include and cover (unless otherwise expressly specified to the contrary in any CONTRACT document(s)):

- a) All costs, expenses, outgoings and liabilities of every nature and description whatsoever and all risks whatsoever (foreseen or unforeseen, including FORCE MAJEURE) to be taken or which may occur in or relative to execution, completion, testing, commissioning and/or handling over the WORKS to the OWNER and/or in or relative to acquisition, loading, unloading, transportation, storing, working upon, using, converting fabricating, or erecting any item, equipment, system, material or component in or relative to the WORKS, and the CONTRACTOR shall be deemed to have known the nature, scope, magnitude and the extent of the works and items, MATERIALS, EQUIPMENT, and components required for the proper and complete execution of the Works though the CONTRACT documents may not fully and precisely set out, describe or specify them, and the generality hereof shall not be deemed to be anywise limited, restricted or abridged because in certain cases the CONTRACT documents or any of them shall or may and/or in other cases they shall or may not expressly state that the CONTRACTOR shall do or perform any particular labour or service or because in certain cases the CONTRACT documents state that a particular work, operation, supply, labour or service shall be performed/made by the CONTRACTOR at his own cost or without additional payment, compensation or charge or without entitlement of claim against the OWNER or words to similar effect, and in other cases they do not, or because in certain cases it is stated that the same are included in or covered by the Price Schedule and in other cases it is not so stated.
- b) The cost of all construction and related vessels, craft, vehicles, movements, plant, equipment, distribution of water and power, construction of temporary roads and access, temporary works, pumps, wiring, pipes, scaffolding, piling, shuttering and other materials, supervision, labour, insurance, fuel, stores, spares, supplies,

appliances and materials, items, articles and things whatsoever (foreseen or unforeseen) by expression or implication to be supplied, provided or arranged in or relative to or in connection with the performance and/or execution of the WORKS and/or related or incidental thereto, complete in every respect in accordance with the CONTRACT document, and the plans, drawing, designs, orders and/or instructions;

- c) The cost of mobilisation including but not limited to mobilization of vehicles, movements, machinery, equipment, gear, tools, tackle, consumables and other items and goods and personnel necessary for or to perform the WORKS contemplated under the CONTRACT, preparation and erection of work yards and other work places and facilities necessary for or to perform the WORKS contemplated under the CONTRACT and/or to supply the material included within the scope of supplies including all work, labour, inputs, goods, EQUIPMENT, and other items and things whatsoever necessary for the performance of the WORKS, dismantling and/or removal of the same and restoration of the SITE, lifting the materials and transporting them to CONTRACTOR's stock piles/work yard, job sites and loading, stacking and/or storing the same.
- d) The costs and risks of all rents, royalties, licenses, permits, permission and other fees, duties, penalties, levies, and damages whatsoever payable for or in respect of any protected or patented goods, materials, equipment or processes employed in or relative to the works and of all rents, royalties, licenses, permits, permissions and any other fee, duty, penalty, levy, loss or damages payable on the excavation, removal or transportation of any material or acquisition or use of any right of way or other right, licenses, permit, privilege, permission or uses required for or relative to the performance of the WORK.
- e) The cost of all sales taxes and/or octroi or terminal taxes payable in India with regard to materials supplied by the CONTRACTOR within the scope of supplies, all customs and import duties, excise duties, Indian Income Tax, Sales Tax and other direct and indirect taxes and duties, quay, wharfage, demurrage, detention and landing charges and all other duties, taxes, fees, charges, levies, and/or cesses whatsoever imposed or to be imposed by the Central Government or State Government or Municipal or Local Bodies or other Authorities whatsoever and payable on any materials supplied and/or on works performed without any entitlement to the CONTRACTOR for any exemption, remission, refund or reduction thereof.

- f) The cost of all indemnities under the CONTRACT, and insurance premiums on insurance required in terms of the CONTRACT documents or otherwise under any law, rule or regulation, and the cost of all risks whatsoever (foreseen and unforeseen) including but not limited to risks of delay or extension of time or reduction or increase in the work or scope of work and/or cancellation of CONTRACT, and/or accident, strike, civil commotion, war, strike, labour trouble, third party breach, fire, lighting, inclement weather, storm, tempest, flood, earthquake and other acts of God, Government regulation or imposition or restriction, dislocation of road, rail, sea, air and other transport, access or facility, flooding of site and/or access roads and approaches thereto, suspension of work, sabotage and other cause whatsoever.
- g) The cost of all inspections, tests and certificates relative thereto including third party tests and/or inspections where necessary, and of items, instruments, plant and/or tools and appliances required to conduct such inspection and tests.
- h) The cost of all materials supplied and/or intended for incorporation in the WORKS supplied within the scope of work, delivery thereof to the job site, loading, transportation and unloading thereof, waste on materials, and return of empties and surpluses.
- i) The cost of all escalations (foreseen and unforeseen) including but not limited to increase in labour costs and material costs and other inputs whatsoever.
- j) All supervision charges, establishment's overheads, finance charges and other costs and expenses and charges to the CONTRACTOR, and the CONTRACTOR" profit of and relative to the work and/or supply.
- k) The cost of all deductions, reductions, discounts, adjustments and withholdings whatsoever under or in connection with the CONTRACT.

54.5.3 The rates stated in the Price Schedule and the lump sum price(s) shall not be subject to escalation or increase for any reason whatsoever unless otherwise provided in the CONTRACT documents.

54.6 Advance and On Account Payment

54.6.1 Without prejudice to the provisions of Clause 54.-4.- 4 hereof, the OWNER shall by way of assistance to the CONTRACTOR, make "advance" or "on account" payments to the CONTRACTOR during the progress of the work and/or supply on the basis of

Running Account Bills or otherwise as elsewhere more specially provided for in the CONTRACT documents.

54.6.2 The following provisions shall apply with respect to “advance” payments to the CONTRACTOR:

- (a) Advance(s) paid to the CONTRACTOR shall be subject to the terms specified in the SPECIAL CONDITIONS OF CONTRACT and shall be adjustable (without prejudice to the any other mode of recovery) from the Running Account Bills of the CONTRACTOR as provided in the SPECIAL CONDITIONS OF CONTRACT.
- (b) The advances paid to the CONTRACTOR shall be used for execution of this contract only and the CONTRACTOR shall certify that satisfy the OWNER in this regard whenever required. If it is found that an advance has been utilised by the CONTRACTOR in whole or part for any other purpose, the OWNER may at its discretion forthwith recall the entire advance and, without prejudice to any other right or remedy available to the OWNER, recover the same by recourse to any Bank Guarantee(s).

54.6.3 The approved Bill of Materials shall form the basis for the calculation of “on account” payments with respect to supplies of materials. It is to be understood by CONTRACTOR that the Bill of Materials or approval thereof by the OWNER shall not in any way relieve the CONTRACTOR of its full responsibility to supply to the OWNER within the scope of supply, any and all materials whatsoever required for the performance of the WORK within the scope of work, or otherwise howsoever confine the responsibility of the CONTRACTOR within the scope of supply to the supply of MATERIALS indicated in the Bill of Materials, nor shall it otherwise be assumed or be deemed or construed as an acceptance by the OWNER of the adequacy or sufficiency of the MATERIALS listed in the Bill of Materials to meet the quantitative and/or qualitative requirements of the materials required to be supplied by the CONTRACTOR under the scope of supply or otherwise in any manner operate to bind the OWNER or to limit the liability of the CONTRACTOR, such Bill(s) of Materials being designed only to provide a basis for making “on account” payments to the CONTRACTOR for materials supplied, with a view that the OWNER shall make “on account” payments to the CONTRACTOR for the various materials supplied on the basis thereof in the manner and at the time in this behalf provided for in the CONTRACT.

54.6.4 The approved Schedule of Activities shall form the basis for the calculation of on account payments with respect to services/works performed by the CONTRACTOR.

It is however understood that the Schedule of Activities or approval thereof by the OWNER shall not in any way relieve the CONTRACTOR of his full responsibility to perform within the scope of services/WORKS whatsoever is required for the performance of the WORK covered by the scope of work or otherwise however confine the responsibility of the CONTRACTOR to the performance of the services indicated in the Schedule of Activities, nor shall otherwise be assumed or be deemed or construed as an acceptance by the OWNER of the adequacy or sufficiency of the WORK/activities listed in the Schedule of Activities to meet the quantitative and/or qualitative requirements of services required to be performed or WORK required to be done by the CONTRACTOR under the scope of services or otherwise in any manner operate to bind the OWNER or to limit the liability of the CONTRACTOR, such Schedule of Activities being designed primarily to provide a basis for making On Account payments to the CONTRACTOR for works/services performed, with a view that the OWNER shall make “On Account” payments to the CONTRACTOR for the work/services performed on basis thereof in the manner and at the time in this behalf provided for in this CONTRACT.

54.6.5a) For the purposes of making “on account” payments for the WORK performed, monthly or otherwise as the ENGINEER-IN-CHARGE may specify in this behalf, the CONTRACTOR shall make a milestone based quantitative assessment of the WORK performed by the CONTRACTOR as listed in the Schedule of Activities during the preceding month or other specified period and shall submit a Running Account Bill (in the form prescribed by the OWNER) in quadruplicate to the ENGINEER-INCHARGE for the WORKS performed during the said month/period with detailed measurement thereof, the said Running Account Bill(s) to be drawn by applying the rates applicable under the Schedule of Activities to the applicable items, which shall be subject to certification by the ENGINEER-INCHARGE specified for the purpose. The ENGINEER-IN-CHARGE shall thereafter have a summary verification undertaken of the quantities entered in the Running Account Bills and shall certify the Running Account Bills for payments on basis of such verification.

54.6.5b) For the purpose of making “On Account” payment for materials supplied within the scope of supply other than payments made in advance monthly or otherwise as the ENGINEER-IN-CHARGE may specify in this behalf, the CONTRACTOR shall make a quantitative list of material supplied by the CONTRACTOR within the scope of supplies at the job site and of the “On Account” payment made in respect thereof prior thereto, and of the “On Accounts” payment(s) becoming due in respect thereof

during the preceding month or other specified period as the case may be supported by the Certificate of Verification and Good Condition given by the ENGINEER-IN-CHARGE in order to qualify for the relative on account payment claimed as due. The CONTRACTOR shall submit such assessment in the form of a Running Account Bill prepared in the format prescribed or approved by the OWNER in this behalf in quadruplicate to the ENGINEER-IN-CHARGE. The Running Account Bill(s) shall be drawn by applying applicable parts of the price(s) for relative materials as indicated in the Bill(s) of materials for the applicable item(s) and shall be subject to certification by the ENGINEER-INCHARGE. The ENGINEER-IN-CHARGE shall thereafter have a summary verification undertaken of the materials and quantities entered in the Running Account Bill(s) and of the amount claimed and shall certify the Running Account Bill(s) for payment on the basis of such verification.

54.6.6 The amount certified for payment by the ENGINEER-INCHARGE on any Running Account Bill within the provisions for “on account” payments in the CONTRACT documents shall be conclusive for the determination of any “on account” payments and no claim shall be entertained by the OWNER contrary thereto or in contradiction thereof.

In any certificate for on account payment, the ENGINEER-IN-CHARGE shall be authorised to adjust in whole or part, any previous amount certified by error.

54.6.7 All “on account” payments shall be subject to deduction of previous payments on account and of all claims of the OWNER, adjustments and/or deductions provided for in the CONTRACT or agreed to between the parties, tax deductions and any other deductions required to be made under any law, rule or regulation for the time being in force. (a) All “advance” and “on account” payments shall be regarded merely as advance payments against the amounts due to the CONTRACTOR in terms of the CONTRACT, and any such payments shall be without prejudice to the full rights of the OWNER under the CONTRACT and the liabilities of the CONTRACTOR thereunder, and specially shall not be regarded as an acceptance or completion of any works or the acceptance of any materials paid for in terms of any Running Account Bill or otherwise, notwithstanding any verification or certification by the ENGINEER-INCHARGE or otherwise in respect thereof.

(b) Except as elsewhere herein to the contrary provided, the Schedule of Activities or Bill of materials or other criterion applied by the CONTRACTOR in respect of any work or supply in his Running Accounts Bill(s) or acceptance thereof by the ENGINEER-INCHARGE in verifying the bill in respect of such work or supply or

criterion applied shall not be deemed to be binding upon the OWNER as determining the completeness, acceptance or price payable for relative work or supply.

54.6.8 Notwithstanding anything elsewhere provided in the CONTRACT documents, all advances made by the OWNER to the CONTRACTOR shall forthwith become repayable to the OWNER in the event of the CONTRACT being terminated for any cause except any amount due to the CONTRACTOR for the WORK performed by CONTRACTOR before the effective date of such termination and duly certified by ENGINEER-IN-CHARGE. However, should the termination of CONTRACT be for OWNER's convenience and consequently OWNER cancels the remaining part of the WORK, OWNER shall pay to CONTRACTOR the amount for WORK performed by CONTRACTOR before the effective date of such termination plus a mutually agreed amount for partially completed jobs.

54.7 Mode of Payment and Tax Deductions

54.7.1 All payments made under or in terms of the CONTRACT, payable in Indian currency, shall be paid by crossed "Account payee" cheque sent to the office of the CONTRACTOR notified in

this behalf by the CONTRACTOR by courier. All cheques drawn shall be payable at the designated office of the OWNER's bankers and in no case will the OWNER be responsible if the cheque is mislaid, misappropriated or otherwise lost or stolen.

However, payment can also be made through Electronic Fund Transfer mechanism (EFT), on request of CONTRACTOR and approval of ENGINEER-IN-CHARGE. Any additional cost in the form of Bank Charges, if applicable, shall be borne by CONTRACTOR. Three small bills or amount from one bills shall be transferred on Trial basis in regular banking hour, beyond banking hours and off-day of banks and outcome studied by CONTRACTOR and after both parties are satisfied with the outcome regular transfer of bill amount shall be undertaken.

54.7.1.1 Subject to the other provisions hereof, if the execution of the WORKS or the supply of the materials shall necessitate the importation into India of MATERIALS, PLANT or EQUIPMENT executed by labour from outside India or if any other circumstances exists as shall render this necessary or desirable, a portion of the payments to be made under the CONTRACT shall be made in the appropriate foreign currencies as requested in the CONTRACTOR'S bid and accepted by the OWNER.

54.7.1.2 On written request from the CONTRACTOR, the payments by the OWNER to the CONTRACTOR may be made by wire transfer to an account or accounts to be designated by the CONTRACTOR and maintained by the CONTRACTOR with a bank or banks in India in relevant bank account is located in respect of the Dollar/Home Currency payments, and shall be deemed to have been fully discharged when deposited in Dollars/Home Currency or Rupees as the case may be, in the account or accounts designated by CONTRACTOR as aforesaid, provided that, once all acts necessary to initiate the relevant wire transfer have been completed within the time specified for such payment, any delays within the international or domestic banking system in the transfer of such payments to CONTRACTOR's account or accounts shall not give rise to a claim that OWNER has breached its payment obligations hereunder. If funds are not received in the account or accounts designated by CONTRACTOR, OWNER will furnish upon CONTRACTOR's written request, documentary substantiation that all steps necessary to initiate the transfer of such funds have been taken by OWNER's bank or banks. All costs associated with such wire transfer and incurred in India shall be for OWNER's account, and all other costs shall be borne by the CONTRACTOR.

54.7.2 The CONTRACTOR shall be primarily responsible for the payment of all Indian Income tax. 54.7.2.1 It is to be understood that in terms of the Indian Law, the OWNER is responsible also to deduct at source Indian Income Tax at prescribed rates on any money paid or payable by the OWNER to a non-resident CONTRACTOR. With this in view, the following stipulations shall apply with respect to payments to non-resident CONTRACTOR.

- i) The CONTRACTOR shall promptly apply for instructions from Income Tax Authorities in India of the rate at which deductions of tax at source shall be made by the OWNER on payments to the CONTRACTOR. Any information required by the OWNER or Income Tax Authorities for such instructions shall promptly be furnished by the CONTRACTOR, in the form (if any) required. Pending such instructions, the OWNER shall not release any payment to non-resident CONTRACTOR.
- ii) The amount(s) deductible at source by way of Indian Income Tax in accordance with the instructions of the Indian Authorities or otherwise as aforesaid shall be deducted from all amounts payable by the OWNER to the CONTRACTOR.

- iii) The amounts deducted shall be paid by the OWNER directly to the Income Tax Authorities on behalf of the CONTRACTOR.
 - iv) In the event of the amounts deducted being found ultimately to be in excess of the Indian Income Tax assessed, the CONTRACTOR shall be exclusively responsible to apply for and collect the refund thereof from the Income Tax authorities concerned in this behalf.
 - v) In the event of the amount deducted being found to be less than the Indian Income Tax payable on assessment or otherwise, the CONTRACTOR shall forthwith pay the short-fall to the concerned Indian Income Tax Authorities, and shall indemnify and keep indemnified the OWNER from and against all claims and recoveries against the OWNER relative thereto.
- 54.7.2.2 The CONTRACTOR shall be exclusively liable to pay directly to the concerned Income Tax Authorities in India and to bear all Indian Taxes payable relative to employment of any personnel by the CONTRACTOR.
- 54.7.2.3 Payments to a non-resident CONTRACTOR shall be subject to deduction of taxes under the Income Tax Act, 1961 and relevant law, rule or regulation for the time being in force providing for the deduction of tax at source.
- 54.7.2.4 CONTRACTOR represents that it has a valid Permanent Account Number (PAN) in India and further CONTRACTOR will provide the Tax Residency Certificate (TRC) as per provisions of Sec90A (4) of the Income Tax Act, 1961. In case CONTRACTOR fails to provide the PAN and TRC as aforesaid, OWNER shall deduct tax at higher rate as applicable.

54.8 Claims by the CONTRACTOR

- 54.8.1 No claim(s) shall on any account be made by the CONTRACTOR after submission of the Final Bill, with the intent that the Final Bill prepared by the CONTRACTOR shall reflect any and all claims whatsoever of the CONTRACTOR against the OWNER arising out of or in connection with the CONTRACT or any supply made or work performed by the CONTRACTOR thereunder or in relation thereto, and notwithstanding any enabling provision in any law or CONTRACT and notwithstanding any claim that the CONTRACTOR could have with respect thereto, the CONTRACTOR hereby waives and relinquishes any and all such claims not included in the Final Bill and absolves and discharges the OWNER from and against the same, even if in not including the same as aforesaid, the CONTRACTOR shall

have acted under a mistake of law or of fact, or shall claim to have acted under economic compulsion or necessity.

54.8.2 If required by the OWNER, the ENGINEER-IN-CHARGE shall be authorised to require the CONTRACTOR to furnish, and the CONTRACTOR shall, upon the request of the ENGINEER-INCHARGE /OWNER, furnish all invoices, vouchers and accounting records as may be deemed necessary by the EIC /OWNER for the purpose of verifying any CONTRACTOR's claim.

54.9 Discharge of Owner's Liability

54.9.1 The acceptance by the CONTRACTOR of any amount paid by the OWNER to CONTRACTOR in respect of the Final Bill of the CONTRACTOR in settlement of all said dues to the CONTRACTOR under the Final Bill shall, without prejudice to the claims of the CONTRACTOR included in the Final Bill in accordance with the provisions of clause 54.4.2 of GCC, be deemed to be in full and final settlement of all such dues to the CONTRACTOR notwithstanding any qualifying remarks, protest or condition imposed or purported to be imposed by the CONTRACTOR related to the acceptance of such payment, with the intent that upon acceptance by the CONTRACTOR of any payment made as aforesaid, the CONTRACT (including the arbitration clause) shall stand discharged and extinguished in so far as relates to and/or concerns the entitlements of the CONTRACTOR under the CONTRACT except for the CONTRACTOR's right, if any, to receive payment in respect of his notified claims included in his Final Bill and the right to receive payment of the unadjusted balance of the Security Deposit in accordance with the provisions of Clause 54.10.3 on successful completion of the DEFECTS LIABILITY PERIOD. But nothing herein stated shall affect the CONTRACTOR's un-discharged liabilities and obligations under the CONTRACT.

54.9.2 Notwithstanding anything provided in Clause 54.9.1 the CONTRACTOR shall be and remain liable for defects in terms of DEFECT LIABILITY PERIOD and associated clause thereunder and for any indemnity to the OWNER in terms of Clause 54.10.2 and shall be and remain entitled to receive the unadjusted balance of the Security Deposit remaining in the hands of the OWNER in terms of Clause 54.10.3 and associated clauses thereunder.

54.10 Final Acceptance Certificate and Release of Security

54.10.1 Forthwith on the CONTRACTOR's application made after the expiry of DEFECT LIABILITY PERIOD provided and associated clauses thereunder and satisfaction of all liabilities of the CONTRACTOR in respect thereof, the Engineer-In-Charge shall issue a FINAL ACCEPTANCE CERTIFICATE to the CONTRACTOR Certifying that the CONTRACTOR has performed his obligations in respect of the DEFECT LIABILITY PERIOD and associated clauses thereunder, and until issue of such FINAL ACCEPTANCE CERTIFICATE, the CONTRACTOR shall be deemed not to have performed such liabilities notwithstanding issue of the PRELIMINARY ACCEPTANCE CERTIFICATE or payment of the Final Bill by the OWNER.

54.10.2 Upon application for the FINAL ACCEPTANCE CERTIFICATE, the CONTRACTOR shall:

- i) Be deemed to have warranted that it had been fully paid and satisfied all claims for or arising out of the WORK, labour, MATERIALS, supplies and EQUIPMENT used in or connected with the CONTRACT and all other liabilities whatsoever touching or affecting the CONTRACT, or its performance, including in relation to SUB-CONTRACTORS and suppliers, and
- ii) To have undertaken to indemnify and keep indemnified the OWNER from and against all claims, demands, debts, liens, obligations and liabilities whatsoever arising there from or relating thereto.
- iii) Be deemed to have released, acquitted and discharged the OWNER from and against all claims (known or unknown), liens, demands or causes of action of any kind whatsoever arising out of or relating to the CONTRACT or otherwise howsoever touching or affecting the same.

54.10.3 Forthwith on application made by the CONTRACTOR in this behalf accompanied by the FINAL ACCEPTANCE CERTIFICATE, or within 84 (Eighty Four) days of the OWNER passing the CONTRACTOR's Final Bill, whichever shall be later, the OWNER shall cancel and return to the CONTRACTOR all previous Bank Guarantees remaining unutilised in the hands of the OWNER, and upon such cancellation and return, the OWNER shall stand discharged of all obligations/ liabilities under the CONTRACT provided that the cancellation and return of any Bank Guarantee(s) furnished by the CONTRACTOR as and by way of security deposit shall be subject to the CONTRACTOR replacing such Bank Guarantee(s) with a Bank Guarantee from

OWNER's approved list of banks in a format acceptable to the OWNER covering the value equivalent to the estimated and mutually agreed price of EQUIPMENTS/WORKS replaced or repaired during the DEFECTS LIABILITY PERIOD for the unexpired term of extended DEFECTS LIABILITY PERIOD in respect thereof plus a 6 (six) months period.

54.11 Claims of Owner

The release/payment of any unadjusted balance of the Security Deposit (furnished in the form of a Bank Guarantee or otherwise) by the OWNER to the CONTRACTOR as aforesaid or otherwise shall not be deemed or treated as a waiver of any right(s) or claim(s) of the OWNER or shall not stop or prevent the OWNER from thereafter making or enforcing any claim or any rights against the CONTRACTOR with the intent that the claims of the OWNER, against the CONTRACTOR shall continue to survive and shall not get extinguished notwithstanding the issue of FINALACCEPTANCE CERTIFICATE and/or the release of Security Deposit to the CONTRACTOR.

55.0 REGISTRATION OF THE CONTRACTOR WITH STATUTORY AUTHORITIES

- 55.1 Within 30 days of execution of the CONTRACT, the CONTRACTOR shall, insofar as necessary, register itself and the CONTRACT at their own cost with the Reserve Bank of India, Income Tax, Sales Tax and/or any other applicable statutory authorities as required under the rules and regulations governing in India. The TOTAL CONTRACT PRICE shall be deemed to include all costs towards the same. A copy of all documents related to all such registration shall be submitted to OWNER for record.
- 55.2 Immediately after notification of the Acceptance of Bid, the foreign CONTRACTOR shall obtain permission for opening of their office(s) in India from the Reserve Bank of India and shall obtain Income Tax clearance from Indian Income Tax authorities. Among other formalities, these will be required by the OWNER to release any payment due to the CONTRACTOR.

56.0 STATUTORY APPROVALS

- 56.1 Unless otherwise specified in Bidding Documents, it shall be the CONTRACTOR's responsibility to obtain all approvals from Statutory Authorities (except for Environment Clearance, Consent to Establish, Consent to Operate and Essentiality Certificate for import of goods at concessional duty which shall be obtained by

OWNER) required under any statute, rule or regulation of the Central or State Government concerned with the performance of the CONTRACT and/or the contractual Work with OWNER's assistance. The list of such approvals to be obtained by CONTRACTOR shall include but not be limited to the following:

- Approvals from Directorate of Boilers / Chief Boiler inspector of the state Govt related to Fired/Process Waste Heat Boilers, HRSG, Steam Superheaters, Boiler Feed Water Heaters & their mountings, Steam and Boiler Feed Water Piping, etc. under the purview of Indian Boiler Regulations (IBR).
- Approvals from Chief Controller of Explosives (PESO) Nagpur or its relevant regional office related to storage and handling of petroleum products under the purview of Petroleum Rules, including No Objection Certificate (NOC) from District Magistrate for storage of petroleum products.
- Approvals from Chief Controller of Explosives (PESO) Nagpur or its relevant regional office related to storage of gas cylinders and other static pressure vessels (say, Chlorine, Oxygen, Acetylene, Nitrogen, etc and/or compressed Air Bullets) under the purview of Gas Cylinder Rules and Static & Mobile Pressure Vessel Rules. x Plan approval of all the Plant & non-Plant Buildings including Stability Certificate from Directorate of Factories (U.P.) under the purview of Factories Act.
- No Objection Certificate (NOC) for all tall structures like Tower, Chimney, Stacks and other tall structures etc. from the Airport Authority of India (AAI) for Civil Aerodromes and Commercial HQ/MoD for Defense Aerodromes.
- Consent for Captive Power Plant from State Electricity Regulatory Commission x Approval of all electrical installations like transformers, switchgears, panels, motor control centers, etc. from Director of Electrical Safety, State Govt under the purview of Indian Electricity Act / Indian Electricity Rules.
- Approval for use of radioactive sources / nucleonic devices from Atomic Energy Regulatory Board (Radiological Safety Division), Mumbai. x Calibration & stamping of Storage Tanks, packing & weighing machines, weigh bridges, etc from the Department of Weights & Measures.
- Approval of the Fire Hydrant System & Fire-fighting System from the Insurance / Underwriter-accredited Agency for compliance with the provisions of Factories Act / State Govt Factory Rules and/or Tariff Advisory Committee recommendations.

- No Objection Certificate (NOC) / Clearance from Chief Fire Officer of State Govt. regarding adequacy of Fire-fighting arrangements at SITE.
- Allotment of wireless frequency and radio paging (captive) license for intra-plant communications through walkie-talkie sets / pagers by Wireless Planning & Coordination Wing, Dept. of Telecommunications (Min. of Communications), including NOC from MoD for wireless communications systems, if required.

The application on behalf of the OWNER for submission to relevant authority's along with copies of required certificates complete in all respects shall be prepared and submitted by the CONTRACTOR well ahead of time so that the actual construction/COMMISSIONING of the WORKS is not delayed for want of the APPROVAL/inspection by the concerned authorities. The CONTRACTOR shall arrange for the inspection of the works by the authorities and will undertake necessary coordination and liaison required and shall not be entitled to any extension of time for any delay in obtaining such approval. All statutory fees shall be paid by the CONTRACTOR and the same shall be reimbursed by the OWNER upon production of documentary evidence by the CONTRACTOR.

56.2 Any deficiency(ies) as pointed out by any such authority shall be rectified by the CONTRACTOR within the scope of relative supply and/or WORK at no extra cost to the OWNER. The inspection and acceptance of the WORKS by such authorities shall, however, not absolve the CONTRACTOR from any of its responsibilities under this CONTRACT.

56.3 No extension of time shall be granted for meeting the requirement and/or obtaining APPROVAL of statutory authorities.

57.0 UTILISATION OF LOCAL RESOURCES

57.1 The CONTRACTOR shall ascertain the availability of local SUB-CONTRACTORS and skilled/unskilled manpower and engage them to the extent possible for performance of the WORKS on preferential basis.

57.2 The CONTRACTOR shall not recruit personnel of any category from among those who are already employed by the other agencies working at the site but shall make maximum use of local labour available. Rules of the Inter-state Migrant Workmen (Regulation of Employment and Conditions of Service) Act, 1979 are to be strictly complied by the CONTRACTOR. A monthly report shall be submitted by

CONTRACTOR to OWNER for all skilled/unskilled manpower engaged by CONTRACTOR.

58.0 SCRAP / SURPLUS MATERIAL

Notwithstanding anything provided elsewhere, all surplus materials shall be dealt as follows:

- 58.1 Any Scrap generated out of material where duty benefits have been availed by the OWNER shall be OWNER's property.
- 58.2 Any material, both imported and indigenous, brought with intention for permanent installation/absorption, and remain unutilized in plant should become OWNER's property in case duty benefits have been availed by OWNER on the same.
- 58.3 For taking out CONTRACTOR's EQUIPMENT upon the completion of the PROJECT, the CONTRACTOR shall have to furnish proof of entry and ownership of such equipment, temporary facilities, tools and other materials (like: temporary lighting; scaffolding; shuttering; measuring instruments; rigging accessories; debris & scrap of temporary buildings / facilities / structures dismantled by CONTRACTOR; etc) inside the SITE for certification of ENGINEER-IN-CHARGE and OWNER in this regard.

59.0 COORDINATION WITH OTHER AGENCIES

- 59.1 CONTRACTOR shall be responsible for proper coordination with other agencies operating at the site so that WORK may be carried out concurrently, without any hindrance to others. The ENGINEER-INCHARGE shall resolve disputes, if any, in this regard, and his decision shall be final and binding on the CONTRACTOR.
- 59.2 If and when required for the coordination of the WORKS with other agencies involved at SITE, the CONTRACTOR shall within the scope of work, re-route and/or prepare approaches and working areas as may be necessary.

60.0 ERECTION OF EQUIPMENT

All erection shall be carried out by deploying a crane(s) of suitable capacity. Erection by derrick or any other such improvised method, which jeopardizes safety in any way, shall not be permissible. The CONTRACTOR shall submit erection schemes for erection of critical equipment to ENGINEER-IN-CHARGE for his APPROVAL. No EQUIPMENT shall be erected in the absence of an approved erection scheme for such EQUIPMENT.

The quoted rates of the CONTRACTOR shall be deemed to include load testing of the crane/rigging equipment, as required to establish the safe lifting capacity of the

crane/rigging equipment and certification by relevant statutory authority for “fitness-of service”.

61.0 ELECTRICAL CONTRACTORS LICENCE

- 61.1 The CONTRACTOR or its nominated SUB-CONTRACTOR(s), as the case may be, shall have a valid electrical contractor's license for working in the State in which the job site is located. The CONTRACTOR shall furnish a copy of the same to ENGINEER-IN-CHARGE before commencement of any electrical work or work pertaining to the Electrical System.
- 61.2 No electrical work or work pertaining to electrical system(s) shall be permitted to be executed without a valid Electrical Contractors License being produced by the CONTRACTOR or SUB-CONTRACTOR, as the case may be, intending to execute the WORK.

62.0 SITE CLEANING

The CONTRACTOR shall take care to keep clean the job site at all times for easy access to the job site and also from the safety point of view to the satisfaction of the ENGINEER-IN- CHARGE.

63.0 ACCESS TO SITE

- 63.1 The CONTRACTOR shall at his own cost and initiative arrange for and provide any access to the work area and stringing or other yards for labour, EQUIPMENT and MATERIAL as may be necessary for any cause in addition to the ingress and egress available. Any arrangements in respect thereof as may be entered into by the CONTRACTOR with any person interested in the land through which access is sought, shall be in WRITING and a copy of the WRITING (certified by or on behalf of the CONTRACTOR to be true copy thereof) shall forthwith be lodged with the OWNER. Such a WRITING shall specifically stipulate that the OWNER shall not be responsible for any claims under the CONTRACT or for any damage, loss or injury to the land or any material, item or thing thereon or in, and the CONTRACTOR shall keep the OWNER indemnified from and against any claim, action or proceedings in respect thereof.
- 63.2 The CONTRACTOR shall at his own cost and initiative arrange for and obtain all necessary permissions, permits, consents and licenses as may be necessary to transport the MATERIALS, tools, EQUIPMENT, machinery and labour along or across any highway, roadway, or other way, or railway, tramway, bridge, dyke, dam

or embankment, or lake, pond, canal, river, state terminal toll octroi, or other line, border or barrier. Traffic study, if required, shall be carried out by CONTRACTOR independently without any liability on OWNER.

64.0 INDEPENDENT CONTRACTOR

64.1 OWNER shall have the right to instruct and direct CONTRACTOR, as to the results to be obtained under the CONTRACT and shall be entitled to ascertain whether the WORK is carried out in accordance with the requirements of the CONTRACT, including the right to inspect the WORK at all stages of its performance. Such instructions, direction and/or inspection by OWNER shall not relieve CONTRACTOR of his obligation, duties or liabilities under the CONTRACT.

64.2 Neither CONTRACTOR nor any SUB-CONTRACTOR nor the employees, agents or representative of either shall be represented anywhere verbally or in writing or deemed to be employees, agents or representative of the OWNER in the performance of the CONTRACTOR obligations here under, unless otherwise specified in the CONTRACT or unless specific permission in WRITING is obtained by CONTRACTOR from ENGINEER-INCHARGE for a specific purpose.

65.0 PAYMENT TO THE SUB-CONTRACTOR

65.1 CONTRACTOR agrees that he shall furnish to OWNER, if requested, satisfactory evidence that all SUB-CONTRACTORS, including vendor to CONTRACTOR have been paid on the time and in full for work done or ~~good~~ supplies made in connection with the performance of the WORK as per the terms and conditions of Agreement / Purchase Order between CONTRACTOR and SUB-CONTRACTOR / VENDOR.

65.2 If such satisfactory evidence is not supplied then the OWNER shall not be bound to make any further payment to CONTRACTOR for that part of work until it is provided.

65.3 CONTRACTOR shall notify OWNER of any dispute of any kind between CONTRACTOR and any of his SUB-CONTRACTOR or vendors stating the nature of dispute, the amount of any payment which is being withheld by CONTRACTOR, the reasons thereof and the CONTRACTOR's plan to settle the dispute.

66.0 ORDER OF WORKS / PERMISSION / RIGHT OF ENTRY / CARE OF EXISTING SERVICES

66.1 CONTRACTOR is required to submit to OWNER the various details with respect to their personnel(s) to be deputed for the execution of WORK such as name(s), nationality

and passport details in case of Foreign Nationals (Passport No., Date of Issue, Date of Expiry etc.). These details are required for granting permission to enter and work in the existing Plants / work site. The OWNER reserves the right to declare any person(s) as persona non-grata. No claim whatsoever shall be entertained by the OWNER on this account.

66.2 OWNER or Contractor in case of foreign National employee shall submit their details along with duration of stay etc to office of district Superintended of Police (SP) & Police station / local intelligence unit and shall have the right to object to any Representative or personnel deputed to India by CONTRACTOR for execution of WORK or in connection with WORK, due to their misconduct or breach of law and regulation or who are found to be incompetent or negligent. CONTRACTOR shall remove such persons from SITE forthwith and take immediate action for replacement at no cost to OWNER.

67.0 GIFTS, COMMISSIONS, ETC.

Any gift, commission or advantage given, promised or offered by or on behalf of the CONTRACTOR or his partner, agent, officers, directors, employee or servant or anyone on his or their behalf in relation to the obtaining or to the execution of this CONTRACT with the OWNER, shall in addition to any criminal liability which it may incur, be subject to the termination of this CONTRACT and also the payment of any loss or damage to the OWNER resulting from any such termination. The OWNER shall then be entitled to deduct the amounts payable from any monies otherwise due to the CONTRACTOR under the CONTRACT.

68.0 LABOUR LAWS- PF, EPF AND ESI

68.1 The CONTRACTOR shall obtain necessary license from the Licensing Authority under the Contract Labour (Regulation & Abolition) Act 1970 and the Central Rules framed there under and produce the same to the ENGINEER-IN-CHARGE before start of WORK. 68.2 The CONTRACTOR shall not undertake or execute or permit any other agency or SUBCONTRACTOR to undertake or execute any work on the CONTRACTOR'S behalf through contract labour except under and in accordance with the license issued in that behalf by the Licensing Officer or other authority prescribed under the Factories Act or the contract labour (Regulation & Abolition) Act 1970 or their applicable lay, rule or regulation, if applicable.

68.3 The provision of EPF & MP Act, 1952 and Rules scheme there under shall be applicable to the CONTRACTOR and the employees engaged by him for the WORK. The CONTRACTOR shall furnish the code number allotted by the RPFC Authority, to the ENGINEER-IN-CHARGE before commencing the WORK.

68.4 The CONTRACTOR shall be exclusively responsible for any delay in commencing the work on account of delay in obtaining a license under clause 68.1 above or in obtaining the code number under clause 68.3 above and the same shall not constitute a ground for extension of time for any purpose.

68.5 The CONTRACTOR shall enforce the provisions of ESI Act and Scheme framed there under with regard to all his employees involved in the performance of the CONTRACT and shall deduct employee's contribution from the wages of each of the employees and shall deposit the same together with employer's contribution of such total wages payable to the employees in the appropriate account.

68.6 All liabilities like salaries, wages and other statutory obligations in respect of the persons engaged by the CONTRACTOR shall be borne by the CONTRACTOR during the period of agreement. In view of the provisions of the ESI Act, PF and EPF Act and other Acts, as may be applicable to OWNER, the CONTRACTOR shall take necessary steps to cover its employees under the said enactments and shall submit proof of such compliance to ENGINEER-INCHARGE periodically or at any date upon such request, as may be made by ENGINEER-INCHARGE to the CONTRACTOR. In the event of non-compliance with the statute or the provisions thereof, referred to above, it shall be open to OWNER, as the Principal Employer, to withhold such amount as in its opinion is due and payable by the CONTRACTOR in respect of its employees from and out of dues, payable by OWNER to the CONTRACTOR and such due shall be held by OWNER with it until proof is submitted by the CONTRACTOR to OWNER indicating compliance with such statutes within reasonable time, failing which OWNER shall deposit such amounts with the authorities concerned on behalf of the CONTRACTOR and inform the CONTRACTOR of such deposit or deposits.

69.0 GENERAL PROVISIONS

69.1 Confidential Information

69.1.1 non-disclosure

Each party agrees to hold in confidence any information imparted to it or in the case of CONTRACTOR, to any of its SUB- CONTRACTOR / VENDOR, by the other Party which pertains to that other Party's business activity in any manner, and which is not be subject of general public knowledge, including, without limitation, proprietary processes, technical information and know-how, information concerning other projects, management policies, economic policies, financial and other data and the like. The preceding non-disclosure requirements shall not apply to:

- i) Information furnished without restriction by the other Party prior to the date hereof
- ii) Information in the public domain; or
- iii) Information obtained by a Party from a third Person not under obligation of non- disclosure to the other Party.

69.1.2 Disclosure to Govt. Agency

Either Party may disclose any such information to the extent that such Party is required by any Government Agency to make such disclosure. In addition, OWNER may disclose such information to the extent that such disclosure is required by any Lender / Lender's Representative, etc.

69.1.3 Upon completion of the WORKS or in the event of termination pursuant to the provisions of the CONTRACT, CONTRACTOR shall immediately return to the OWNER all drawings, plans, specifications and other documents supplied to the CONTRACTOR by or on behalf of the OWNER or prepared by the CONTRACTOR

solely for the purpose of the performance of the WORKS, including all copies made thereof by the CONTRACTOR.

69.1.4 This clause shall survive and remain in full force for a period of ten years following the issue of FINAL ACCEPTANCE CERTIFICATE.

69.2 Training of Personnel

CONTRACTOR shall make necessary arrangements for the practical training of reasonable number of Technicians/Engineers of OWNER, if so desired by OWNER at its office or SUBCONTRACTOR'S works of manufacture in the operation and maintenance of EQUIPMENT as elaborated in clause 10.0 of SCC. The expenses for travelling, lodging and boarding of the personnel of OWNER deputed for training shall be borne by OWNER.

69.3 Recovery of Sums / Dues

69.3.1 All costs, damages or expenses which OWNER may have incurred, for which CONTRACTOR is liable under CONTRACT, shall be notified to CONTRACTOR and shall be recovered by OWNER from any payment due to or becoming due to CONTRACTOR under this CONTRACT or other CONTRACT and/or shall be recovered by action at law or otherwise. If the payment due to CONTRACTOR is not sufficient for recovery of the said sums/dues, CONTRACTOR shall pay immediately to OWNER such sums/dues or the balance sums/dues on demand.

69.3.2 All Price Discount applicable and to be recovered from CONTRACTOR under CONTRACT, shall be recovered by OWNER from any payment due to or becoming due to CONTRACTOR under this CONTRACT and/or shall be recovered by action at law or otherwise. If the payment due to CONTRACTOR is not sufficient for recovery of the said PRICE DISCOUNT amount, CONTRACTOR shall pay immediately to OWNER such Price Discount amount or the balance Price Discount amount on demand.

69.4 Payments etc. not to affect rights of OWNER:

No sum paid on account by OWNER, nor any extension of the date for completion granted by OWNER, shall affect or prejudice the rights of OWNER against CONTRACTOR or relieve CONTRACTOR of its obligation for the faithful performance of CONTRACT.

69.5 Cut-Off Dates

No claims or communication arising out of this CONTRACT shall be entertained by either Party after a period of 6 months from the date of expiry of the Performance Bank Guarantee, unless specified otherwise in CONTRACT.

However, the Contractor's liability for Latent Defects (as defined herein) shall be for a period of five (5) years from the end of DEFECTS LIABILITY PERIOD.

'Latent Defects' means such defects caused by

- i) the design of the Works
- ii) Plant or Material and/or workmanship not being in accordance with the Contract which cannot be detected during inspection, testing etc. based on the technology available for carrying out such tests.



69.6 Miscellaneous

- 69.6.1 No CONTRACT or understanding in any way modifying the conditions of CONTRACT shall be binding upon either Party hereto unless made in WRITING and approved by both Parties.
- 69.6.2 Without prejudice to FORCE MAJEURE, CONTRACTOR shall, during inclement weather, carry out WORK in accordance with CONTRACT and CONTRACTOR shall not be entitled to any additional payment over and above the fees payable under CONTRACT by reason of its being unable to carry out WORK owing to inclement weather.
-



Client – Hindalco Industries Ltd
Project - Aditya Alumina Refinery
TCE.13833A-ME-6002-6001, Rev-R0



TECHNICAL SPECIFICATION FOR MAIN PLANT SYSTEM

Page 1 of 1

ATTACHMENT-19 SPECIAL CONDITIONS OF CONTRACT



Client – Hindalco Industries Ltd
Project - Aditya Alumina Refinery



TCE.13833A-ME-6002-6001, Rev-R0

SPECIAL CONDITIONS OF CONTRACT (SCC) For
LSTK TENDER PACKAGES

Section-A3

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ADITYA ALUMINA REFINERY

of

Hindalco Industries Ltd

SPECIAL CONDITIONS OF CONTRACT

(SCC)

For

Lump Sum Turn Key (LSTK) Contracts



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1. GENERAL

The SPECIAL CONDITIONS OF CONTRACT(SCC) shall be read in conjunction with the GENERAL CONDITIONS OF CONTRACT(GCC), specifications of work, DRAWINGS and any other document forming part of this CONTRACT wherever the context so requires.

Where any portion of the GENERAL CONDITIONS OF CONTRACT is repugnant to or at variance with any other provisions of the SPECIAL CONDITIONS OF CONTRACT, then unless a different intention appears, the SPECIAL CONDITIONS OF CONTRACT shall be deemed to over-ride the provisions of GENERAL CONDITIONS OF CONTRACT and shall prevail to the extent of such repugnancy or variations.

2. PROJECT SPECIFIC DEFINATIONS

- a) “OWNER”: shall means Hindalco Industries Ltd (hereinafter referred to as HIL), having its registered office at One Unity Centre Tower 4, 21st Floor, Senapati Bapji Marg, Prabhadevi, Mumbai 400013 and plant office at Kansariguda Podapdi, Rayagada – 765 015 (which expression shall include its successors & permitted assigns). The terms “Company”, “Owner” and “Purchaser” are synonymous.
- b) “CONSULTANT”: shall mean Tata Consulting Engineers Ltd, (hereinafter referred to as TCE) Tata Consulting Engineers Ltd, (hereinafter referred to as TCE) the PMC agency engaged by OWNER as CONSULTANT for their Project.
- c) “CONTRACTOR” or “BIDDER”: shall mean the successful BIDDER whose bid has been accepted by the OWNER and who has been selected by the OWNER for the award of WORKS and shall include his heirs, legal representatives, successors and permitted assigns. The terms “CONTRACTOR”, “BIDDER” “SUPPLIER”, “VENDOR” and “SELLER” are synonymous.



2.1 NOTICES

a) Notices to Company

Any contractual notice, report, certificate or other communication to be given to Company under the Contract shall be served by sending the same by facsimile transmission (with a confirmation copy by couriers or by hand delivery only in case of major issues relating to the Contract, Viz. Notices of Tests, arbitration, making a claim, termination etc.) to, or by leaving the same at, the respective addresses set out below or such other addresses as may be specified for that purpose in writing to the Supplier and upon obtaining proper receipt of the same.

Company: Head – Projects

Hindalco Industries Ltd (HIL)

Unit Aditya Alumina Refinery

Village Kansariguda, PO: Podapadi

Dist: Rayagada Odisha -765015

with a copy in all cases to the Company's Representative:

Manager - Materials

Hindalco Industries Ltd. (HIL)

b) Notices to Supplier

All certificates, notices or decisions, instructions and orders to be given by EIC or the Company under the Contract shall be served by sending the same by facsimile transmission (with a confirmation copy by couriers or by hand delivery only in case of major issues relating to the Contract, Viz. Notice of Tests, arbitration, claims, termination etc.) to, or by leaving the same at, the address set out below or such other address as the Supplier shall nominate in writing for that purpose and upon obtaining proper receipt of the same :

Supplier: [Address for communication to be inserted]

3. CONTRACTOR'S OBLIGATIONS

3.1 General Responsibility

3.1.1 The CONTRACTOR shall be deemed to have visited the SITE and surroundings of the proposed SITE at his own Cost and satisfied himself with all aspects, nature and extent of work and / or any other factor (e.g. availability of Labour, water, power, ground and sub-soil conditions, uncertainties of weather, general and local conditions etc.) which might influence his work and shall be deemed to have verified and / or checked the data furnished by the OWNER except “rely-upon information”, if any.

3.1.2 The CONTRACTOR acknowledges that this CONTRACT is a lump sum turnkey contract and CONTRACTOR'S obligation hereunder, notwithstanding anything to the contrary contained herein, is to provide OWNER with fully operational PLANT, complete in all respects and in accordance with the provision of CONTRACT, within the stipulated time and for the purpose designated herein by OWNER, and to do, furnish and provide everything necessary in connection therewith.

Without prejudice to the foregoing and 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 work and services up to the PRELIMINARY ACCEPTANCE OF 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 PLANT in all respects up to the PRELIMINARY ACCEPTANCE OF PLANT, and having the performance as guaranteed under the CONTRACT by the CONTRACTOR on a total, fixed price basis in accordance with this CONTRACT. The WORK shall, without prejudice to the generality of the foregoing or those enumerated in Clause 3.2 include but not be limited to the following:

- a) All engineering and design services including necessary investigation required for a completely engineered PLANT including necessary documentation.



- b) Provision of all equipment, systems, materials, processes, CONTRACTOR's EQUIPMENT, temporary works and all other items, whether of a temporary or permanent nature including those required for the design, erection, completion commissioning, conducting of

PERFORMANCE AND GUARANTEE TESTS and remedying of DEFECTS during DEFECTS LIABILITY PERIOD.

- c) Transportation from works, port of entry and import clearance and handling services in and into country where proposed plant is located and inland transportation from the relevant points of delivery of EQUIPMENT required in connection with the completion of the PLANT, and performance of other WORK.
- d) Project Management.
- e) Receipt of EQUIPMENT at SITE including stores management, as a representative of Owner
- f) Construction infrastructure services, civil and structural construction; mechanical, electrical and instruments erection and installation services; testing, pre-commissioning and commissioning, and PERFORMANCE AND GUARANTEE TESTS before PRELIMINARY ACCEPTANCE of PLANT-including all relevant applicable permits and statutory approvals to be obtained hereunder by CONTRACTOR and all training activities.
- g) Provision of all necessary superintendence, labour, construction fuels and construction (but not fuel, raw material to the plant, water and electricity for commissioning, testing and operating the PLANT which OWNER will provide to CONTRACTOR at no cost), chemicals, utilities, tools, supplies and other consumables and services; and
- h) Rectification of DEFECTS during DEFECTS LIABILITY PERIOD.

3.1.3 CONTRACTOR shall provide services for PLANT, in accordance with good engineering practice. CONTRACTOR shall provide services of engineers, designers, draftsmen, buyers, inspectors, expeditors and other persons required for the performance of WORK pursuant to CONTRACT.



- 3.1.4 In the event that there is any item of EQUIPMENT or WORK of the type provided for in CONTRACT, which is not specifically mentioned in the specifications or drawings set out in FINAL PROPOSAL, but which is necessary (even though not mentioned in CONTRACT) for normal, safe and continuous operation of PLANT, based on mutual agreement between OWNER and CONTRACTOR, CONTRACTOR shall include such item of EQUIPMENT in the design and perform such items of WORK, for such EQUIPMENT or WORK free of cost to OWNER as if the same had been originally included in its Scope of Work/FINAL PROPOSAL.
- 3.1.5 Subject to prior consent of OWNER, CONTRACTOR may make use of the services of SUB-CONTRACTOR/ VENDOR (previously approved in WRITING by the OWNER) in accordance with the provisions in CONTRACT provided, however, the CONTRACTOR shall remain responsible and liable for the work done by such SUBCONTRACTOR/vendor.
- 3.1.6 The CONTRACTOR shall be responsible for obtaining all necessary approvals which are to be issued either in the OWNER's name or in the CONTRACTOR'S name from the various statutory authorities as per Subclause 56.1 of GCC.
- 3.1.7 The OWNER shall provide full technical support and assistance to CONTRACTOR for obtaining the necessary approvals to be issued in the name of OWNER from the various statutory authorities as stipulated in Clause 56.1 of GCC.
- 3.1.8 The CONTRACTOR shall furnish Performance Bank Guarantee (PBG) as per the format mutually acceptable to OWNER and CONTRACTOR which is attached as Annexure-V of SCC.
- 3.1.9 The enumeration in subsequent Clauses of SPECIAL CONDITIONS OF CONTRACT, in GENERAL CONDITIONS OF CONTRACT and other documents of CONTRACT shall not in any manner limit the general scope of obligations and responsibilities of designing, engineering, procurement, supply, construction,



commissioning and proving the performance guarantees of PLANT within the scope of CONTRACT.

3.1.10 CONTRACTOR shall undertake design of the PLANT on the basis of commercially available proven equipment and process units / utility packages (including standard catalysts, adsorbents, resins chemicals, lubricants, trays, packings, other consumables, etc.), avoiding the use of proprietary equipment and consumables to the extent feasible, in order to permit economic sourcing of replacements/top-ups/make-ups at a later stage by the OWNER on a competitive basis.

3.2 **CONTRACTOR'S Scope of Work**

CONTRACTOR shall strictly follow Tender Enquiry Documents for complete details of Scope of Work & Scope of Supply, HSE & QA Requirements, Technical & Construction Specifications, Commissioning requirements & Other requirements etc.

In case of any contradictions, Section B to Section E supersedes all other details furnished in SCC, here below.

3.2.1 CONTRACTOR shall provide and be responsible for the following tasks specified in this clause.

Delivery of fully integrated & operational plant, utility facilities & offsite integration in LSTK mode with single point responsibility of the following:

- i. Name of Plant(s)
- ii. Name of Utility facilities
- iii. Offsite facilities
- iv. Plant & non-plant buildings

The functional category of various supply & services of LSTK Contractor is further described under the following heads:

3.2.2 **Design & Engineering**



- I. CONTRACTOR shall provide all design and engineering services necessary for completion of the PLANT in conformity with the CONTRACT and Good Engineering Practices but not limited to:
- a) Preparation of
 - Project design book (Design basis) which shall form the basis of PLANT design.
 - The conceptual design; and
 - Engineering and design are necessary to describe and detail the PLANT & 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 for project control and preparation of billing schedule 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.
 - d) CONTRACTOR shall perform the design and engineering for PLANT so that when constructed and commissioned, PLANT shall be capable of meeting the guarantees with respect to quality and quantity of products, consumption of raw materials and utilities (in terms of WORKS COST for PLANT), and Pollution Level as guaranteed under CONTRACT and shall be reliable and safe and operable in accordance with the sound engineering practice. CONTRACTOR shall ensure design capacity of all sections of PLANT in accordance with CONTRACTOR's experience and expertise for obtaining a full throughput under varying conditions within the limits specified in CONTRACT. PLANT shall be designed so as to be capable of producing at full plant capacity when operated as specified in FINAL PROPOSAL. CONTRACTOR shall review the basic design conditions, including soil data, and other conditions furnished by OWNER. If CONTRACTOR observes any inconsistency or insufficiency in these data, CONTRACTOR shall bring to the notice of OWNER the same before its use.



- II. It is expressly understood by both Parties (OWNER & CONTRACTOR) that the specifications and drawings contained in the FINAL PROPOSAL provide general guidelines and scope, based on which the PLANT shall be engineered and constructed by the CONTRACTOR. Notwithstanding the aforesaid, both Parties may mutually agree to suitably amend / modify the specifications, conditions or other requirements contained herein during Basic or Detailed Engineering phase or implement SITE changes during Construction phase of PROJECT execution, with or without the issuance of a formal CHANGE ORDER, should it be necessary to do so on account of the following, without materially affecting the configuration or functionality of the PLANT:
- a) Operating reliability, safety, operability, maintainability of the PLANT; and/or
 - b) Compliance with revised Statutory / Code requirements; and/or
 - c) Incorporation of current knowledge / state-of-the-art/ learning from operating experience
 - d) Standardization / inter-changeability with OWNER's existing Plant; and/or
 - e) Obsolescence / non-availability of specific MATERIALS; and/or
 - f) Practical expediency or physical constraints at SITE; and/or
 - g) Additional equipment, instruments and other modifications required during HAZOP conducted by CONTRACTOR in presence of mutually accepted independent HAZOP facilitator and in presence of OWNER's qualified representatives, their comments finally scrutinized and accepted for incorporation in plant overall design.
 - h) Any other technical considerations.
- III. Any departure from the scope, specifications and drawings contained in the FINAL PROPOSAL, shall be effected only after putting it on record under the signatures of the authorized / competent personnel of both Parties along with sufficient justification for doing so and relevant supporting documentation. As a general rule, in case any changes, modifications or substitutions from the original specifications contained in this FINAL PROPOSAL are mutually agreed to be implemented, an equivalent or more robust /



stringent solution than what was originally envisaged, shall be selected, so that the overall performance of the PLANT is not jeopardized in any manner.

3.2.3 Codes and Standards

The Engineering shall be performed, and EQUIPMENT shall be manufactured and supplied according to acceptable international standards, as specified in the Technical Specification/ FINAL PROPOSAL, meeting safety and other requirements of various national / international Codes and Regulations being in force as on EFFECTIVE DATE OF CONTRACT. The design of PLANT shall be based on the criteria enumerated in CONTRACT. However, it shall be CONTRACTOR'S responsibility to follow all Indian Rules and Regulations as applicable.

CONTRACT 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.

The CONTRACTOR shall ensure that all actions on its behalf in connection with the WORKS shall be in compliance with applicable laws in India and the highest ethical and technical standards. The contractor agrees to take all reasonable steps to ensure that persons appointed by it in connection with the work shall comply with the applicable laws/regulations/guidelines and obligations.

3.2.4 Drawings and Documents

CONTRACTOR shall prepare or secure and furnish to OWNER all data, specifications, drawings, plans and other documents as required/used for WORK as specified in Technical Specifications.

3.2.5 Owner's Review

- i. CONTRACTOR shall associate ENGINEER-IN-CHARGE, with WORK as carried out by CONTRACTOR and SUB-CONTRACTOR / vendor. ENGINEER-IN-CHARGE shall review

mutually agreed list of documents submitted by CONTRACTOR and give its comments to CONTRACTOR within 14 days from the date of receipt of the same. In case comments, if any, are not communicated by OWNER to CONTRACTOR within 14 days, document shall be deemed to be reviewed by OWNER. Review as aforesaid by OWNER & furnishing of comments by OWNER or the failure of OWNER to review or comment as aforesaid shall not relieve CONTRACTOR in any manner of its obligations including performance guarantees under this CONTRACT.

In case of 3-D modelling by CONTRACTOR, there shall be a minimum of 2 Model reviews with OWNER / CONSULTANT participation.

3.2.7 **Procurement Services**

- i. 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-CONTRACTOR'S labour, materials, equipment, supplies, soil, gravel and similar materials and manufacturing, fabrication and related services (whether on or off the PLANT Site) for construction of and incorporation in the PLANT 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 FINAL PROPOSAL.
- ii. CONTRACTOR shall procure and provide all EQUIPMENT required for PLANT. EQUIPMENT procured shall be according to specifications as set forth in the CONTRACT, of the best acceptable quality, proven record of performance and with suitable delivery time to achieve the GUARANTEED COMPLETION DATE as given by CONTRACTOR. EQUIPMENT shall be procured from the vendor list agreed between CONTRACTOR and OWNER. No materials shall be sourced / shipped from countries which are restricted in Chapter 2 of India's Foreign Trade Policy: 2008-2014 (as amended from time to time) and/or countries restricted by economic or other trade sanctions by UN Security Council Sanctions Committees under Chapter VII of the UN Charter, during the pendency of the CONTRACT.

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 FINAL PROPOSAL 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 required 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 FINAL PROPOSAL.

3.2.8 Equipment

- i. CONTRACTOR agrees that EQUIPMENT procured shall be strictly in accordance with the specifications as provided, however, that any apparent omission or error in the specifications will be corrected by CONTRACTOR if it is necessary for the functioning of EQUIPMENT. CONTRACTOR shall inform OWNER for such omission or error or ambiguity in the specifications and corrections made for the same.
- ii. The completeness of EQUIPMENT shall be the responsibility of CONTRACTOR. Any fittings, accessories, etc. which may not be specifically mentioned in Technical Specifications/FINAL PROPOSAL but which is required for the satisfactory functioning of EQUIPMENT and successful achievement of PERFORMANCE & GUARANTEE TESTS shall be provided by CONTRACTOR without any extra cost.
- iii. CONTRACTOR shall ensure that the modern practices in the manufacture and quality assurance procedure of Class I EQUIPMENT are followed notwithstanding any omission in the specifications.
- iv. The supplies including fittings, accessories, etc. shall be in strict compliance to the specifications/codes/standards. Components for which no relevant standards exist, the same shall be designed and manufactured as per good engineering & manufacturing practices, in the country of origin.

- v. The true intent and meaning of this Clause is that CONTRACTOR shall in all respects design, engineer, ensure quality of manufacture and supply EQUIPMENT in a thorough workman like manner, within prescribed time and in accordance with good engineering practice in order to enable proper operation of EQUIPMENT and PLANT for entire designed life without any pre-mature failure and defect.
- vi. CONTRACTOR shall furnish drawings and documents of EQUIPMENT as described under Clause 3.2.5. These documents shall include but not limited to technical documents, final drawings, layouts, preservation instructions, operation and maintenance manuals, test certificates, spare parts catalogues, etc. in a bound book for all rotating EQUIPMENT and in a folder for other EQUIPMENT, before despatch of EQUIPMENT under intimation to OWNER. All dimensions and weights shall be in metric system, unless agreed otherwise.
- vii. The documents required for statutory approvals once submitted during construction period by CONTRACTOR shall be firm and final and not subject to subsequent changes. CONTRACTOR shall be responsible for any payment of penalty as imposed by the Statutory Agencies consequent to furnishing of the incorrect data/drawings.
- viii. EQUIPMENT to be supplied and WORK to be carried out under CONTRACT shall conform to and comply with the provision of relevant Regulations/Acts (or both) as may be applicable in the State where SITE is located in India and necessary certificates of such compliance shall be furnished.
- ix. CONTRACTOR shall provide cross-sectional drawings wherever applicable to identify the spare part numbers and their location, e.g. the size of bearings/ seals, their make and number shall be furnished.
- x. EQUIPMENT supplied under CONTRACT shall conform to the standards as specified in clause 3.2.4



- xi. CONTRACTOR shall furnish an un-priced copy of PURCHASE ORDER (priced copy of PURCHASE ORDER, if required, to be submitted to Government Authorities) for all items of EQUIPMENT together with spares and special maintenance tools covering accurately all terms and conditions such as specifications requirements for quality, inspection, and test, warranties and guarantees, erection and commissioning assistance by vendor, delivery schedule, packing, transportation and insurance (wherever applicable), and documentation. For priced copies of PURCHASE ORDER, OWNER shall submit to CONTRACTOR, a copy of the relevant notifications or notice received from the respective Government Authorities with OWNER's request for such priced copy.
- xii. CONTRACTOR shall arrange & furnish/provide to OWNER:
- a) Lubrication schedule from VENDOR
 - b) Mechanical specifications and equipment data sheets for review by OWNER for critical EQUIPMENT before manufacture is started.
 - c) Shop fabrication drawings as made available by vendor.
 - d) Characteristic curves for pumps and compressors, etc. as made available by vendor
 - e) Certified drawings including civil scope drawing and loading data, pertinent bulletin, installation, installation manuals and test certificates as received from vendor.
 - f) Final revised vendor's drawings operation & maintenance manuals (6 copies each) including an editable electronic version in CD/DVD/USB drive, as described in Technical Specifications, before MECHANICAL COMPLETION
- xiii. CONTRACTOR shall provide services of vendor's specialist(s) for installation and commissioning of EQUIPMENT, whenever necessary, and cost for their mobilisation, travel, stay, per diem rate, incidental/out-of-pocket expenses, overtime, etc. is to be borne by CONTRACTOR as a part of CONTRACTOR's Scope of Work



- xiv. THE CONTRACTOR shall be responsible for the accuracy and completeness of PURCHASE ORDERS. Any comments by ENGINEER-IN-CHARGE shall not relieve CONTRACTOR of such responsibility.

3.2.9 Quality Assurance, Inspection, Expediting & Testing

- i) The CONTRACTOR shall prepare and submit an effective Quality Assurance Plan and get it approved by the ENGINEER-IN-CHARGE.

Till the time the ENGINEER-IN-CHARGE approves the detailed Quality Assurance Plan the CONTRACTOR, shall adhere to the quality assurance system as per specification for quality management provided in the Special Conditions of Contract.

The Quality Assurance Plan shall be furnished in the form of a QA manual. This document should cover details of the personnel responsible for quality assurance, plans or procedures to be followed for quality control in respect of Contractor's Scope of Works under this Contract. The Quality Assurance Plan should indicate an organizational approach for quality control and quality assurance of the construction activities at all stages of work at SITE as well as at manufacturer's works and dispatch of materials.

The CONTRACTOR has to ensure the deployment of Quality Assurance and Quality Control Engineer(s) depending upon the quantum of work to the full satisfaction of ENGINEER-IN-CHARGE. This QA/QC group shall be fully responsible to carry out the work as per applicable standards and codes.

- ii) CONTRACTOR shall establish an inspection and expediting system and use its services to obtain EQUIPMENT which conforms to the required technical and quality specifications and delivery according to PURCHASE ORDER. CONTRACTOR shall send copies of expediting and inspection reports regularly to OWNER. CONTRACTOR shall arrange Third Party Inspection and quality certification of EQUIPMENT.
- iii) OWNER or its INSPECTOR shall have the right to inspect and/or to test EQUIPMENT to check its conformity to the specifications. CONTRACTOR shall specify the inspections and tests to be carried out giving reference of applicable codes/standards and the location



of inspection/test to OWNER. OWNER shall notify CONTRACTOR the name of INSPECTOR retained for this purpose.

- iv) The inspection and tests may be conducted at the premises of CONTRACTOR or SUB-CONTRACTOR/vendor before delivery and/or at SITE. All reasonable facilities and assistance including access to all drawings and production data shall be furnished to INSPECTOR at no charge to OWNER.
- v) Should any inspected or tested EQUIPMENT fail to conform to the specifications, OWNER may reject it and CONTRACTOR shall either replace the rejected EQUIPMENT or make all alterations necessary to meet specification requirements free of cost.
- vi) All Raw Materials for Civil Works e.g. Steel, Bricks, Cement, Sand, Aggregate, etc. shall conform to the relevant BIS Specifications and workmanship shall generally conform to Central Public Works Department (CPWD) Specifications Vol. I & II. Test specimens of concrete used in the work shall be taken at defined intervals for crushing strength and density measurements. Concrete test cubes shall be made and tested strictly in accordance with IS:456 and IS:516 and test result submitted to OWNER before use. Frequency of the Tests will be guided by relevant B.I.S. Specifications and cost of such tests shall be borne by CONTRACTOR.
- vii) INSPECTOR shall follow the progress of the manufacture of EQUIPMENT under CONTRACT by carrying out stage wise inspection of equipment's & works to ensure that the requirements out lined in CONTRACT are not being deviated from with respect to Schedule and Quality.
- viii) CONTRACTOR shall allow INSPECTOR to visit, during working hours, the workshops relevant to execution of CONTRACT during the contractual period and INSPECTOR will have the right to inspect EQUIPMENT at all stages of manufacture right from identification of material up to its



shipment/dispatch, to the extent that the delivery schedule shall not be delayed, with prior notice to CONTRACTOR in WRITING.

- ix) In case of foreign manufacturer and in order to enable INSPECTOR to obtain entry visa in time, CONTRACTOR shall notify OWNER two months before assembly, testing and packing of main EQUIPMENT and if requested assist INSPECTOR in getting visa in the shortest possible time.
- x) CONTRACTOR shall place at the disposal of INSPECTOR free of charge all tools, instruments and other apparatus necessary for the inspection and/or testing of EQUIPMENT. INSPECTOR is entitled to prohibit the use and dispatch of EQUIPMENT that has failed to comply with the characteristics/specifications of EQUIPMENT during test and inspection.
- xi) CONTRACTOR shall ensure that the permission for inspection/test is granted by its SUBCONTRACTOR/VENDOR
- xii) In respect of the inspection, CONTRACTOR shall advise in WRITING of any delay in the program at the earliest possible date, describing in detail what has caused the delay and the proposed corrective action.
- xiii) All tests and trials in general of EQUIPMENT shall be witnessed by INSPECTOR. Therefore, CONTRACTOR shall confirm to OWNER by E-mail/fax about the exact date of inspection at least 15 DAYS in advance. CONTRACTOR shall specify the items and quantities ready for testing and indicate whether a Preliminary or Final Test is to be carried out.
- xiv) On receipt of this notice, if OWNER decides to waive the right to witness the test, information shall be given to CONTRACTOR within 15 DAYS of receipt of the notice from CONTRACTOR and CONTRACTOR then shall have right to proceed with the inspection.



- xv) Any and all expenses incurred in connection with tests, preparation of reports and analysis made by qualified laboratories, necessary technical documents, testing documents and drawings shall be at CONTRACTOR's cost. Technical documents shall include the references and numbers of the standard used in the fabrication/construction and, wherever deemed practical by INSPECTOR. INSPECTOR shall attach importance to the views given by CONTRACTOR or its SUBCONTRACTOR/VENDOR. Any and all expenses for living, lodging and airfare/rail fare incurred in connection with INSPECTOR shall be borne by OWNER.
- xvi) Nothing in Clause 3.2.9(iii) to 3.2.9 (iv) shall in any way relieve CONTRACTOR from any warranty or other obligations under this CONTRACT.
- xvii) Not performing or failing to perform the inspection by OWNER hereunder shall not be a waiver of any of CONTRACTOR's obligations hereunder nor it be construed as an approval or acceptance of any of the WORK hereunder nor it shall absolve the CONTRACTOR in any way or manner of its liabilities, responsibilities and obligations under the CONTRACT.
- xviii) Arrangements for all inspections required by Statutory Authorities (local) and as specified in Technical Specifications/FINAL PROPOSAL shall be made by CONTRACTOR. Certain category of Equipment/piping fall under the jurisdiction of Indian Boiler Regulations (IBR), irrespective of the fact whether these are proprietary in nature or not, certification from an internationally recognized agency approved by IBR is considered necessary to enable local IBR authorities to allow their installation and operation. In such cases, inspection and certification from such authorities will also have to be arranged by CONTRACTOR. CONTRACTOR shall also submit, as may be required by IBR authorities, necessary design calculations from respective fabricators and/or manufacturers of such EQUIPMENT.

3.2.10 Rejections, Removal and Replacement of Rejected EQUIPMENT



- i. Preliminary inspection at SUB-CONTRACTOR's / vendor's works by INSPECTOR shall not prejudice OWNER for commenting on EQUIPMENT including its specifications on final inspection at SITE or claim under warranty provisions.
- ii. If EQUIPMENT is not of specification or fail to perform specified duties, OWNER shall be entitled to reject EQUIPMENT or part thereof and ask for modification, repair or free replacement within reasonable time mutually decided failing which obtain its requirements from elsewhere at CONTRACTOR's cost and risk.
- iii. In the event of such rejection, OWNER shall be entitled to use EQUIPMENT in a reasonable and proper manner for a time reasonably sufficient mutually decided to enable it to obtain replacement, without any liability to CONTRACTOR. After free replacement of such rejected EQUIPMENT, the same shall become the property of CONTRACTOR.
- iv. Nothing in this Clause shall be deemed to deprive OWNER and/or affect any of its rights under CONTRACT which it may otherwise have in respect of such defects or deficiencies or in any way relieve CONTRACTOR of its obligation under CONTRACT.
- v. EQUIPMENT rejected by OWNER shall be removed by CONTRACTOR, within reasonable time, at its own cost after replacement of the said EQUIPMENT. OWNER shall in no way be responsible for any deterioration or damage to rejected EQUIPMENT under any circumstances whatsoever.
- vi. In case, the rejected EQUIPMENT is to be taken out of OWNER's premises for repair, OWNER shall have the right to recover the cost of such EQUIPMENT from any of CONTRACTOR's invoice pending with OWNER or by alternative method, should the CONTRACTOR fail to deliver the said EQUIPMENT duly repaired or replaced by a new one. Fresh transit insurance, if not covered under other insurance policies, shall be arranged by Contractor & full cost of repair, transportation, inspection, expediting & transit insurance shall be borne by Contractor.



3.2.11 Packing

CONTRACTOR shall ensure that packing of EQUIPMENT is as required to prevent their damage or deterioration during transit to its final destination.

The packing, markings, and documentation within and outside the packages shall comply strictly with the provisions of CONTRACT.

CONTRACTOR shall be responsible for any eventual consequence occurred to EQUIPMENT due to improper packing of the same.

In case of electrical panels, switchgears and other electrical & instrument items, contractor will ensure weatherproof packing and all necessary protection to electrical contacts.

3.2.12 Delivery and Documents

- i. CONTRACTOR shall submit and adhere to the delivery schedule of EQUIPMENT, which is intended for monitoring and controlling by OWNER, it being expressly understood that only the GUARANTEED COMPLETION DATE is guaranteed by CONTRACTOR as set out herein.
- ii. Delivery schedule shall include time for submission of documents/drawings for review/approval, incorporation of comments, if any, and final review of drawings by ENGINEER-IN-CHARGE. Within 14 days after receipt by ENGINEER-IN-CHARGE of any document requiring OWNER's review, ENGINEER-IN-CHARGE shall, either return one copy thereof to CONTRACTOR as it is, if ENGINEER-IN-CHARGE has no comments or with its comments and reasons thereof. If ENGINEER-IN-CHARGE fails to return the document/ drawing within 14 days, the said document/drawing shall be deemed to have been reviewed by OWNER. However, there can be exception in very few high value equipment's, ENGINEER-IN-CHARGE / Owner may take additional 14 days (28 days in

total) to conclude their review comments with prior intimation to Contractor within 14 days of submission.

- iii. Special care shall be taken by CONTRACTOR to furnish Manufacturer's Test Certificates, material of construction, make, type, pressure ratings wherever applicable and included in the scope of supply of EQUIPMENT.
- iv. In case of delay beyond GUARANTEED COMPLETION DATE for reasons:
 - a. not attributable to OWNER
 - b. not due to FORCE MAJEURE
 - c. not due to suspension of WORK by OWNER
 - d. not due to suspension of WORK by CONTRACTOR under clause 45.4 of GCC

All additional costs on account of changes of statutory regulations/Acts, taxes and duties or increase in price on any other account, shall not apply to TOTAL CONTRACT PRICE and the same shall be borne solely by CONTRACTOR.

3.2.13 Despatch, Transportation/Shipping

- i. CONTRACTOR shall be responsible for despatch of EQUIPMENT by sea/ rail/ road / air after proper packing and protection. The consignment shall be despatched after inspection by OWNER unless otherwise agreed to in writing. However, such inspection shall not constitute waiver of the CONTRACTOR's obligations, responsibilities for the EQUIPMENT including care, safety and preservation in any way and manner and the CONTRACTOR's responsibility and obligation in this behalf shall continue till PRELIMINARY ACCEPTANCE OF PLANT, or the issuance of a conditional PRELIMINARY ACCEPTANCE CERTIFICATE (as envisaged under Sub-Clause 20.8 of SCC), whichever is earlier, to the extent of CONTRACTOR's liability for damage to the PLANT as per clause 7.2.3 of GCC.



- ii. On-Deck shipment shall not be made without prior permission of OWNER. However, in case of large process vessels like towers, reactors, vessels and other large-sized EQUIPMENT like Kiln etc.

CONTRACTOR may, at its own discretion, make “on-deck” shipment, without OWNER’s prior permission.

In case of damage to such EQUIPMENT, during delivery or at any stage before PRELIMINARY ACCEPTANCE OF PLANT or the issuance of a conditional PRELIMINARY ACCEPTANCE CERTIFICATE (as envisaged under Sub-Clause 20.8 of SCC), whichever is earlier, CONTRACTOR shall be responsible for repair/replacement of EQUIPMENT, to the extent of CONTRACTOR’s liability for damage to the PLANT as per clause 7.2.3 of GCC. Rotating machinery shall in no case, be shipped as “on-deck” cargo.

- iii. Clean on-board bill of lading for all offshore supplies shall be drawn as under: For CFR/CIF/CIP/CPT Shipments

- Shipper = Supplier

Consignee:

Hindalco Industries Ltd.,

Unit Aditya Alumina Refinery

Village Kansariguda, PO: Podapadi

Dist.: Rayagada Odisha -765015

with a copy in all cases to the Company’s Representative:

Manager - Materials

Hindalco Industries Limited

Unit Aditya Alumina Refinery

Village Kansariguda, PO: Podapadi

Dist : Rayagada Odisha -765015

Head – Projects

- Port of Loading = [●]
- Port of Discharge = [●]



3.2.14 Property in EQUIPMENT (Title Transfer)

- i. In case of imported EQUIPMENT whether supplied on CFR basis, title to and property in EQUIPMENT shall pass to OWNER, FOB port of export or in the case of shipment by airfreight on delivery to the international airline at the port of export. Notwithstanding the transfer of the title to and property in EQUIPMENT to OWNER, CONTRACTOR shall carry out all obligations in regard thereto as stipulated in CONTRACT.
- ii. In case of EQUIPMENT purchased in India, title to and property in EQUIPMENT shall pass to OWNER, ex-works VENDOR shop. Notwithstanding the transfer of the title to and property in EQUIPMENT to OWNER, CONTRACTOR shall carry out all obligations in regard thereto as stipulated in CONTRACT.
- iii. CONTRACTOR shall arrange services of ocean transportation, carry out the services of port clearance on behalf of OWNER, take into possession the custody and care of GOODS handed over to CONTRACTOR by OWNER at the port of export for imported supplies and Ex-Works for indigenous supplies and inland transportation up to SITE, unloading, storage at SITE, transportation within SITE, complete services of erection, structural and PRE-COMMISSIONING, COMMISSIONING and PERFORMANCE AND GUARANTEE TEST runs for PLANT.
- iv. OWNER shall duly Authorize CONTRACTOR to take prompt action to file the papers with customs authorities on behalf of OWNER, for getting the GOODS cleared from Customs. Where the sale to or purchase by the CONTRACTOR is deemed to take place in the course of inter-state trade or commerce or by endorsement / transfer of railway receipt or trucks/ lorry or any receipts during transit, the sale to the OWNER of the same material shall similarly be deemed to take place by endorsement / transfer during transit in the course of Inter State Trade or Commerce. For GOODS purchased from within the state where the SITE is located, title to and property of GOODS shall pass to OWNER by endorsement / transfer of railway receipt or trucks / lorry receipt.
- v. As to GOODS purchased, OWNER shall handover the same to the CONTRACTOR as free issue at SITE for the purpose of installation into the Project. Notwithstanding the transfer of the title to and property in GOODS to OWNER, CONTRACTOR shall carry out



all obligations in regard thereto as stipulated in CONTRACT. The responsibility of receipt of material at SITE, its handling and its custody shall be with the CONTRACTOR, on behalf of the Owner.

- vi. CONTRACTOR's EQUIPMENT used by the CONTRACTOR and its SUB-CONTRACTORS in connection with the execution of works shall remain the property of CONTRACTOR or its SUB-CONTRACTORS. All duties, levies, taxes etc. payable on account of CONTRACTOR's EQUIPMENT shall be borne by the CONTRACTOR. CONTRACTOR shall indemnify the OWNER on this count. All forms & legal documents required for the transportation of CONTRACTOR's EQUIPMENT shall be in CONTRACTOR's scope and the Contractor shall never utilize E-way bill of Owner for Contractor's equipment's.
- vii. All construction surplus including imported surplus materials other than CONTRACTOR's EQUIPMENT and consumables, which is brought to the SITE after availing concessional rate of under Customs Duty under any project import benefit schemes, under GST for permanent incorporation in plant or to service it during operation and maintenance shall be the OWNER's property and be returned by the CONTRACTOR to the OWNER's designated stores. All such materials shall be subject to reconciliation and a proper accounting procedure shall be developed and strictly followed by the CONTRACTOR recorded in the inspection reports, proforma of which will be approved by the ENGINEER-IN-CHARGE. These reports shall form part of the completion DOCUMENTS. Inspection and acceptance of the WORK shall not relieve the CONTRACTOR from any of its responsibilities under this CONTRACT. All other surplus material apart from above, which belongs to the contractor and for which the owner have not made the payment shall be taken out by the contractor from time to time, with full account placed before Engineer-in-charge, Engineer-in Charge will allow Contractor to take out the material in best interest of maintaining Plant Fabrication area clean and in good house-keeping condition.



- viii. The care and custody responsibility of CONTRACTOR for EQUIPMENT shall terminate upon PRELIMINARY ACCEPTANCE of PLANT or the issuance of a conditional PRELIMINARY ACCEPTANCE CERTIFICATE (as envisaged under Sub-Clause 20.8 of SCC), whichever is earlier, or issuance of conditional PRELIMINARY ACCEPTANCE CERTIFICATE of PLANT, whichever is earlier.

3.2.15 Assembly Marks and Name Plates

- i. All component/parts of EQUIPMENT shall be indelibly hard marked with identification marks, comprising EQUIPMENT, part numbers, and CONTRACT number/PO number which shall also be shown on drawing to facilitate speedy identification, assembling or dismantling.
- ii. On each EQUIPMENT, a nameplate indicating basic details, pressure rating, wherever applicable, code number of EQUIPMENT, electrical characteristics in case of electrical EQUIPMENT, name of instrument with tag no., manufacturer's name shall be fixed at proper unobstructed place.
- iii. For packages where marking is not possible at least two metallic nameplates must be affixed. Marking on the plates will be by means of engraving or indelible paint and will include the information listed above.

3.2.16 Despatch/Shipping notice

- i. CONTRACTOR shall notify OWNER by fax/E-mail for its information the expected date of delivery of a consignment, date of readiness of EQUIPMENT for shipment, total gross weight and total volume with dimensions.
- ii. Heavy Lift Consignment (HLC) or Over Dimensional Consignments (ODC).



- iii. For Road Transport in India, packages exceeding one or more of the following measurements.

Weight 49 tons

Length 18 meters

Width 2.6 meters

Height 3.8 meters

will be considered as HLC's or ODC's (herein after referred to as ODC).

- iv. For railway transport in India, packages exceeding one or more of the following measurements will be considered as ODC:

Broad Gauge

Length 13716 mm

Maximum Width 2845 mm

Maximum Height 2743 mm

Top width at Max. Height 610 mm

Height of Max. Width 2133 mm

Weight 54 MT

- v. CONTRACTOR shall make his own arrangements for the movement of all consignments including ODC. For obtaining the approval of the Indian Railways, CONTRACTOR shall need to submit the particulars regarding each ODC to Railways.
- vi. The above is as per information available with OWNER. However, CONTRACTOR shall verify the same with concerned authorities. OWNER shall not be liable for any extra cost which CONTRACTOR incurs due to use of above information without verifying it.



- vii. CONTRACTOR confirms that it has surveyed the route for transportation of ODC items of EQUIPMENT and CONTRACTOR further confirms that it has included all cost of repairs of road, civil works, strengthening of bridges, culverts, widening of roads, etc. as required for transportation of ODC items of EQUIPMENT in its TOTAL CONTRACT PRICE.

3.2.17 Marking

CONTRACTOR shall mark the following on three sides of the packing, i.e., two sides and cover (Top) EQUIPMENT with indelible paint in conspicuous printed letters not less than

5 cm. in size in English:

For Imported EQUIPMENT

CONTRACTOR A/c (NAME of UNIT) or Name of the Group Company

- a) CONTRACT / PO No. : [•]
- b) Equipment Description and Item Nos. : [•]
- c) Package : [•]
- d) Gross / Net Weight (Kgs.) : [•]
- e) Dimension Lx W x H Cms : [•]
- f) WARNING MARKS (FRAGILE, ATTENTION, TOP, KEEP-DRY, ETC)
- g) Forwarding No. : [•]
- h) Part shipment / full shipment : [•]
- i) Each package shall bear a symbol contained in the package as follows:
 - 'A' Storage in a closed storehouse.
 - 'B' Storage under a shed.
 - 'C' Storage in the open.



- j) Other internationally practiced marking & symbol shall be painted on the package.

3.2.18 Packing List

- i. CONTRACTOR will include in each package an item-wise packing List, Invoice No. and associated drawings. One each inside the packing and other attached outside in waterproof envelop.
- ii. The packing list and any other documents shall be put in a closed polyethylene envelope and included in each package.

3.2.19 Shipping Arrangements and Forwarding of Documents

For arranging clearance of shipment at Indian Port of entry, one set of shipping document as under is to be dispatched by mail to CONTRACTOR's Clearing Agents/CONTRACTOR. Concurrently other copies and original shipping documents shall be submitted to the Bank and to officers of the OWNER also as given hereunder:



Documents	Owner's Finance Chief	Owner's ENGINEER-IN- CHARGE	Bank	Contractor's clearing agent / Contractor
Original B/L	NIL	NIL	1/3 original	1/3 original
Non- negotiable B/L	1 (copy)	1 (copy)	1 (copy)	2 (copy)
Packing List (including weights)	1 (copy)	1 (original)	1 (copy)	2 (copy)
Signed Commercial invoice	2 (copy)	1 (copy)	1 (original)	2 (copy)
Freight Bill	1 (copy)	NIL	NIL	1 (copy)
Certificate of origin (Signed)	1 (copy)	1 (copy)	1 (copy)	2 (copy)
Supplier's Test / Quality Certificate	1 (copy)	1 (original)	1 (copy)	1 (copy)
Inspection Certificate / Release Note issued by 3 rd Party / Contractor	1 (copy)	1 (original)	1 (copy)	1 (copy)
Certificates of confirmatory & phytosanitary certificate (4 copies)	1 (copy)	1 (original)	1 (copy)	1 (copy)

(The above table is based on payment through LC. In case of direct payment, bankers copy will go to Consignee)



3.2.20 Despatch/Shipment Notice and Insurance

- i. CONTRACTOR shall send intimations of despatches indicating items despatched, quantity, value, weight and carrier particulars directly through fax/email to the OWNER. A copy of this letter/ intimation shall also be given to commercial negotiating bank for payment against Letter of Credit, if applicable. Copies shall also be sent to OWNER.
- ii. For the portion of the Equipment to be supplied on delivered to Site basis, the Company shall take comprehensive marine cum storage cum erection insurance cover for such portion of the Equipment. The CONTRACTOR shall intimate the Company within 2 days of dispatch of each consignment, details of goods supplied as part of the Equipment, value and L.R./RR etc. as per requirement of the Policy.
- iii. CONTRACTOR shall provide, at its own expense, each of its Supervisors with appropriate life, sickness and accident insurance for the duration of their service at Site.
- iv. CONTRACTOR shall insure at its own expense any special erection and/or testing tools or instruments, which the Supplier may bring to the Site for the period of installation and commissioning of the Equipment.
- v. CONTRACTOR shall insure against its liability to third parties for damage or death or personal injury occurring before the Works have been taken over by Company, to CONTRACTOR's person or property, other than property forming part of the Works, due to or arising out of fault attributable to CONTRACTOR during execution of Works. Company shall take comprehensive marine cum erection insurance policy for entire Equipment from the date of first dispatch till the date of successful commissioning and taking over of Equipment by Company from CONTRACTOR.
- vi. In case any part of the Equipment damaged or lost during transit, storage or erection during execution of the Works until taking over of the Equipment, the Company shall lodge their claims with the concerned insurance company for such mishaps. The CONTRACTOR shall assist the Company in lodging such claim with relevant documents like FIR, Survey Report etc., failing which, financial implications, if any, for reasons attributable to the CONTRACTOR, shall be to CONTRACTOR's account. The CONTRACTOR shall supply, repair or replace the Equipment or goods or parts lost or damaged during transit, storage

or erection after the Company having placed fresh order on the CONTRACTOR in this regard at the same price and terms.

- vii. All Parties shall make available to each other a copy of the insurance policies within two (2) months after the date of the Contract. viii. Supplier shall at his own expenses carry and maintain insurance with reputable insurance companies to the satisfaction of the Company as follows:

3.2.20.1 **Employees State Insurance Act**

3.2.20.1.1 The CONTRACTOR agrees to and does hereby accept full and exclusive liability for the compliance with obligations imposed by the Employees State Insurance Act, 1948, as amended from time to time and the CONTRACTOR further agrees to defend, indemnify and hold the Company harmless from any liability or penalty which may be imposed by Central, State or Local Authority by reason of any asserted violation by CONTRACTOR or Sub-Contractor of the Employees State Insurance Act, 1948, and its amendments and also from all claims, suits or proceedings that may be brought of by reason of the work provided for by the Contract whether brought by employees of the CONTRACTOR, the Sub-Contractor or his employees by third parties or by Central or State Govt. Authority or any administrative subdivision thereof, or other local authorities.

3.2.20.1.2 CONTRACTOR agrees to fill in with ESIC, the declaration forms and all forms which may be required in respect of CONTRACTOR's or Sub-Contractor's employees, whose aggregate remuneration is Rs. 10,000.00 per month or less or such other sums as the said act may provide and who are employed in the work provided for or those covered by ESI from time to time under the agreement. CONTRACTOR shall deduct and secure the agreement of the Subcontractor to deduct the employees' contribution as per the first schedule of the ESI Act from wages and affix the employee's contribution shall remit and secure the agreement of Subcontractor to remit to State Bank of India, ESIC accounts, the employer's contribution as required by the act, the term employer being understood as the Supplier.



3.2.20.1.3 CONTRACTOR agrees to maintain all cards and records as required under the act in respect of employees and payments and Supplier shall secure the agreement of the Sub-Contractor to maintain such records. Any expenses incurred for making contributions or maintaining records whether by Supplier or his Sub-Contractor shall be to the Supplier's account.

3.2.2.1.4 Company shall retain such sum as may be necessary from Contract Price until Supplier shall furnish satisfactory proof that all contributions as required by ESI Act, 1948, and its amendments from time to time have been paid.

3.2.20.2 **Workman's Compensation & Employer's Liability Insurance**

Insurance shall be affected for all CONTRACTOR's employees engaged in the performance of Contract. If any of the work is sublet, CONTRACTOR shall require Sub-Contractor to provide workman's compensation and employer's responsibility insurance for latter's employees if such employees are not covered under Supplier's Insurance.

3.2.20.3 **Automobile Liability Insurance**

CONTRACTOR shall take out automobile liability insurance to cover all risks to the Company for each of his vehicles plying on works of the Contract and this insurance shall be valid for the total Contract Period. No extra payment shall be made for this insurance. The Company shall not be liable for any damage or loss not made good by the insurance company, should such damage or loss result from unauthorized use of vehicle.

3.2.20.4 Any other Insurance required under Law or Regulations or by the Company

3.2.20.5 CONTRACTOR shall also carry and maintain any and all other insurance, which he may be required under any Local/ National law or regulations from time to time. He shall also carry and maintain any other insurance, which may be required by the Company.

3.2.20.6 Both Parties shall make available to the other a copy of the insurance policies within three (3) month after the date of signing the Contract.

3.2.21 **Spares, Special Maintenance Tools, Lubricants, Chemicals, Utilities and Consumables**

CONTRACTOR shall strictly follow the Scope of Work for **Spares, Special Maintenance Tools, Lubricants, and Chemicals** as mentioned in **Section C8**.

3.2.21.1 **Water Supply:**

- a) Unless otherwise provided in the Contract, the CONTRACTOR shall be responsible for the arrangements to obtain supply of water necessary for the works, his labour colony, his workshops, his offices etc. All pumping installations, pipe network and distribution system shall have to be carried out by the CONTRACTOR at his own cost.
- b) Company may agree to supply water to Supplier for use in Company's works on specified terms & conditions as shall be determined by Company, which shall be binding on CONTRACTOR. CONTRACTOR is however required to exercise his option to receive such water supply from Company's main at the time of submission of bid.
- c) When the Company supplies the water, the Company's main shall be within 500 metres from the site of work. The Supplier shall provide at his own cost, all necessary ferrules, pipes, fitting, couplings and tanks and temporary works required, and he shall maintain all such works in satisfactory condition. The CONTRACTOR shall remove all such works and shall reinstate and make good any work disturbed, to the satisfaction of the EIC.
- d) In event of Supplier's drawing water from the Company's main/source, he shall not claim any compensation for interruption or failure of Company's water supply caused due to any reasons beyond the control of the Company. The water so supplied by the Company shall be free of cost for the Construction work only.
- e) Construction Water shall be provided by Company (free of cost) within battery limits of each section / unit and at Contractor's construction infrastructure locations. Further distribution shall be done by Contractor at his own cost. Any other statutory requirement shall be met by the Contractor.



3.2.21.2 Power Supply:

- a) Subject to availability, Company shall supply power at 415V at only one point at the nearest substation, from where the CONTRACTOR shall make his own arrangement for temporary distribution. The point of supply shall not be more than 500 meters away from the CONTRACTOR's premises. All the work shall be done as per IEA regulations and passed by EIC. The temporary line shall be removed forthwith after the completion of work or if there is any hindrance caused to the other works due to the alignment of these lines; the CONTRACTOR shall re-route or remove the temporary lines at his own cost. The CONTRACTOR at his cost shall also provide suitable electric meter, fuses, switches, etc. for purposes of payment to the Company, which should be in the custody and control of the Company. The Company shall not, however, guarantee the supply of electricity and no compensation for any failure or short supply of electricity shall be entertained and this does not relieve the CONTRACTOR of his responsibility for timely completion of this works as stipulated in the contract.
- b) It shall be the responsibility of the CONTRACTOR to provide and maintain the complete installation of the load side of the supply with due regard to safety requirement at site. All cabling, equipment, installations etc. shall comply in all respects with the latest statutory requirements and safety provisions i.e. as per and the Central/ State Electricity Acts and Rules etc. The CONTRACTOR shall ensure that his equipment and Electrical wiring etc. are installed modified, maintained by a licensed electrician/Supervisor. A test certificate is to be produced to EIC for his approval before power is made available.
- c) At all times, IEA regulations shall be followed failing which Company has a right to disconnect the power supply without any reference to the CONTRACTOR. No claim shall be entertained for such disconnection by EIC. Power supply shall be reconnected only after production of fresh certificate from authorized electrical supervisors.
- d) The Company is not liable for any loss or damage to the CONTRACTOR's equipment as a result of variation in voltage or frequency or interruption in power supply or other loss to the CONTRACTOR arising there from.

- e) The Supplier shall ensure that the Electrical equipment installed by him are such that average power factor does not fall below 0.90 at his premises. In case power factor falls below 0.90 in any month, he shall reimburse to the Company at the penal rate determined by the Company for all units consumed during the month.
- f) The Supplier shall have to provide and install his own light and power meters, which shall be governed as per Central/State Government Electricity Rules. The Company shall seal the meters.
- g) In case of damage to any of the Company's equipment on account of fault, intentional or unintentional on the part of the CONTRACTOR the Company reserves the right to recover the cost of such damage from the CONTRACTOR's bill. Cost of HRC Fuses replaced at the Company's terminals due to any fault in the Supplier's installation shall be to CONTRACTOR's account at the rates decided by the EIC.
- h) Only motors up to 3HP shall be allowed to be started direct online. For motors above 3HP and up to 100 HP a suitable starting device approved by the EIC shall be provided by the CONTRACTOR.
- i) The CONTRACTOR shall ensure at his cost that State Electricity Inspector approves all electric lines & equipment and all installations before the Company can supply power.
- j) The CONTRACTOR along with his bid shall indicate the total requirement of power.
- k) Construction Power shall be provided by Company (free of cost) within battery limits of each section / unit and at CONTRACTOR's construction infrastructure locations. Further distribution shall be done by CONTRACTOR at his own cost. Any other statutory requirement shall be met by the CONTRACTOR with the consent and approval of Company's or EIC. However, in case the Company is not in a position to provide Construction Power due to Grid failure of State Electricity Board or any other reason whatsoever, CONTRACTOR shall make his own arrangement for Construction Power without affecting the work schedule. No claim whatsoever shall be entertained on account of non-availability of Construction Power from Company except that the generation cost including cost of diesel shall be reimbursed to CONTRACTOR for construction power generated by him due to non-availability of construction power from Company.

l) The CONTRACTOR has to arrange and install switchboards with HRC fuses and switches including cable of required length (from Company supply to Contractor's main board and further distribution Boards) of appropriate size and capacity at his own cost. Power supply shall be made available only after fulfilling the above requirements.

3.2.21.3 Construction Surplus & Scrap

Any scrap, construction surplus material including cement, steel, pipes, fittings, cables, other bulk material, etc. resulting from execution of WORK, for which OWNER has made payments to CONTRACTOR, shall be the property of OWNER and CONTRACTOR shall not take these materials out of SITE.

3.2.22 CONSTRUCTION / EARTH-MOVING EQUIPMENT AND RIGGING TOOLS, TACKLES

- i. All necessary Tools, Tackle and Equipment required for execution of the WORK including Welding machines, Gas cutting sets, grinding machines, Winches, cranes, pull-lifts, forklifts, excavators, dozers, pay-loaders, Jack Hammers, Lifting & Shifting devices, Pan Mixers, Pneumatic rammer, Concrete mixers, Concrete Vibrators, Pneumatic Portable Air Compressors, Chisels, Hammers, Weigh Batching machines, Transit Mixers, Trailers, tipper trucks, Lorries, etc. shall constitute CONTRACTOR's EQUIPMENT and have to be arranged by the CONTRACTOR at his own cost including the cost of fuel & consumables, as required. CONTRACTOR shall prepare templates, jigs and fixtures for fabrication of structures / positioning of bolts, sleeves, inserts etc. wherever necessary, at no extra cost to the OWNER.

3.2.23 Warrantees and Guarantees

- i. **Materials and Workmanship Warranty**
 - a) CONTRACTOR warrants that EQUIPMENT supplied under CONTRACT are new, unused, of the recent or current models and incorporate all recent improvements in design and materials unless provided otherwise in CONTRACT.
 - b) The warranty period for EQUIPMENT supplied by CONTRACTOR shall be valid for 12 months for all EQUIPMENT from PRELIMINARY ACCEPTANCE or the issuance of a

conditional PRELIMINARY ACCEPTANCE CERTIFICATE (as envisaged under Sub-Clause 20.8 of SCC), whichever is earlier.

- c) The warranty shall be valid for the period as described under Clause 3.2.23 i(b) from the date of PRELIMINARY ACCEPTANCE or the issuance of a conditional PRELIMINARY ACCEPTANCE CERTIFICATE (as envisaged under Sub-Clause 20.8 of SCC), whichever is earlier, and shall be governed by Clause 19 of SPECIAL CONDITIONS OF CONTRACT. Should any DEFECTS be noticed in design, material and/or workmanship within the said warranty period, ENGINEER-IN-CHARGE shall inform CONTRACTOR and CONTRACTOR shall immediately on receipt of such intimation depute their personnel within 10 DAYS to investigate the causes of DEFECTS and arrange rectification /replacement / modification of the defective EQUIPMENT at SITE without any cost to OWNER, within a reasonable period mutually decided. If CONTRACTOR fails to take proper corrective action to replace/ repair defective Equipment satisfactorily within a reasonable period, OWNER shall be free to take such corrective action as may be deemed necessary at CONTRACTOR's risk and cost, after giving notice to CONTRACTOR. OWNER shall promptly notify CONTRACTOR in WRITING of any claims arising under this warranty.
- d) In case defects are of such nature that EQUIPMENT shall have to be taken to CONTRACTOR's/ SUB-CONTRACTOR's/ vendor's works for rectification etc., CONTRACTOR shall take EQUIPMENT at its own cost after giving necessary undertaking or security as may be required by OWNER. OWNER shall, if so, required by CONTRACTOR, despatch EQUIPMENT by quickest mode on freight to pay basis to CONTRACTOR's / SUB-CONTRACTOR's / vendor's works. After repairs CONTRACTOR shall deliver EQUIPMENT at SITE on freight paid basis. All risks to transit to and from shall be borne by CONTRACTOR.
- e) EQUIPMENT or part thereof so repaired or replaced shall have further warranty for a period of 12 months from the date of its acceptance after repair/replacement and the performance bank guarantee shall be suitably extended for the same subject to an upper limit of 60 months from date of PRELIMINARY ACCEPTANCE or the issuance of a conditional PRELIMINARY ACCEPTANCE CERTIFICATE (as envisaged under

Sub-Clause 20.8 of SCC), whichever is earlier. The value of the performance bank guarantee during the extended warranty period shall be for a sum equivalent to the estimated and mutually agreed prices of such repaired/replaced EQUIPMENT or its parts subject to a maximum of 5% of the TOTAL CONTRACT PRICE.

- f) If the repairs, replacements or modifications referred to above are of such nature which may affect the efficiency of EQUIPMENT, OWNER shall have right to give notice in WRITING to CONTRACTOR within one month of such repair/ replacement/ modification to carry out tests as may be required for acceptance of EQUIPMENT.
- g) If CONTRACTOR fails to meet its obligation to repair or replace defective EQUIPMENT and make it good within a reasonable period of time mutually decided and or if CONTRACTOR refuses to carry out WORK under the guarantee clause conditions and/or in case of severe urgency, OWNER shall be entitled to carry out repair/replacement/WORK or arrange to carry out repair/ replacement/WORK by a third party. The entire cost of such repair/ replacement/WORK including taxes and duties etc.; shall be borne by the CONTRACTOR. In case, the cost of such repair/replacement/WORK has been incurred by OWNER, CONTRACTOR shall reimburse the same immediately on demand by OWNER.
- h) Damages to EQUIPMENT deriving from incomplete, erroneous instructions issued by CONTRACTOR will be considered CONTRACTOR's fault and will be treated according to the provision of warranty clause. Normal wear and tear shall not come under purview of this clause.

3.2.24 Performance Guarantee of PLANT / EQUIPMENT

- i. CONTRACTOR guarantees that the performance of PLANT supplied under CONTRACT shall be strictly in conformity with the specifications and shall perform the duties and have consumption, production and other guarantees set forth in CONTRACT.



- ii. If the performance of PLANT and/or any of EQUIPMENT fails to be as guaranteed and set forth in FINAL PROPOSAL, CONTRACTOR shall investigate the causes and provide free of cost to OWNER, design, engineering, MATERIALS and services and EQUIPMENT within a reasonable period to prove guarantees. CONTRACTOR's liability to demonstrate guarantees as set forth in the FINAL PROPOSAL shall be in accordance with the provisions of CONTRACT.
- iii. CONTRACTOR shall confirm the acceptance to the Performance Guarantee as mentioned in Annexure-II to SCC.

3.2.25 Government Clearances, Permits and Certificates

- i. CONTRACTOR shall procure at its expenses, all necessary applicable permits, certificates and licenses required by virtue of all applicable laws, regulations, ordinances and other rules in effect and any amendments if any at the place where any of WORK is to be performed as stipulated under clause 56.1 of GCC, and CONTRACTOR shall further hold OWNER harmless from liability or penalty which might be imposed by reason of any asserted or established violation of such laws, regulations, ordinances or other rules. OWNER will provide the necessary assistance to CONTRACTOR for obtaining PERMITS for CONTRACTOR's personnel to undertake WORK in India in connection with CONTRACT.
- ii. CONTRACTOR shall provide necessary information, data of EQUIPMENT, other documentation and assistance to OWNER, as required, for complying with the requirements of Banks / financial institutions or any other Government agencies or authorities.

3.2.26 Network Schedule

I. Project Master Schedule

- i. OWNER shall utilize a computerized time and cost monitoring system (e.g. latest version of Primavera) and CONTRACTOR shall provide necessary input data for the same. CONTRACTOR shall prepare within 30 (thirty) days from EFFECTIVE DATE OF

CONTRACT and provide to OWNER a Project Master Schedule indicating the important milestones of activities relating to WORK from EFFECTIVE DATE OF CONTRACT to the date of FINAL ACCEPTANCE. This Project Master Schedule shall be discussed with and approved by OWNER. Based on the approved Project Master Schedule, CONTRACTOR shall prepare SOFTWARE based network schedules on Primavera or similar software for planning, scheduling and monitoring for of activities relating to WORK. CONTRACTOR shall obtain the details of progress of various activities of WORK from SUB-CONTRACTOR and VENDOR wherever required and update the network schedules and Project Master Schedule incorporating the progress achieved by CONTRACTOR, SUB-CONTRACTOR and VENDOR and submit the same to ENGINEER-IN-CHARGE on monthly basis in soft form as well as hard copies along with brief comments on actual progress visa-vis planned progress based on the Project Master Schedule

CONTRACTOR shall clearly indicate any delay in WORK in the above schedules and shall inform ENGINEER-IN-CHARGE the action taken to achieve the GUARANTEED COMPLETION DATE.

II. Time Schedule Network/Bar Chart – Detail Planning package

The WORK shall be executed strictly in line with the time schedule given in **Annexure - III to SCC.**

- a) Within 30 (thirty) DAYS from EFFECTIVE DATE OF CONTRACT, CONTRACTOR shall submit to ENGINEER-IN-CHARGE its time schedule regarding delivery of Design / Engineering and documentation, supply and manufacture of EQUIPMENT, time schedule for placement of purchase order and SUB-CONTRACT, etc.
- b) The time schedule will be in the form of a network and a bar chart clearly indicating all main or key events regarding documentation, supply of raw materials, manufacturing, testing and delivery of equipment, Civil, Mechanical, Electrical and instrumentation works, erection, commissioning, testing etc.

- c) The original issue and subsequent revisions of such time schedule shall be sent to OWNER in two copies (of which one shall be a reproducible/soft copy). The time schedule network/bar chart shall be updated at least once every month for the period of CONTRACT. However, should there be a specific need during any stage of execution of the project, ENGINEER-INCHARGE may advise CONTRACTOR to update the Network twice a month and such request shall not be unreasonably denied.

3.2.27 Progress of WORK

- i. CONTRACTOR shall report to OWNER of the execution of CONTRACT and achievement of targets set out in time bar chart, in a monthly progress report latest by 5th of every Month with “status cut-off date” mutually decided. During the peak period of project execution, daily/weekly progress on critical activities, identified and mutually agreed between the OWNER and CONTRACTOR for close monitoring, shall be generated and submitted electronically to OWNER’s core project team.
- ii. Progress shall be expressed in percentages for all activities.
- iii. The monthly progress report shall be forwarded together with the time bar chart.
- iv. OWNER shall also review the physical/actual progress of WORK on the basis of CONTRACTOR’s time schedule documentation.
- v. Irrespective of such review, CONTRACTOR shall advise OWNER at the earliest possible date of any anticipated delay in the progress.
- vi. In the event that the delay is caused by a delay in the delivery of a sub-contracted the event that the delay is caused by a delay in the delivery of a sub-contracted EQUIPMENT, CONTRACTOR shall be responsible for such delay and submit details together with copies of the appropriate orders an agreement with SUB-CONTRACTOR/VENDOR.
- vii. Notwithstanding the above, in case progress on the execution of CONTRACT at various stages is not as per time schedule and is not satisfactory in the opinion of

OWNER, which shall be conclusive or if CONTRACTOR shall neglect to execute CONTRACT with due diligence and expedition or shall contravene the provision of CONTRACT, OWNER may give notice of the same in WRITING to CONTRACTOR calling upon him to make good the failure, neglect or contravention complained of. Should CONTRACTOR fail to take necessary corrective measures within 30 (thirty) DAYS from the date of receipt of OWNER's notice provision of clause 32.0 of GCC shall apply.

3.2.28 Transportation and Storage of EQUIPMENT

- i. CONTRACTOR shall be responsible for proper packing, transportation from vendor's workshop to port or railway station (whether by road, rail, ship or aircraft), handling and clearances at port or railway station including loading and unloading, customs clearance, carriage to SITE, unloading at SITE, warehousing, coding and tagging, storage including proper preservation, etc. of EQUIPMENT. Any special clearance, lifting, handling, loading/unloading, and transport arrangements for over dimensional consignments shall also be done by CONTRACTOR. CONTRACTOR shall ensure timely delivery of EQUIPMENT. CONTRACTOR shall be responsible for inspection of EQUIPMENT on receipt at SITE and for management of stores and warehousing of EQUIPMENT at SITE including all activities connected with the issue of EQUIPMENT, accounting and final reconciliation and handing over of stores to OWNER with proper codification of all applicable materials.
- ii. OWNER shall provide area at SITE for making shed/covered stores etc. for storing EQUIPMENT. CONTRACTOR shall be responsible for making shed/covered stores, etc. for safe storage of EQUIPMENT.
- iii. CONTRACTOR shall do preliminary coding of all spares and construction surplus as per OWNER's material codification guidelines, obtain final code for each item/spares part and mention code while handing over the same to OWNER's stores / warehouse.

3.2.29 Construction

- i. CONTRACTOR shall be responsible for all civil and structural work, foundations, insulating & painting works, erection, site fabrication, piping, instrumentation, electrical installation, and other miscellaneous construction jobs of PLANT leading to MECHANICAL COMPLETION and PRELIMINARY ACCEPTANCE of PLANT. CONTRACTOR shall organise these activities in appropriate sequence and use proper methods giving due regard to the requirements of safety, quality, sound engineering practice and compliance with relevant Codes.

The CONTRACTOR shall within the scope of work observe in addition to specifications, all national and local laws, ordinances, rules and regulations and requirements pertaining to the WORK. Various procedures and methods to be adopted by CONTRACTOR during the construction as required in the respective specifications shall be submitted to OWNER in due time and well in advance of the specific work for approval.

The CONTRACTOR shall carry out required supervision as per Quality Assurance Plan and furnish all assistance required by the OWNER in carrying out inspection work. The OWNER will have authorised representatives present who shall have free access to the WORK at all times. If an OWNER's representative notifies the CONTRACTOR's representative of any deficiency in any work or in the supervision thereof, the CONTRACTOR shall make every effort to carry out such instructions consistent with best industry practice.

The CONTRACTOR shall so far as reasonably feasible employ skilled workers who are Certified Tradesmen in the field(s) of their relative activities(s).

- ii. CONTRACTOR shall submit and adhere to the completion schedule of construction, which is intended for monitoring and controlling by OWNER, it being expressly understood that only the GUARANTEED COMPLETION DATE is guaranteed by CONTRACTOR as set out herein.
- iii. In case of delay beyond GUARANTEED COMPLETION DATE for reasons:
- a) not attributable to OWNER
 - b) not due to FORCE MAJEURE
 - c) not due to suspension of WORK by OWNER

d) not due to suspension of WORK by CONTRACTOR under clause 45.3 of GCC

all extra costs on account of changes of statutory regulations/Acts, taxes and duties or increase in price on any other account, shall not apply to TOTAL CONTRACT PRICE and the same shall be borne by CONTRACTOR.

3.2.30 **Civil Work Warranty**

CONTRACTOR shall certify that all civil works, reinforced concrete, structures, permanent buildings and foundations have been designed and constructed in accordance with stipulations of relevant BIS Codes and best engineering design practices.

3.2.31 **Safety and Plant Security**

- i. CONTRACTOR shall observe and also use its best efforts to ensure that all parts of WORK carried out at SITE is being done in a safe and satisfactory manner conforming to the applicable Safety Rules and Regulations. Further, CONTRACTOR shall observe and make provisions in SUB-CONTRACT that employees working for PLANT observe all the Safety Rules as required under the Factories Act and Regulations and other Local Laws and SUB-CONTRACTOR to provide safety apparel and equipment to all its employees. OWNER shall have the right to object to any unsafe practice followed by SUB-CONTRACTOR's employees or any CONTRACTOR's personnel and direct them to carry out the job in a manner considered safe by OWNER. CONTRACTOR shall further abide by all the Security Regulations imposed by OWNER and shall identify an independent safety team under a qualified senior safety officer.
- ii. CONTRACTOR shall observe all safety rules so that no harm is done to OWNER's employees or property. If on account of CONTRACTOR, OWNER's property or personnel are likely to suffer any damage, in such cases any directions issued by OWNER shall be carried out by CONTRACTOR. Following will be also included in the scope of Contractor:
 - a. Maintain First Aid Centre for all contractor employees.
 - b. Maintain properly equipped Ambulance with para-medical staff in attendance.



- iii. CONTRACTOR shall follow all HSE requirements of HIL as mentioned in Section C4, Rev R0 of the Tender Documents.

3.2.32 **PRE-COMMISSIONING Services of PLANT**

- i. Pre-commissioning is testing individual, stand-alone components for correct installation and functioning such as motor rotational checks, air cooler run-ins, loop testing and cleaning activities such as flushing, air- or steam blowing and chemical cleaning. Activities like steam boiler boil-out, drying of furnaces and drying out furnace or reactor refractory and subsequent curing are also considered pre-commissioning activities.
- ii. Depending upon the complexity of the equipment or systems, the contractor shall carry out pre-commissioning checks of systems, subsystems or components. Involvement of vendor representatives and process licensor if required, shall be arranged by the contractor to ensure adherence to their requirements during construction and confirmation of their acceptance of the installation. However, as a minimum, they shall provide checklists and procedures for pre-commissioning checks on their equipment or systems.

3.2.33 **Mechanical Completion (M/C)**

Mechanical Completion is the point in time where all subsystems and systems in a facility (or part of) have reached a final stage in construction and pre-commissioning activities and can be regarded as completed with the exception of punch list items. The Contractor shall be responsible for mechanical completion in order to have the facilities boxed up and leak tested. All mechanical items like static equipment, rotating equipment etc. shall be installed, all civil and structural items completed, and piping and in-line instruments are reinstated after hydro-testing and cleaning.

3.2.34 **Commissioning Services of Plant & START-UP**

- i. Commissioning involves site/field-based execution of commissioning plan. Commissioning is testing completed systems (consisting of several individual, stand-alone components) for correct functioning such as establishing circulations, functionally testing complex control

loops, emergency shutdown systems, anti-surge testing for centrifugal compressors and run-in & calibrating reciprocating compressor and their control systems. Typical activities in Contractor's scope include but are not limited to:

- Conduct Pre-Start-up Safety Reviews (PSSRs)
 - Take control of turned over systems/sub system.
 - Implement Lockout Tagout (LOTO) procedure for Commissioning and Start-Up
 - Calibration and testing of equipment, instruments, prior to start-up with a special focus on Safety devices such as pressure safety valves, rupture discs, fire detection & protection systems, emergency shutdown systems, etc.
 - Ensure timely liquidation of Punch List items.
 - Energize and commission turned over systems.
 - Personnel training
 - Coordinate availability of Process Licensor and Vendors' representatives for Commissioning, Start-Up and Performance Guarantee test, as applicable
- ii. The ready for START-UP is the point in time, where a facility is mechanically completed, leak tested, components functionally tested and ready to be started up. All statutory authorities shall be suitably informed by the contractor about start-up date and permission requested where ever applicable. Plant commissioning shall continue with initial system operation and verification of the system's operability per design.

The functionality of the overall plant shall be demonstrated at normal operating conditions from cold shutdown to full capacity. During this phase, system response tuning shall be optimized, process control set points refined, emissions controls placed into service and the unit is readied for Normal Operation by the Contractor.

3.2.35 Performance Guarantee (PG) Test



- i. Performance Guarantee Testing of the plant is a fully recorded test that shall be carried out by contractor to prove with evidence that it is performing at the contractually guaranteed parameters such as efficiencies, catalyst activity, product specifications, raw material and utility consumptions etc.
- ii. Typically, Performance Guarantee (PG) Tests are carried out after start-up, when the plant or system or equipment is operating in a reasonably stable manner. Execution of the Performance Guarantee Test is dictated by the term and conditions of Performance Guarantee in the contract. Performance Guarantee testing activities should be halted and corrective action taken if problems are discovered during the Performance Guarantee tests. Owner shall provide the design feedstock and facilities to support the Performance Guarantee tests.
- iii. Owner and its representatives (Consultant or Process Licensor's personnel) shall be associated and witness the complete PG test, to satisfy that Plant capability as per Contract is acceptable.

3.2.36 Post-COMMISSIONING Services (Optional)

CONTRACTOR shall arrange to provide the services of engineers, operators and technicians in any process and/or utility plant after PRELIMINARY ACCEPTANCE for a maximum period of 12 months, if so, required by OWNER, under the terms and conditions to be mutually agreed as per the optional rates given by the CONTRACTOR in Schedule of Prices.

3.2.37 Laws and Regulations

CONTRACTOR shall abide, while fulfilling its obligations, by all applicable CODES and applicable laws from time to time in force in the State and Country. FINAL PROPOSAL shall be based on the codes and regulations as applicable on date of submission of Final Priced Bid after which no opportunity would have been available to CONTRACTOR for revision in price.



In the event of change in any CODES, LEGISLATION (excluding Minimum Wages Act or any other law governing minimum wages / salaries) applicable to PLANT after submission of Final Revised Priced Bid, which alters the scope of CONTRACTOR's obligations under CONTRACT and which results in increase in cost, CONTRACTOR shall agree to make the necessary changes in scope of WORK and/or TOTAL CONTRACT PRICE. Such changes shall be governed by a CHANGE IN WORK/CHANGE ORDER as per the provisions of Clause 5.0 of SCC.

3.2.38 Statutory Obligations

- i. CONTRACTOR shall comply with the requirements of statutory provisions and shall be solely responsible for fulfilment of all legal obligations under Contract Labour (Regulation and Abolition) Act, Inter-state Migrant Workmen (Regulation of Employment and conditions of Service) Act, Payment of Wages Act, Workmen Compensation Act, Factories Act, Employees Provident Fund and Misc. Provisions Act, Payment of Bonus Act, Payment of Gratuity Act, Industrial Disputes Act and all other applicable Industrial/Labour enactment and Rules made there under, as applicable, from time to time. In case OWNER incurs any liability as a principal employer towards payment of any kind whatsoever, due to non-fulfilment of statutory provisions under any industrial/labour law by CONTRACTOR, the same shall be made good by CONTRACTOR.
- ii. SUB-CONTRACTOR engaged by CONTRACTOR for performing civil and erection work/other jobs at SITE shall have all relevant authorisation like PF Code No. in its name issued by Regional Provident Fund Commissioner (RPFC) as prevalent in India.
- iii. The CONTRACTOR shall ensure that the SUB-CONTRACTOR shall comply with the Statutory Requirements, as applicable, for the execution of this CONTRACT.

3.2.39 Progress Monitoring and Reporting

CONTRACTOR shall develop a suitable system for monitoring and reporting progress and submit Project Master Schedule and detailed Network Schedule covering the activities and milestones as described under Clause 3.2.26. The above-mentioned schedules shall include the activities of CONTRACTOR, SUB-CONTRACTOR and VENDOR. These reports will also include progress at VENDOR's workshops and shall be supplemented with photographs, wherever necessary. The Clause 16.2.2 of GCC may as well be referred for the above.

3.2.40 Technical Information

CONTRACTOR shall furnish to OWNER, CONTRACTOR's Technical Information and know-how as may be necessary for the operation of PLANT and relating to its own process or process acquired from the Process Licensor under the license agreement referred to in sub-Clause 3.2.2. CONTRACTOR shall grant or cause to be granted to OWNER an irrevocable right to use all technical information for PLANT; and shall further advise OWNER for a period of five (5) years from date of PRELIMINARY ACCEPTANCE of any improvements in process, know-how, engineering, operation methods, and other conditions which will result in more efficient operation of PLANT that are developed by CONTRACTOR at no extra cost to OWNER. OWNER shall also grant to CONTRACTOR, at no extra cost to CONTRACTOR, the same right on OWNER's improvements as per the provisions of this Clause. Notwithstanding the generality of the foregoing, ownership of data, technical information, processes, technology or software proprietary to CONTRACTOR and/or SUB-CONTRACTORS shall remain with CONTRACTOR and/or SUB-CONTRACTORS. CONTRACTOR and/or SUBCONTRACTORS shall ensure that OWNER is legally entitled to use of such data, processes, technology and software in the form of a perpetual, non-exclusive, royalty-free license for the operation and maintenance of the PLANT.

3.2.41 Work of SUB-CONTRACTOR and VENDOR

CONTRACTOR shall remain responsible for proper execution of such part of WORK as are carried out by its SUB-CONTRACTOR and vendor and any failure of SUB-CONTRACTOR/VENDOR shall not relieve CONTRACTOR of its obligations under CONTRACT. Furthermore, in the event of any default by SUBCONTRACTOR/VENDOR,

CONTRACTOR shall either take over SUB-CONTRACTOR/VENDOR's part of WORK on mutually agreed terms or take remedial action as may be necessary in order to comply with GUARANTEED COMPLETION DATE and any other activities leading to PRELIMINARY ACCEPTANCE by OWNER.

3.2.42 Co-ordination

CONTRACTOR shall render all necessary assistance to ENGINEER-IN-CHARGE required for overall coordination of all activities connected with WORKS. For this purpose, CONTRACTOR and ENGINEER-INCHARGE shall agree on a meeting as soon as practicable after EFFECTIVE DATE OF CONTRACT, with SUBCONTRACTORS/VENDOR's and such other parties as are necessary to settle the following:

- a) Review the basic design conditions set forth in CONTRACT and where appropriate, review possibilities of standardisation with any similar existing facility of OWNER.
- b) Assess the priorities and key dates required to be included in CONTRACTOR's Project Master Schedule.
- c) Make an assessment of all items requiring co-ordination.
- d) Fix up a date and agenda of Project Kick-Off meeting, any subsequent meeting, and SITE take over date and SITE kick-off meeting, as may be required, in association with OWNER.
- e) Discuss with ENGINEER-IN-CHARGE and furnish all technical information about various effluents/emissions and discharge points from different sources indicating the quality and quantity of gaseous and liquid emission of pollutants from PLANT. CONTRACTOR shall also supply ENGINEER-IN-CHARGE any additional information required on the above matter during the performance of process design and basic engineering design.

In the event, ENGINEER-IN-CHARGE pursuant to its responsibilities of overall coordination, requests CONTRACTOR to make any alteration to the programme, scope of responsibility under CONTRACT, CONTRACTOR shall do the same, subject to the provisions of Clause 5.0.

3.2.43 Notices and Reports

CONTRACTOR shall submit the following copies of notices to ENGINEER-IN-CHARGE as part of the.

Scope of Work:

- a) Immediate notification of safety incidents and accidents, including near misses, of any kind or type followed as soon as possible after such event by a full report.
- b) Notices from any Government / Statutory Agency or any other Person for a violation of any Law or Government Approval, immediately upon receipt by CONTRACTOR and no later than twenty-four (24) hours after its receipt.
- c) Inspection reports by any inspector whether relating to any accident, accepting any test reports or otherwise immediately upon receipt by CONTRACTOR and no later than two (2) working DAYS after its receipt.

3.2.44 **CONTRACTOR's Representative and Key Personnel**

- i. CONTRACTOR shall with prior consent of ENGINEER-IN-CHARGE appoint a Contract Manager to manage the execution of WORK and to be CONTRACTOR's Representative (in India in case of foreign contractors). CONTRACTOR's personnel stationed at SITE for providing services during the execution of WORK shall work under the supervision and guidance of Contract Manager. The Contract Manager shall have the full authority to make binding and enforceable representations in the name of CONTRACTOR and shall receive all notices/correspondence that OWNER serves on CONTRACTOR.

This arrangement will not however relieve the contractor of their responsibility and accountability of Top management personnel of contractor, including the reporting office of the contractor, Manager or Sponsor identified for this contract within Contractor's organisation. ENGINEER-IN-CHARGE may requisition presence/ visit of such senior personnel of contractor to meeting / site visit to decide important issues / concerns.

- ii. CONTRACTOR shall be responsible and accountable for the work performed by Contract Manager and CONTRACTOR's personnel and shall under no circumstances be relieved

of its responsibilities and obligations under CONTRACT on account of acts or omissions of Contract Manager and personnel.

- iii. The Key Personnel shall hold the staff positions as indicated in CONTRACT. CONTRACTOR shall use reasonable efforts to ensure that such Key Personnel will be engaged in the execution of WORK continuously until their role is completed unless prior release is approved by OWNER, such approval not to be unreasonably withheld or delayed. Replacement of or addition to Key Personnel shall only be made with persons having qualifications and experience equal to or better than those replaced or added to and shall be similarly subject to OWNER's prior approval. In the event, any person identified in CONTRACT decides to leave the employment of CONTRACTOR, CONTRACTOR shall use reasonable efforts to retain the services of such person until his portion of WORK is complete. CONTRACTOR further agrees not to remove from WORK Key Personnel, which OWNER considers to be necessary for the proper performance of WORK without the prior written approval of OWNER.
- iv. In case one or more key personnel of CONTRACTOR leaves WORK and CONTRACTOR is not able to control the attrition of key personnel and effectively manage SITE activities by timely deployment of other resources.

3.2.45 General Warranties

- a) CONTRACTOR shall perform WORK in full compliance with the CONTRACT and all other terms and conditions set forth herein.
- b) WORK shall be performed, in a good and workmanlike manner and in accordance with the FINAL PROPOSAL, all other terms and conditions of this CONTRACT, all DOCUMENTS, all Government Approvals, all APPLICABLE LAWS, and Good Industry Practices.
- c) All EQUIPMENT, installed as part of PLANT, (i) shall be of first class quality, free from any encumbrance or lien and shall conform to the specifications and descriptions set



forth in CONTRACT and (ii) shall be new and unused, of first quality, free from DEFECTS and Deficiencies of any kind and shall meet the requirements of the Scope of Work.

- d) The completed PLANT shall be free of DEFECTS and Deficiencies and shall be designed, constructed and engineered, in compliance with the Scope of Work.
- e) PLANT shall be designed, engineered, constructed, tested, completed and delivered based on Good Industry Practices, CONTRACTOR's specifications and guidelines for operation and maintenance in accordance with the Scope of Work, for TOTAL CONTRACT PRICE. COMMISSIONING of all process and utility plants shall be achieved no later than the GUARANTEED COMPLETION DATE.
- f) All SUB-CONTRACTORS/VENDORS shall perform their portion of the Scope of Work or supply or install EQUIPMENT in accordance with the applicable terms set forth herein.
- g) Adherence to the Operations Manual shall allow safe start-up, operation, maintenance and shut-downs of the completed PLANT, in accordance with CONTRACTOR's guidelines and will not impair any warranty or guarantee of EQUIPMENT incorporated or to be incorporated into PLANT.

3.2.46 Additional Tests

- i. Except for tests required as per the provision of CONTRACT, OWNER may at any time prior to FINAL ACCEPTANCE OF PLANT request re-testing or additional testing of any EQUIPMENT, incorporated or to be incorporated into PLANT, or WORK if OWNER believes the results of earlier tests are not accurate or do not establish the true condition of EQUIPMENT or WORK being tested.

- ii. If a portion of WORK or any EQUIPMENT, incorporated or to be incorporated into PLANT

fails any additional test or retest requested by OWNER pursuant to Clause.

- 3.2.46(i), then CONTRACTOR shall correct or replace, or cause its SUB-CONTRACTOR/VENDOR to correct or replace, such item or portion so as to pass additional testing or re-testing and otherwise meet or conform to such requirements. No changes to time schedule or increase in the TOTAL CONTRACT PRICE shall be granted with respect to such additional testing. CONTRACTOR shall solely bear any cost resulting

thereof (including the cost of any required un-covering and re-covering of WORK). Neither the failure by OWNER to discover Defects and Deficiencies, nor any payment to CONTRACTOR in respect thereof shall prejudice the rights of OWNER thereafter to require and obtain from CONTRACTOR the satisfactory performance of WORK hereunder. OWNER shall not be deemed to have accepted any WORK as a result of any additional testing.

- iii. If the results of the original test and such additional/retest are the same as of the original test or in accordance with the CONTRACT, OWNER shall bear the cost, if any, of such additional/retest and extend the completion time, if required.

4. OWNER'S OBLIGATIONS

OWNER shall be responsible for fulfilling all obligations as specified under the following heads:

4.1 Basic Conditions for Design

OWNER shall furnish information concerning the basic conditions for design to CONTRACTOR as soon as practicable, but in any event not later than as per the requirements of CONTRACTOR's engineering schedule established and made available to OWNER during the early stages of WORK. Any "rely-upon" information/data furnished by OWNER shall be specifically indicated to the CONTRACTOR. CONTRACTOR shall review the basic conditions, including soil data, and other conditions furnished by OWNER. If CONTRACTOR observes any inconsistency or insufficiency in these data,

CONTRACTOR shall bring to the notice of OWNER the same before use of such data/information as provided by OWNER or modified subsequent to discussion and written consent of OWNER. CONTRACTOR will undertake its own site-specific geo-technical investigation as per final plot plan before proceeding with design of foundations for EQUIPMENT, structures, and other associated civil works.

4.2 Overall Co-Ordination

The objective of overall co-ordination is to organize orderly execution of WORK, bring about requisite integration amongst the various project activities of executing agencies, to achieve the technical quality, cost objective of WORK and to avoid interference between the various activities of the parties in order to achieve the earliest possible completion of WORK. The aim will be to integrate, have compatibility between plants and uniform standardization of design, engineering, layout etc.

4.3 Review and Approval of Work

4.3.1 CONTRACTOR shall associate OWNER's representatives with WORK as carried out by CONTRACTOR's personnel. For this purpose, OWNER shall associate with WORK at all stages. Specifically, OWNER shall undertake the following tasks:

- a) Review/APPROVAL of drawings and other documents identified under approval category in tech spec and other documents connected with basic and detailed engineering.
- b) Review of specifications for EQUIPMENT, lists of spare parts and special maintenance tools, and lists of special construction aids, tools, tackles, and fixtures.
- c) Participation in inspection, expediting and testing EQUIPMENT at SUB-CONTRACTOR's / VENDOR's works and at SITE, wherever considered necessary by OWNER.
- d) Participation in HAZOP study and 3D model review, as applicable to Plant and is required as per engineering practices for such Plants.

4.3.2 For smooth functioning, OWNER will nominate an individual who will act as ENGINEER-IN-CHARGE under the CONTRACT. The ENGINEER-IN-CHARGE will have full authority to act on behalf of the OWNER in connection with the CONTRACT. Except as otherwise provided in the CONTRACT, all communications between the OWNER and the CONTRACTOR relating to the WORKS, shall be between the ENGINEER-IN-CHARGE and the CONTRACTOR's designated representative. However, Owner may appoint a senior executive to deal with change orders with time & cost

implication, extension of Contract period, suspension & termination of work on Owner's behalf with intimation to the Contractor.

- 4.3.3 ENGINEER-IN-CHARGE nominated by the OWNER for the CONTRACT shall depute its representatives to carry out above work at the office(s) of Contractor. OWNER shall bear the cost of travel and stay of its personnel for such deputation. CONTRACTOR shall provide office accommodation, secretarial assistance etc. in its office(s) to OWNER's personnel. Number of OWNER's personnel to be deputed at CONTRACTOR's office on single location shall not exceed 10 (Ten) at a time.

4.4 **Government Clearances**

OWNER shall provide necessary services and assistance to CONTRACTOR in obtaining Government clearances to be obtained in the name of OWNER as referred to in GCC clause 56.1. However, OWNER shall be responsible to obtain Environment Clearance, Consent to Establish, Consent to Operate and Essentiality Certificate for import of goods at Concessional Duty. All other approvals/clearances as per Sub clause 56.1 of GCC, shall be obtained by CONTRACTOR.

4.5 **Facilities for CONTRACTOR's Personnel**

OWNER shall assist CONTRACTOR in obtaining Visas and other Permits from the appropriate authorities for CONTRACTOR's and SUB-CONTRACTOR's / VENDOR's expatriates to enter and stay in India in lawful manner, as necessary for performance of WORK.

4.6 **Operating and Maintenance Personnel**

OWNER shall provide available experienced operating and maintenance personnel according to its organisation, specifications, and standards during the PRE-COMMISSIONING and COMMISSIONING activities, who will work under the lawful & technical direction and control of CONTRACTOR. OWNER shall associate its personnel with the construction and erection of PLANT to familiarise the personnel with WORK,

ascertain quality, and generally to prepare for proper operation and maintenance of PLANT.

4.7 **Feed stock and Utilities**

OWNER shall make available raw materials, packaging materials, bulk chemicals, fuel & utilities (specifically included in OWNER's scope subject to limit specified in CONTRACT & take over all products and effluents at BATTERY LIMIT as specified in CONTRACT.

4.8 **Site Establishment & Site Cleaning**

It shall not be possible for the COMPANY to provide residential accommodation for staff and labour of CONTRACTOR. CONTRACTOR shall have to make his own arrangement at his cost.

- a) The Company shall provide the CONTRACTOR, adequate leveled unhindered and unencumbered land inside the Plant premises for all construction infrastructures, batching plants, maintenance workshop, fabrication yard, bending yard, field offices, temporary structures, storage of construction materials, etc. free of cost. The construction and subsequent demolition / area clearance of such facility shall be at CONTRACTOR 's own cost.
- b) The security of the CONTRACTOR 's equipment and materials is his own responsibility. CONTRACTOR shall record all materials brought to site with the COMPANY.
- c) The CONTRACTOR at his own cost shall make such provisions for lighting of work, temporary works, materials and plant etc. as may be required by the COMPANY/Engineer together with all labour, stores and services required for CONTRACTOR's efficient working.
- d) It shall be entirely the CONTRACTOR 's responsibility to provide all types of cranes and other construction equipment, tools, tackles, equipment for transport, cross-ties, shackles, clamps, winches, lifting tackles with accessories, hydraulic jacks, beams,



steel mats, base plates, steel scaffoldings, work platforms, anchoring gear, tong tester, shears, saws, hand measuring tools, measuring equipment, torque wrenches, consumable materials, services and each and every item necessary to perform the work in a workman like and efficient manner, and complete the job as per time schedule indicated.

- e) Crawler mounted equipment on the road inside the refinery is strictly prohibited, if crawler mounted equipment are required to be used, it is CONTRACTOR's responsibility to shift the equipment as per work requirement without marching the equipment on the road.
- f) The CONTRACTOR shall clean and keep clean the work site from time to time to the satisfaction of the Engineer- in-Charge for easy access to work site and to ensure safe passage, movement and working.
- g) The CONTRACTOR shall dispose off the unserviceable materials, debris etc. to the designated area, within 5 kms inside the of the Plant boundary limits, by the Company.
- h) All the dismantled materials (serviceable and / or unserviceable materials, debris etc.) shall be the property of the CONTRACTOR. It shall be the responsibility of the CONTRACTOR to take away all the dismantled materials (serviceable and / or unserviceable materials, debris etc.) generated from the WORK, outside the Project Area and to the CONTRACTOR's own borrow areas / earmarked places.
- i) No extra payment shall be paid on this account. The rates quoted in SOR are deemed to be inclusive of all the costs towards all the above activities as well.

4.9 **Process License**

This clause to be read as 'Deleted'.



5. CHANGE IN WORK / CHANGE ORDER

This Clause should be read in conjunction with Clause 48.5 of GCC

- 5.1 OWNER shall have the right to request in WRITING changes in WORK within the scope of CONTRACT. When the request for a change in WORK by OWNER has been agreed and complied by CONTRACTOR, CONTRACTOR's obligations under CONTRACT shall remain unaffected unless otherwise agreed.
- Changes may consist of additions, deletions or revisions of or to the Scope of Work, and may cause the TOTAL CONTRACT PRICE, the work schedule or the GUARANTEED COMPLETION DATE or any other CONTRACTOR's WARRANTIES to be adjusted.
- 5.2 In the event that CONTRACTOR is instructed by OWNER to perform any CHANGE ORDER, whether it be additional work or a reduction in the scope of work, a 10% mark-up shall be allowed to cover the cost of overheads and profits of the CONTRACTOR on the total lump-sum cost of the CHANGE ORDER for procurement of equipment, services including third party, including all taxes, duties and all other related costs.
- 5.3 On each request for a change in WORK, CONTRACTOR shall promptly inform OWNER in WRITING whether this request will fall within the provision of CONTRACT. If this request does not fall under the provision of CONTRACT and CONTRACTOR has to incur additional expenses, then CONTRACTOR shall promptly submit a cost estimates, and terms of payment for making the requested change in WORK together with the details of any variation required to be made to any of CONTRACTOR's or OWNER's obligations and/or guarantees.
- 5.4 If in CONTRACTOR's opinion fulfilment of any of its obligations under CONTRACT Would be jeopardized by a change in WORK requested by OWNER, then CONTRACTOR shall explain in WRITING to OWNER the reasons for not accepting these changes within thirty (30) days of receipt of OWNER's written request.
- 5.5 OWNER and CONTRACTOR shall agree upon the basis and terms of the change



in WORK in WRITING.

5.6 It is understood that no change shall become effective, and no change will alter the scope of WORK until all of the matters referred to in this Clause have been mutually agreed upon in WRITING by OWNER and CONTRACTOR.

5.7 It is agreed by both parties that the following changes shall not be considered a change in WORK in the meaning in this Clause:

- a) Minor changes requested by OWNER and accepted by CONTRACTOR which do not involve any substantial additional cost or man-hour effort and changes requested by OWNER and accepted by CONTRACTOR that has no effect on contractual completion period.
- b) Changes in CONTRACTOR's WORK required on account of CONTRACTOR not having included any item of EQUIPMENT or WORK which, in the opinion of OWNER / CONTRACTOR is necessary for the normal safe and continuous operation of PLANT.
- c) Any change necessitated due to requirements of laws prevailing in India at the time of submission of Final Revised Price Bid.

5.8 It is agreed by both Parties that:

- d) If after the date of submission of Final Revised Priced Bid there shall be enacted or brought into force any new CODES, LEGISLATION (excluding Minimum Wages Act or any other law governing minimum wages / salaries) which causes an increase or decrease in cost of carrying out of WORK, such increase or decrease shall be added to or deducted from the TOTAL CONTRACT PRICE as mutually agreed between OWNER and CONTRACTOR, as the case may be.

- a) If any change in the CODES, LEGISLATION causes or results in an increase or decrease in the Project Master Schedule, the CONTRACT PERIOD shall be reasonably adjusted as mutually agreed between OWNER and CONTRACTOR.

5.9 In case of non-fulfilment of OWNER's obligations as stated in the CONTRACT (excluding Payment Obligations), CONTRACTOR may give a written request to OWNER for a CHANGE ORDER for the impact of such non-fulfilment on the performance of the WORK. Any request submitted by the CONTRACTOR will not automatically qualify for CHANGE ORDER and will



be considered in accordance with clause 5.6 of SCC and also in conjunction with Clause 31.3 of GCC.

6. ACCEPTANCE OF PLANTS AND FACILITIES

CONTRACTOR's liabilities for the Performance Guarantees given for the PLANT in respect of capacity, consumption, product quality and pollution level shall be discharged only when the PERFORMANCE AND GUARANTEE TESTS as stipulated in the CONTRACT have been successfully carried out as per acceptance criteria specified below or alternatively, Mutually Agreed Damages as stipulated in clause 29 of GCC have been paid by the CONTRACTOR and OWNER has issued PRELIMINARY ACCEPTANCE CERTIFICATE.

7. PLANT ACCEPTANCE CRITERIA

Subject to fulfilling PERFORMANCE AND GUARANTEE TESTS as per CONTRACT and Clause 20.0 of SCC, OWNER shall be in readiness to accept the PLANT. CONTRACTOR shall take all steps to fulfil the provisions of the CONTRACT for OWNER to issue PRELIMINARY ACCEPTANCE CERTIFICATE.

8. ISSUANCE OF PRELIMINARY ACCEPTANCE CERTIFICATE

Within 30 (thirty) DAYS from completing successfully PERFORMANCE AND GUARANTEE TESTS by the CONTRACTOR and CONTRACTOR fulfilling all the obligations under the provisions of the CONTRACT, or as set out in Clause 20.0, OWNER shall issue RELIMINARY ACCEPTANCE CERTIFICATE to CONTRACTOR and care and custody of the PLANT shall be transferred to the OWNER. If the OWNER fails to issue the PRELIMINARY ACCEPTANCE CERTIFICATE or provide written notice stating the reasons for refusing to issue the PRELIMINARY ACCEPTANCE CERTIFICATE within 30 DAYS of CONTRACTOR's written request, the same shall be deemed to have been issued. Except as provided in Sub-clause 20.8, on issue (or deemed issue) of PRELIMINARY ACCEPTANCE CERTIFICATE by OWNER, CONTRACTOR shall become entitled to receive all payment as per provisions



of the CONTRACT due to CONTRACTOR subject to CONTRACTOR's fulfilling the obligations stipulated under CONTRACT.

9. LABOUR AND STAFF

9.1 The CONTRACTOR shall make his own arrangement for labour, erection and COMMISSIONING engineers and all other staff required for carrying out the CONTRACT. The necessary permissions from Government of India regarding work permit and visa requirement shall be obtained by the CONTRACTOR in case of foreign technicians.

However, it is to be understood by the CONTRACTOR that Government of India allows work permits after required due diligence about necessity of engaging foreign technician and labour.

9.2 The CONTRACTOR shall make his own arrangements for providing canteen service to his labour and staff. Open space for this purpose may be provided by OWNER.

9.3 The CONTRACTOR shall at his own cost provide office, supply of drinking water, canteen and other accommodation for his staff and workmen including provisions of toilets and other welfare facilities in compliance with the relevant laws. The CONTRACTOR shall also provide communication, transport and medical facilities to his staff and workmen.

One first aid center at SITE with Ambulance & Para medical staff in attendance is required to be kept operational at all working hours.

Additionally, contractor shall enter into MOU with one general hospital/ nursing home, with facility to treat head injury also, which will attend to any injured staff of contractor / sub- contractor on credit, to be paid and settled by contractor.

9.4 The CONTRACTOR shall be responsible for all statutory obligations like payment of labour Cess, complying with central and State labour laws and any other laws in this regard in force from time to time regarding the employment or conditions of service of CONTRACTOR's labour, workman or employees.

9.5 The CONTRACTOR shall observe all health & safety rules as required under various rules, regulations and laws in India and shall also strictly adhere to health & safety regulations of OWNER.



- 9.6 The Contractor shall, if required by the OWNER/OWNER's representatives, deliver a Return in such forms and at such intervals as the OWNER's representative may prescribe showing the staff and the number of different classes of labour from time to time employed by the CONTRACTOR or his SUBCONTRACTORS on SITE and such other information as the OWNER/OWNER's representative may require.
- 9.7 CONTRACTOR shall not employ any children below the age of 18 years as labourers, directly or through SUB-CONTRACTORS, for execution of the WORK, PRE-COMMISSIONING or COMMISSIONING of the PLANT & maintenance period.
- 9.8 In dealing with employment of labour and employees, the CONTRACTOR and his SUBCONTRACTORS shall comply fully with all laws and statutory regulations such as the Payment of Wages Act, 1936, Minimum wages Act, 1948, Workmen's Compensation Act 1923, The Contract Labour (Regulation and Abolition Act 1961, Employees Provident Fund and Miscellaneous Provisions Act 1952, Employees State Insurance Act 1948, Equal Remuneration Act 1979, Payment of Gratuity Act 1972, Child Labour (Prohibition & Regulation) Act 1986, Inter State Migrant Workmen's (Regulation of Employment & Condition of Service) Act, 1979, Payment of Bonus Act 1965, any other laws or regulations and/ or Notifications and bye laws relating to their employment, health, safety, welfare, immigration and emigration framed by competent legislative authorities (State or Central Government or Local Authorities) from time to time as may be applicable and shall allow them all their legal rights.
- 9.9 The CONTRACTOR shall keep the OWNER/OWNER's Representative indemnified in case any action is taken against the OWNER by the competent authority on account of contraventions of any of the provisions of any act or rules made thereunder, regulations or notifications, including amendments, if any.
- 9.10 The CONTRACTOR's personnel shall be appropriately qualified, skilled and experienced in their respective trades or occupations. The OWNER/OWNER's representative may require the CONTRACTOR to remove (or cause to be removed) any person employed on the SITE of works, including the CONTRACTOR's Representative, if applicable, who:
- (a) persists in any misconduct or lack of care,
 - (b) carries out duties incompetently or negligently,



- (c) fails to conform with any provisions of the CONTRACT, or
- (d) persists in any conduct which is prejudicial to safety, health, or the protection of Environment.
- (e) Intoxicated state due to likely use alcohol or drug.
- (f) Looks sick and unhealthy for nature of work like height work, welding, grinding and similar works.

The CONTRACTOR shall then appoint (or cause to be appointed), a suitable replacement person in consultation with the OWNER.

9.11 Should the CONTRACTOR fails to act as required in the preceding clauses from 9.1 to 9.10 above, the OWNER may make necessary alternative manpower arrangements, the cost of which shall be recoverable from the CONTRACTOR.

10. TRAINING OF OWNER'S PERSONNEL

10.1 The CONTRACTOR shall provide facilities for Training of OWNER's personnel at CONTRACTOR's Process Licensor's facilitated, other installations, before the PLANT goes into operation, for the operation and maintenance of PLANT

The costs towards travel, transportation and living expenses of the OWNER's personnel shall be borne by OWNER.

THE CONTRACTOR shall make arrangements, for training of OWNER's personnel.

in PLANT of CONTRACTOR's design, having similar capacity and design features

as of process units of this project and all related Off Site & Utilities Facilities and in VENDOR's workshops for a period as stipulated in the CONTRACT. CONTRACTOR shall provide assistance to OWNER's personnel for proper co-ordination and management of the practical experience. Detailed programme and modalities for practical experience shall be mutually agreed between OWNER and CONTRACTOR.

10.2 The fee for Training of OWNER's personnel shall be as per contract. OWNER may reduce the number of man-months of training, if it so desired. The fee quoted for total man-months shall



accordingly be reduced on pro-rata basis if the number of man-months of training is reduced by OWNER.

11. MODE OF CONTRACTING

- 11.1 Notwithstanding anything stated elsewhere in the CONTRACT documents, the CONTRACT is awarded on lump sum turnkey basis with single point responsibility.
- 11.2 The CONTRACT shall be in all respect being construed and governed in accordance with the Indian laws.
- 11.3 It is clearly understood that the total consideration for the CONTRACT has been broken up into various components only for the convenience of payment of advance in the form of running bills under the CONTRACT and for the measurement of deviation or modification under the CONTRACT(s) and preparation of logical billing schedule.

12. BID PRICES

- 12.1 The Bid price is to be filled in the formats given in Price Schedule enclosed as Annexure-I.
- 12.2 The lump-sum TOTAL CONTRACT PRICE shall be derived from Price Schedule comprising the total of the price of materials and price of services given in the Price Schedule.
- i. Percentage apportionment of Fixed Lump-sum Price to Cost Centres, Sub-Cost Centre and sub-Heads not exceeding the total percentage of payment for (i) process & engineering design (ii) supply of material with sub-limit for equipment cost and balance towards construction, Pre-commissioning & M/C, start-up & commissioning, test run and vacating the site.
 - ii. The whole of Works including design are to be divided into Cost Centres/Sub-Cost Centres/Sub-heads. Each of these Cost Centres/Sub-Cost Centres/Sub-heads are named according to their general scope of work.
 - iii. The fixed Lump-Sum Price for the whole of Works shall be payable as per the apportioned amount to be calculated with respect to the apportioned percentages as applicable to various Cost Centres, Sub-Cost Centres and Sub-heads are fixed



and cannot be varied by the Contractor while submitting his bid. The scope and extent of the Works are to be ascertained by reference to the various requirement of the Contract documents as a whole and shall not be limited in any manner whatsoever by the indicative descriptions of the Cost Centres or of the Sub-Cost Centre and Sub-Heads given in the Bill of Quantities/Pricing schedule.

12.3 This clause number to be read as 'deleted'.

12.4 The TOTAL CONTRACT PRICE shall remain firm and fixed and shall be valid until FINAL ACCEPTANCE and shall not be subject to variation/escalation on any account except as otherwise specifically provided in the CONTRACT.

12.5 PRICE quoted for supply of MATERIALS and Services.

- i. The CONTRACTORS are to quote firm prices in respect of both direct transaction between OWNER and the CONTRACTOR and Bought Out Items to be despatched directly from the sub-contractor/vendor's site. The payment towards all applicable taxes and duties like Custom duty, GST and other tax/duty/levy/cess will be made by OWNER at actuals limited to the amount indicated in the bid.
- ii. In case of entire scope of jobs under this contract has been classified as supply of service in relation to immovable property under GST and the place of supply of services shall be the location at which the entire scope of works to be carried out as mentioned elsewhere in the bidding documents. Accordingly, the CONTRACTOR is required to take GST registration for supply of services.
- iii. In case of Bought Out items to be despatched directly from sub-contractor/vendor's work to the OWNER's site, the CONTRACTOR shall ensure that his sub-contractor/vendor raise tax invoice under the provisions of GST law, billed to the CONTRACTOR and shipped to the OWNER's site. The CONTRACTOR shall further ensure that he raises his corresponding tax invoices under the provision of



GST law in the name of OWNER during transit of the material before the delivery of material is taken by OWNER.

- iv. It shall be the duty of the CONTRACTOR to duly observe and comply with all laws, rules, regulations and notifications applicable to GST, Customs Duty, cess, fee, Royalties, etc. on the import, manufacture, sale and/or supply of any material to the OWNER and performance of the WORKS under the CONTRACT. The CONTRACTOR shall keep the OWNER indemnified from and against any and all claims, demands, prosecutions, actions, proceedings, penalties, damages, demurrages and/or other levies whatsoever made or levied by any Court, Tribunal or other Statutory Authorities with respect to any alleged breach, evasion or infraction of such duties, taxes, charges or levies or any breach or infraction of any applicable laws, rules, regulations, or notifications concerning the same and from the consequence thereof attributable to the CONTRACTOR.
- v. The price of materials is divided into two parts, the Foreign Exchange component and the Indian Rupee component. It is recognised by the OWNER that the Price of Materials may be loaded to cover various factors other than the cost of materials, such as (but not limited to) office overheads, bidding and procurement costs, financing costs and profits.
- vi. Customs duty is leviable in India on the CIF price of imported materials at the time and place of delivery of such goods in an arms-length transaction. The CONTRACTOR is advised that for the purpose of calculating Customs Duties on imported materials, the Supplier's invoice(s) of the relative materials will ordinarily constitute the arms-length price and that the Customs duties would ordinarily be payable on that price plus the cost of freight and insurance.
- vii. In this context, it has been decided to split the Price of imported MATERIALS so far as is payable in foreign exchange, into two parts namely, "the CFR/CIF/CIP/CPT

value of imported materials” and “Procurement and other charges”. The CFR/CIF/CIP/CPT value of imported materials indicated in the Bid is expected to indicate the CIF value of the imported materials as represented by the Supplier’s invoice(s). Under the head “Procurement and other charges” bidders are expected to indicate all other amounts payable by the OWNER to the CONTRACTOR in Foreign Exchange towards the Lump-sum Price of Materials with reference to the supply of imported materials. It is understood that this break-up between CFR/CIF/CIP/CPT value and Procurement and other charges can only be tentative at this stage and can be more firmly established only at the time of preparing the relative Bill of Materials.

viii. Payment for imported materials to the extent of the CIF value of the materials as indicated in the Bill of Materials will be made on the basis of the Supplier’s Invoice(s) which shall, without prejudice to CONTRACTOR’s full obligations to the OWNER in respect of such materials, be drawn on the OWNER to whom the materials shall be consigned by the Supplier, although payment of the Supplier’s invoice(s) shall be made directly to the CONTRACTOR, who will be exclusively liable to pay the Supplier. Freight on these supplies {to the extent not already included within the Supplier’s invoice(s)} shall be paid against the CONTRACTOR’s invoice(s) raised on the OWNER in this behalf. The balance Foreign Exchange payable on the Price of Materials shall be payable under the head “Procurement and other charges” and the shortfall or excess (if any) between the CIF value of relative imported materials as indicated in the Bill of Materials and the aggregate value as derived from the Supplier’s invoice(s), and the CONTRACTOR’s invoice(s) for freight, shall be released or adjusted , as the case may be, against the CONTRACTOR’s invoice(s) therefore drawn for “Procurement and other charges”.

- ix. Should the total cumulative value of Supplier’s invoice(s), and the CONTRACTOR’s invoice(s) for freight on the imported cumulative materials, in fact exceed the total

CIF value for imported materials resulting in the OWNER having to reimburse duties of customs in excess of the customs duties (including IGST and Goods and Services compensation cess) payable by the OWNER on the CIF value along with insurance component, the CONTRACTOR shall pay and bear such excess customs duties (including IGST and Goods and Services compensation cess)

- x. Payment for indigenous materials to the extent indicated in the Bill of Materials shall be made on the basis of Bill of Materials accompanied with Supplier's invoice Supplier. proof of despatch which shall, without prejudice to the CONTRACTOR'S full obligations to the OWNER in respect of such materials, be drawn on the OWNER to whom the materials shall be consigned by the Supplier although payment of the Supplier's invoice(s) shall be made directly to the CONTRACTOR, who will be exclusively liable to pay the Supplier"

13. CURRENCIES OF BID AND PAYMENT

- 13.1 i) For the purpose of this clause and any other relevant provisions in these documents, foreign Currency (maximum 3 currencies) shall mean the currencies excluding INR as quoted by the bidders.
- ii) Foreign Bidders may quote prices for MATERIALS and services to be imported into India either in Indian Rupees or in the Foreign Currencies or in a combination of Indian Rupees and the Foreign Currencies.
- iii) Bidders shall quote the price for MATERIALS and services to be procured from India and for expenses to be incurred in Indian Rupees only in Indian Rupees.
- iv) Indian bidders may quote the prices for materials and services to be imported into India in the Foreign Currency. Such bidders quoting in foreign currency shall separately indicate in a list the materials and services to be imported into India and the Foreign Currency price payable for such materials and services.

- 13.2 Indian bidders who have indicated materials or services to be imported into India, and who have indicated the Foreign Currency price for such materials and/or services in their bids as specified above, shall on proof of payment be paid the Foreign Currency paid for the relevant materials or services imported into India (subject to the maximum of the Foreign Currency indicated in the last priced bid in relation to such supplies or services). If as a result, there shall remain any unutilized foreign currency indicated in the last priced bid relevant to the formation of the CONTRACT in relation to such supplies or services, these shall be considered to be the CONTRACTOR's fee for the relative procurement or services, as the case may be, and shall be added to and paid for separately, in the Final Bill, in addition to the price of services, in Indian Rupees equivalent of such unutilised foreign currency balance(s) converted at the currency exchange rate, available at RBI's website<www.rbi.org.in/home.aspx>, prevailing on the date of MECHANICAL COMPLETION.
- 13.3 If in the performance of the CONTRACT, the CONTRACTOR obtains or procures within India any materials or services which at the time of the bid were indicated to be procured or provided from outside India, the CONTRACTOR shall be paid only the Indian Rupee equivalent of the foreign currency cost of such materials or services as indicated in the last priced bid relevant to the formation of the CONTRACT, converted at the currency exchange rate, available at RBI's website www.rbi.org.in/home.aspx, prevailing on the date of payment by the CONTRACTOR for such supplies or services. Any change in such sourcing shall be subject to the OWNER's prior consent. However, in such a case, the CFR price indicated in the CONTRACT shall stand reduced by the price attributable to such supplies and such changes shall not oblige the OWNER to reimburse GST in excess of such duties payable on the Indigenous materials.
- 13.4 If in the performance of the CONTRACT, the CONTRACTOR obtains or procures from outside India any materials or services which at the time of the bid were indicted to be procured or provided from within India, such bidder shall be paid only the Indian Rupees indicated in the Bill of Materials or in the Schedule of Activities, as the case

may be, for such materials or services. However, such changes shall not oblige the OWNER to reimburse customs duties in excess of such duties payable on the CIF Value of imported materials.

13.5 The CONTRACTOR shall not be entitled to switch the quoted foreign currency to another foreign currency.

13.6 The lump sum price quoted by the CONTRACTOR shall be gross of Indian Income Tax, and the lumpsum price(s) shall be deemed to include Indian Income Tax.

14. PRICES, TAXES DUTIES AND OTHER LEVIES

14.1 Except as specifically provided to the contrary in the SPECIAL CONDITIONS OF CONTRACT:

- i. The CONTRACTOR shall within the price of MATERIALS and scope of supply be liable to pay and bear any and all duties, taxes, Royalties, levies, rent, fee, and cesses inclusive of tax deducted at source etc., be it levied by Central, State or Local Authorities lawfully payable on any goods, EQUIPMENT or MATERIALS imported into India or within any local limits for permanent incorporation in the WORK(S), and on materials sold and supplied to the OWNER pursuant to the CONTRACT.
- ii. The CONTRACTOR shall within the price of services and scope of services be liable to pay and bear any and all duties, taxes, Royalties, levies, rent, fee and cesses inclusive of tax deducted at source etc., be it levied by Central, State or Local Authorities lawfully payable on any goods or EQUIPMENT imported into India or within any local limits for use in the performance of the WORK(S), and on services performed pursuant to the CONTRACT.
- iii. The CONTRACTOR shall be liable for and shall pay any and all Indian fees, taxes, duties, rent, fee, levies and cesses etc., assessable against CONTRACTOR in respect of or pursuant to the CONTRACT.
- iv. In addition, the CONTRACTOR shall be responsible for payment of all Indian duties, levies, Cesses, Rent, Fee and taxes etc., assessable against the CONTRACTOR or

CONTRACTOR's employees or SUB-CONTRACTOR'S whether corporate or personal or applicable in respect of the Contract or the property.

- v. The CONTRACTOR should timely submit a tax invoice or valid document under the prescribed rules and regulations of GST to enable the OWNER to claim input tax credit. The payment of the indirect tax cost indicated in the bid is subject to submission of prescribed documents, OWNER having received and accepted the materials or services so supplied, the tax charged in respect of such supply actually been paid to the Government either in cash through utilization of input tax credit admissible in respect of such supply and the CONTRACTOR has declared the Invoice in his return to enable the OWNER to avail credit. The CONTRACTOR hereby covenants that it shall comply with the provisions of Goods and Service Tax law to ensure that the OWNER is able to avail the entire eligible input tax credit on timely basis for the services / supply / work undertaken by the Supplier / Vendor as per this Agreement.

For the avoidance of doubt, it is hereby clarified that the CONTRACTOR's responsibility shall be limited to providing valid documents, payment of tax charged in respect of materials or services supplied to the government exchequer and the invoice is declared in the return pertaining to the month in which the invoice is raised. The OWNER shall, irrespective of the fact whether particular items / EQUIPMENT/services are eligible for input tax credit or not as per extant tax laws or the OWNER not availing the said benefits for any reason whatsoever, pay to the CONTRACTOR the indirect tax amounts so payable, upon submission of valid documents, payment of indirect tax to the government exchequer and declaration of invoice in his return by the CONTRACTOR.

- vi. Any additional incentives/ benefits declared by Government after the submission of bid shall be availed by the CONTRACTOR and passed on to the OWNER to the extent such incentives/ benefits affect the TOTAL CONTRACT PRICE.
- vii. The CONTRACTOR hereby covenants to comply with the applicable provisions of law, including but not limited to section 171 of the Central Goods and Services Tax Act, 2017

or applicable section of IGST/UTGST/SGST law, and pass on to the OWNER all the benefits arising from any reduction in the rate of tax on any supply of goods or services or both or the benefits of input tax credit, exemptions, concessions, rebate, set off, by way of reduction in the prices of the services / supply / work undertaken by the CONTRACTOR per this Agreement.

- viii. In the event the OWNER has rejected the materials or services supplied by the CONTRACTOR, the credit note to be raised maximum by earliest of the following –
- a) September following the end of the financial year in which supply was made or
 - b) The date of furnishing of the relevant annual return.
- ix. Although the TOTAL CONTRACT PRICE is inclusive of all taxes and duties, the Contractor will be required to submit the detailed Indirect tax breakup of the taxes and duties, i.e., CGST, SGST, IGST, Cess, Royalties, fees etc. included therein for execution of the project as per the BOQ which would be incorporated as part of the contract.
- a. Amount on which CGST is applicable and CGST Value.
 - b. Amount on which SGST is applicable and SGST Value
 - c. Amount on Which IGST is applicable and IGST Value.
 - d. Amount on which Custom Duty is paid and Custom Duty Value.
- x. The CONTRACTOR shall maintain complete records of duties, taxes, and levies etc. payable to various authorities in respect of the project and submit the details/records in case demanded by the OWNER.
- xi. In case CBEC (Central Board of Excise and Customs) /any equivalent government agency brings to the notice of the OWNER that the CONTRACTOR has not remitted the amount towards GST collected from the OWNER to the government exchequer, then, that CONTRACTOR shall be put under Holiday List of the OWNER for period of six months.
- xii. In case the GST rating of CONTRACTOR on the GST portal/Government official website is negative/ blacklisted, then the bids may be rejected by the OWNER. Further, in case of rating of the CONTRACTOR is negative/blacklisted after award of work, then the OWNER

shall not be obligated or liable to pay or reimburse GST to the CONTRACTOR and shall be entitled to deduct/recover such GST along with all applicable interest and penalties.

- xiii. CONTRACTOR shall ensure timely submission of returns and details required to be filed under GST laws & rules with requisite details.
- xiv. Ignorance about applicability of the existing laws/taxes will not be a cause of any claim in this CONTRACT.
- xv. The CONTRACTOR shall ensure full compliance with Laws of India and State with regard to this CONTRACT and shall be solely responsible for the same.

14.2 Taxes, Duties and Levies in Foreign Countries

The CONTRACTOR shall accept full and exclusive liability at his own cost for the payment of any and all taxes, duties, cesses, rent, fee, royalties and levies howsoever designated, as are payable to any government, local or statutory authority in any country other than India as are now in force or as are hereafter imposed, increased or modified and as are payable by the CONTRACTOR, his agents, SUB-CONTRACTORS and Suppliers and its/their respective employees for or in relation to the performance of this CONTRACT. The CONTRACTOR shall be deemed to have been fully informed with respect to all such liabilities and shall further be deemed to have consideration and included the same in his bid and the Lump-sum Price shall not be varied in any way on this account.

14.3 Tax Indemnity

It will be the duty of the CONTRACTOR to duly observe and comply with all laws, rules, regulations, orders and formalities applicable to Income tax, GST, Building cess, and Customs Duty on the import and / or supply of any material to OWNER and/or applicable to GST on the services performed by the CONTRACTOR pursuant hereto. The CONTRACTOR shall keep the OWNER indemnified for and against any and all claims, demands, prosecutions, penalties, damages, demurrages and/or other levies whatsoever made or levied by any Authorities, Tribunal or Court with respect to any alleged breach, evasion or infraction of such duties, taxes, charges or levies or any breach or infraction



of such laws, rules, regulations, orders or formalities concerning the same and from the consequence thereof.

The OWNER does not indemnify the CONTRACTOR for any tax liability (Custom duty, GST, Building Cess, Royalties, etc.), except otherwise provided in the CONTRACT.

- 14.4 All the applicable taxes, duties, cess, Royalty, etc. on supply of materials, services and otherwise required for execution of contract on LSTK Basis as quoted in Schedule of Prices shall be included in the TOTAL CONTRACT PRICE.
- 14.5 The CONTRACTOR confirms that it has included all taxes, duties, levies, Cess, Royalty, rent, fees etc., as applicable at prevailing rates, in its TOTAL CONTRACT PRICE. In case, CONTRACTOR has not included any such taxes, duties, levies, etc., at all and/or at prevailing rates and CONTRACTOR has to pay such taxes, duties, levies, etc., OWNER shall not be liable for payment of such liabilities and/or OWNER shall not reimburse such taxes, duties, levies, etc. to CONTRACTOR.
- 14.6 Any statutory variation in percentage of taxes, duties as shown and quoted by the CONTRACTOR in Schedule of Prices shall be reimbursed by OWNER to CONTRACTOR or vice-versa on submission of documentary evidence. However, in case of delay in PRELIMINARY ACCEPTANCE OF PLANT due to reasons attributable to CONTRACTOR, any increase in percentage of taxes/duties over and above those specified and quoted by the Bidder in Schedule of Prices during the delayed period shall be to CONTRACTOR's account and shall not be reimbursed by OWNER.

Notwithstanding to what is stated hereinabove, should any new enactment or law promulgated after the PRELIMINARY ACCEPTANCE of PLANT / Works and having implications with retrospective effect, on the applicability of taxes/duties, on the supplies made and/or services rendered by the CONTRACTOR and/or any other benefits, which accrue as a result of grant of special status to the OWNER or to the PROJECT, which has an impact on the TOTAL CONTRACT PRICE, then both the Parties undertake to co-operate with each other and make reasonable endeavours to respectively comply with the statutory requirements and/or avail benefits and pass-on the same or suitably compensate

the other party as under, after realizing the set-off of such costs mutually agreed in advance, if any, incurred by the said party in complying with such requirements:

- i. CONTRACTOR shall apply for revision of taxes/duties on supplies and/or services paid by them under the CONTRACT (duly reimbursed by the OWNER), if any, as a consequence of such changes in law with retrospective effect and pass-on the actual amount of refund received, to the OWNER.
 - ii. The OWNER shall compensate the CONTRACTOR of any additional financial burden (other than tax on income, wealth or profits of the CONTRACTOR) due to the applicability of taxes/duties on the supplies made and/or services rendered as a consequence of changes in law with retrospective effect, on submission of documentary evidence in support of the same.
- 14.7 Pursuant to clause 25.0 of GCC, any taxes / duties in relation to this CONTRACT which the OWNER is required to deposit as per the applicable law shall be paid by OWNER and recovered from the CONTRACTOR from any subsequent payment due to the CONTRACTOR.
- 14.8 In case of award of CONTRACT to a foreign CONTRACTOR, the CONTRACTOR shall take all necessary steps and comply with all formalities to get or procure to get, through its affiliate in India, the CONTRACT registered with the appropriate Indian Custom Authorities to have the various imported equipment's including spares assessed at concessional custom duty rates or merit duty as applicable to project imports. CONTRACTOR's affiliate in India must be approved by OWNER.
- 14.9 In case of award of CONTRACT to a foreign CONTRACTOR, the CONTRACTOR shall be responsible on completion of CONTRACT or whenever required to undertake, or procure to undertake, through its affiliate in India, customs reconciliation work with Indian Custom Authorities and finalise the customs assessment by furnishing the



necessary technical documents, technical information etc. to the said authorities.
CONTRACTOR's affiliate in India must be approved by OWNER.

14.10 **Income Tax**

- i. Total CONTRACT PRICE shall be inclusive of any and all Indian Income Tax payable in India. OWNER shall deduct Indian Income Tax as per rates prescribed for such contracts from time to time, from the payments due to CONTRACTOR and issue tax deducted at source certificate in original to CONTRACTOR. It is the responsibility of the CONTRACTOR to file proper income tax return and pay taxes thereon if any or claim refund thereof if any. CONTRACTOR shall give an annual declaration letter to OWNER regarding tax compliance.
- ii. Personal income tax payable, if any, in respect of salary and perquisites of CONTRACTOR's personnel / SUB-CONTRACTOR's personnel in India shall be payable by the individual so deputed by CONTRACTOR or SUB-CONTRACTOR. It is the responsibility of the individual or CONTRACTOR to file proper income tax return and pay taxes thereon if any or claim refund thereof if any. The CONTRACTOR shall give OWNER all necessary documents relating to income tax assessments of its personnel and to keep the OWNER informed about their assessments.
- iii. Withholding tax: In case of foreign technicians staying beyond 45 days who are liable to pay Income Tax, shall deduct the applicable withholding tax at source and deposit the same with the Tax Authorities.

14.11 **BOCW Cess**

As a condition to this precedent to this contract, it shall be the sole and absolute liability and responsibility of the contractor to register under the Building and Other Constructions Workers (BOCW) Act, 1996 and comply with the rules and regulations made there under, entirely at the contractors own costs, charges and expenses. The Contractor shall punctually asses, pay and deposit the BOCW cess (as determined under the BOCW Cess act 1996 and Rules made thereunder) @1% (or as may be modified from time to time) as

applicable and shall submit proof of such registration and payment of cess to the company within 7 days of such compliance. Only upon submission of such proof of registration, shall any payment be released to the Contractor. On-compliance of the contractor of the BOCW Act or BOCW Cess Act or BOCW Cess Act shall constitute a material breach of the contract.

15. STATUTORY VARIATION IN TAXES AND DUTIES

15.1 If any new taxes or duties (including any increase in rate of any existing taxes or duties) are levied in India after the date of submission of bids/revised price bids (whichever is later) and on any payments due to the CONTRACTOR under the CONTRACT other than tax on income, wealth or profits of the CONTRACTOR, the OWNER shall reimburse the CONTRACTOR, subject to proper verification, the amount of such taxes or duties lawfully paid and borne by the CONTRACTOR against proof of payment. However, this is applicable within the GUARANTEED COMPLETION DATE only and shall not be reimbursed by OWNER during the delayed contractual project completion attributable to CONTRACTOR'S account.

15.2 If any existing taxes or duties are withdrawn or the rate is decreased after the date of submission of the bids / revised bids (whichever is later) on any payments due to the CONTRACTOR under the CONTRACT other than tax on income, wealth or profits of the CONTRACTOR, the OWNER shall be entitled to discount in the amount payable to the CONTRACTOR of amount equivalent to the amount of such taxes or duties. This is applicable within the GUARANTEED COMPLETION DATE and also during the delayed contractual Project completion.

15.3 In case of delay beyond GUARANTEED COMPLETION DATE for reasons:

- i) not attributable to OWNER
- ii) not due to FORCE MAJEURE
- iii) not due to suspension of WORK by
OWNER
- iv) not due to suspension of WORK by
CONTRACTOR under clause 45.4 of GCC

All extra costs on account of changes of statutory regulations/Acts, taxes and duties or increase in price on any other account, shall not apply to TOTAL CONTRACT PRICE and the same shall be borne by CONTRACTOR. However, any decrease in taxes and duties during the delayed period shall be passed on to the OWNER.

15.4 Statutory variation in tax means the occurrence or coming into force, at any time after the Date of submission of Final Priced Bid and will include the introduction of Goods and Services Tax (GST): Such additional or reduced cost shall be certified by the Owner/Owner's representative after examining records provided by the Contractor and shall be paid by or credit to the Owner.

16. TERMS OF PAYMENT

16.1 The billing of the entire price of MATERIALS and price of Services shall be done from a single point only. In case of Consortium, each Consortium Members' invoices shall be forwarded to OWNER for payment under the letterhead and signature of the Consortium leader having single point responsibility, even though the payment is to be remitted directly to each Consortium Member.

16.2 Payment of the Contract price shall be made by the Company in accordance with the terms mentioned in 16.3 on receipt of invoices and other related documents.

16.3. Payment Terms

16.3.1 In respect of Imported Supplies:

- 10% of Contract Price shall be submitted as Contract Performance Bank Guarantee (CPBG), which shall be submitted within 7 days of signing of LOI/Purchase order, with validity till the completion of all supplies.
- 10% of Contract Price as advance against a bank guarantee of equivalent amount in format enclosed as (Annexure IV to SCC) within 30 days of acceptance of Purchase Order valid till completion of all supplies.

- 40% of Contract Price on pro-rata basis as per approved billing schedule through irrevocable & unconfirmed LC (to be opened within 60 days of signing of Contract) from an International Bank of repute, against shipping documents.
- 35% of Contract Price after mechanical completion of the package
- 15% of Contract Price within 30 days of successful commissioning and issue of PRELIMINARY ACCEPTANCE CERTIFICATE of all Equipment (including all material for completion of Package) against submission of Performance Bank Guarantee (PBG) of equivalent amount valid till expiry of Warranty Period or Defects Liability Period.

16.3.2 In respect of Indigenous Supplies:

- 10% of Contract Price shall be submitted as Contract Performance Bank Guarantee (CPBG), which shall be submitted within 7 days of signing of LOI/Purchase order, with validity till the completion of all supplies.
- 10% of Contract Price as advance against a bank guarantee of equivalent amount in format enclosed (Annexure II) within 30 days of acceptance of Purchase Order valid till completion of all supplies.
- 40% of Contract Price on pro-rata basis as per approved billing schedule within 30 days of receipt of materials at Site.
- 35% of Contract Price after mechanical completion of the package
- 15% of Contract Price within 30 days of successful commissioning and issue of PRELIMINARY ACCEPTANCE CERTIFICATE of all Equipment (including all material for completion of Package) against submission of Performance Bank Guarantee (PBG) of equivalent amount valid till expiry of Warranty Period.

16.3.3 In respect of Design & Engineering, Civil & Structural Work, Erection & Commissioning:



- 10% of Contract Price shall be submitted as Contract Performance Bank Guarantee (CPBG), which shall be submitted within 7 days of signing of LOI/Purchase order, with validity till the completion of civil work.
- 10% of Contract Price as advance against a bank guarantee of equivalent amount in the format enclosed within 30 days of acceptance of Purchase Order valid till commissioning.
- 70% of Contract Price on milestone basis mutually agreed billing schedule.
- 5% of Contract Price after mechanical completion of the package
- 15% of Contract Price within 30 days of successful commissioning and issue of PRELIMINARY ACCEPTANCE CERTIFICATE of all Equipment (including all material for completion of Package) against submission of Performance Bank Guarantee (PBG) of equivalent amount valid till expiry of Warranty Period.

16.3.4 Supervision of Erection & Commissioning etc.

90% Payment for services shall be made on milestone basis against submission of the signed invoice and milestone completion certificate signed by Buyer and Seller. Balance 10% within 30 days of PAC against PBG valid till PG test plus three months claim period.

Note: 1. In case Bidders quote any other payment terms appropriate financial loading shall be made to their prices.

2. Formats for Bank Guarantees like Advance Bank Guarantee (ABG), Performance Bank Guarantee (PBG) & Contract Performance Bank Guarantee (CPBG) are enclosed as Annexure-IV, Annexure-V and Annexure-VI respectively.

16.4 **LIQUIDATED DAMAGES / PRICE DISCOUNT FOR DELAY**

16.4.1 Delay in supplies and completion of the Contract shall attract LD. The LD shall be @1% per week of delay, subject to maximum of 10% of the Contract Price.

16.4.2 LD for not meeting Performance Acceptance Test parameters of the Equipment shall be limited to 12.5% of the Contract Price. The modalities of imposition of this LD shall be mutually discussed and agreed.



- 16.4.3 The Parties hereto agree that the liquidated damages mentioned in Clause 16.4.1 & 16.4.2 are an agreed genuine pre-estimation of damage and the compensation contemplated is not by way of penalty.
- 16.4.4 The Company shall have the right to deduct liquidated damages from any amount due or becoming due.
- 16.4.5 Payment or deduction of Liquidated Damages shall in no way relieve the Supplier from completing the Works and discharging all its other obligations under the Contract provided however that the above-mentioned Liquidated Damages are the Supplier's only obligation to financially compensate the Company in case of delayed completion of the Facility and/or failure to achieve the performance guarantees.
- 16.4.6 This should be read in conjunctions with clause 29.2 of GCC as "Incentive or Bonus for early Completion is not applicable for this Project".
- 16.4.7 If due to reasons not solely attributable to the Buyer, the guaranteed performance figures stipulated under Annexure 2 could not be finally achieved, even after two repetitions of the Performance Guarantee Tests but the parameters are within the acceptable tolerance limits as specified in Annexure 2, the Buyer shall be entitled to Liquidated Damages for non-achievement of guaranteed performance figures as specified under the said Annexure 2. Each repetition of Performance Guarantee test is to be completed within 30 days from the date of previous Performance Guarantee test.
- 16.4.8 The total amount of Liquidated Damages for non-achievement of guaranteed performance figures as per Annexure 2 shall not exceed 10 % (Ten) percent of the total Consideration value. However, this is without prejudice to the Buyer's rights consideration value and remedies under Applicable Law.
- 16.4.9 If even after 2 (two) repetitions the guaranteed performance figures in the Performance Guarantee Test could not be achieved and are beyond the acceptable tolerance limits as specified in Annexure 2, for reasons not solely attributable to the

Buyer, then in such event, the buyer shall in its sole discretion have the right to reject the contract equipment OR to claim enhanced liquidated damages from the Seller, the quantum of which shall be mutually decided between the Buyer and the Seller.

16.4.10 Once the enhanced liquidated damages have been paid by the Seller to the Buyer, the Final Acceptance Certificate shall be signed by the representatives of both the parties within two (2) weeks in 4 (four) originals, 2 (two) for each party.

16.4.11 Overall amount of the above mentioned liquidated damages for delay in delivery and for non-achievement of the Guaranteed Performance Figures, in the Performance Guarantee Test shall be limited to a maximum 15 % (fifteen) of total Consideration value.

17. BILLING SCHEDULE

The CONTRACTOR shall provide a billing schedule with a break-up of price onwards activities as mentioned in clause 12.2 and 16.3 of the SCC based on agreed payment terms within 30 days from the EFFECTIVE DATE OF CONTRACT for APPROVAL by the OWNER.

The CONTRACTOR shall raise “TAX INVOICE” on the OWNER against the taxes like GST, Cess etc., as the case may be, to enable OWNER to claim the Input Credit, as permissible under the respective indirect tax laws.

Similarly, in case of imports, the import duty shall be paid by OWNER hence it is CONTRACTOR's responsibility to ensure that all Import invoicing shall be made in the name of OWNER (i.e. **M/s. Hindalco Industries Ltd**) strictly so that Cenvat benefit will be availed by OWNER. If OWNER will not be able to avail the Cenvat benefit due to errors in Invoicing & other dispatch documents, the equivalent value of lost benefit shall be deducted from CONTRACTOR's balance payments.

The Bill of Entry shall have to be filed by the CONTRACTOR within the stipulated time with the appropriate authorities.

18. DEEMED ACCEPTANCE

In case, COMMISSIONING and/or proving of PERFORMANCE AND GUARANTEE TESTS of the PLANT is delayed beyond 12 months from MECHANICAL COMPLETION due to the reasons solely attributable to the OWNER, PLANT shall be DEEMED ACCEPTED with a DEFECT LIABILITY PERIOD of another 6 months. On DEEMED ACCEPTANCE, the care and custody of the PLANT shall be transferred to OWNER, and CONTRACTOR will be relieved from proving of PERFORMANCE AND GUARANTEE TEST of the PLANT. The Security-Cum-Performance Bank Guarantee shall be extended, accordingly, by the CONTRACTOR.

Final payment shall be released at ninth month from MECHANICAL COMPLETION against bank guarantee already running as Security-cum-Performance Bank Guarantee without any additional Bank Guarantee.

This clause of DEEMED ACCEPTANCE shall not be applicable in case reasons solely attributable to the OWNER are resolved before the completion of 12 months from MECHANICAL COMPLETION and

COMMISSIONING and PERFORMANCE AND GUARANTEE TEST is started within 12 months from MECHANICAL COMPLETION. In that case remaining activities including COMMISSIONING /

PERFORMANCE AND GUARANTEE TESTS shall be completed as per the terms & conditions of the CONTRACT and Security-cum-Performance Bank Guarantee shall be extended, accordingly, by the CONTRACTOR so as to ensure minimum validity of 6 months from the date of PRELIMINARY ACCEPTANCE.

19. LIABILITY FOR DEFECTS

19.1 If at any time before the PRELIMINARY ACCEPTANCE or during the DEFECTS LIABILITY PERIOD stated below, the ENGINEER-IN-CHARGE:

- a) decides that any matter is a DEFECT; and

b) as soon as reasonably practicable gives to the CONTRACTOR notice of the particulars of the DEFECT; the CONTRACTOR shall, as soon as reasonably practicable make good the DEFECTS so notified and the OWNER shall so far as may be necessary place the PLANT at the CONTRACTOR's disposal for this purpose. The CONTRACTOR shall, if so required by the ENGINEER-IN-CHARGE, submit his proposals for making good any DEFECT to the ENGINEER-INCHARGE for his approval.

Subject to clauses 19.4, 19.8 and 19.9, the DEFECTS LIABILITY PERIOD shall be a period of 12 months from the date of PRELIMINARY ACCEPTANCE or the date of issuance of a conditional PRELIMINARY ACCEPTANCE CERTIFICATE (as envisaged under Sub Clause 20.8 of SCC), whichever is earlier,

19.2 If any DEFECT arises from any breach of the CONTRACT by the CONTRACTOR the CONTRACTOR shall bear his own cost of making good the DEFECT. In the case of any other matter made good by the CONTRACTOR, the work done by the CONTRACTOR shall be the subject of CHANGE ORDER.

19.3 If a DEFECT is made good after the issue of a PRELIMINARY ACCEPTANCE CERTIFICATE or the issuance of a conditional PRELIMINARY ACCEPTANCE CERTIFICATE (as envisaged under Sub-Clause 20.8 of SCC), whichever is earlier, the ENGINEER-IN-CHARGE may require the CONTRACTOR to repeat any appropriate test for the purpose of ensuring that the DEFECT has been made good.

The CONTRACTOR shall be responsible for the cost of any such repeat inspection or test.

19.4 If in the course of making good any DEFECT which ariextended DEFECTSFECTS LIABILITY PERIOD the CONTRACTOR repairs, replaces or renews any part of the PLANT, this Clause 19 shall apply to the repair or to that part of the PLANT so replaced or renewed and shall further apply until the expiry of a period of 12 months from the date of such repair, replacement or renewal (the extended DEFECTS LIABILITY PERIOD), except that the extended DEFECTS LIABILITY PERIOD shall be limited to a maximum of 60 months from the date of PRELIMINARY ACCEPTANCE or the date of issuance of a conditional PRELIMINARY ACCEPTANCE CERTIFICATE (as envisaged under Sub Clause 20.8 of SCC), whichever is earlier.

19.5 If the CONTRACTOR does not make good with a reasonable time any DEFECT, which he is liable to make good under Sub-Clause 19.1, then the OWNER may, in addition to any other remedies or relief available to him under the CONTRACT, proceed to do the WORK, provided that the OWNER gives at least fourteen DAYS notice of his intention.

19.6 If the OWNER reasonably requires that any DEFECT notified to the CONTRACTOR under Sub-clause 19.1 which arises during the DEFECTS LIABILITY PERIOD be made good urgently and the CONTRACTOR is unable or refuses to comply within a reasonable

time, the OWNER may, in addition to any other remedies or relief available to him under the CONTRACT, proceed to do the WORK in such a manner as the ENGINEER-IN-CHARGE may decide, including the engagement of a third party.

19.7 If the OWNER has made good a DEFECT in accordance with Sub-clause 19.5 or 19.6, the CONTRACTOR shall reimburse the OWNER his reasonable cost of so doing provided that the OWNER gives a notice to the CONTRACTOR of his intention and submits a claim supported by DOCUMENTS. The ENGINEER-INCHARGE and the CONTRACTOR may mutually agree to the amount to be paid by the CONTRACTOR, or in the absence of agreement, the ENGINEER-IN-CHARGE shall decide such amount as may be reasonable in his considered opinion, which shall be binding on the CONTRACTOR. Such amount shall be:

- a) deducted from any money that would otherwise be payable under the CONTRACT; or
- b) paid by the CONTRACTOR to the OWNER.

19.8 If the PLANT cannot be used because of a DEFECT to which this Clause 19 applies, the DEFECTS LIABILITY PERIOD, or if applicable, the extended DEFECTS LIABILITY PERIOD shall be extended by a period equal to the period during which it cannot be used subject to an upper limit of 60 months from date of PRELIMINARY ACCEPTANCE or the date of issuance of a conditional PRELIMINARY ACCEPTANCE CERTIFICATE (as envisaged under Sub-Clause 20.8 of SCC), whichever is earlier. Similarly the DEFECTS LIABILITY PERIOD, or if applicable, the extended DEFECTS LIABILITY PERIOD shall be extended by any period wherein the PLANT cannot be used by reason of the CONTRACTOR putting the PLANT into such condition that it passes any relevant performance test or attempting to do so subject to an upper limit of 60 months from date of PRELIMINARY ACCEPTANCE or the issuance of a conditional PRELIMINARY ACCEPTANCE CERTIFICATE (as envisaged under Sub-Clause 20.8 of SCC), whichever is earlier.



19.9 If any part of the PLANT has a working life, which is specifically notified by the CONTRACTOR under this CONTRACT, to be less than 12 months, the DEFECTS LIABILITY PERIOD for such part shall be the working life so stated.

19.10 The CONTRACTOR shall have no liability whatsoever for DEFECTS under the CONTRACT or at law, after the expiry of the DEFECTS LIABILITY PERIOD or the extended DEFECTS LIABILITY PERIOD, as the case may be.

20. PERFORMANCE & GUARANTEE TESTS

20.1 The specific guarantees under the CONTRACT in respect of the performance of the PLANT made by the CONTRACTOR which is verifiable by PERFORMANCE & GUARANTEE TESTS shall be governed by this Clause 20.

20.2 If CONTRACT provides for the performance of the PLANT to be tested in sections or in parts, this clause shall apply as if a reference to the PLANT were a reference to a section or a part. The PERFORMANCE & GUARANTEE TESTS to be carried out on the PLANT shall be as specified in the CONTRACT. If any unspecified test is subsequently proposed, the CONTRACTOR and the ENGINEER-INCHARGE shall discuss and mutually agree whether or not such test should be carried out, and if so,

whether the test shall be carried out with or without a formal
CHANGE ORDER.

20.3 The PERFORMANCE & GUARANTEE TESTS shall be carried out by the CONTRACTOR in the presence of OWNER as soon as is practicable using suitably trained and experienced employees of the OWNER and in accordance with the manuals provided by the CONTRACTOR and such other instruction as the CONTRACTOR may issue in the course of carrying out such tests. The CONTRACTOR shall give an advance notice to the ENGINEER-IN-CHARGE of his readiness to carry out the PERFORMANCE & GUARANTEE TESTS, including a proposal for the time when the tests would commence.

20.4 Every performance test shall be carried out to completion unless the ENGINEER-IN-CHARGE or the CONTRACTOR shall order it to be stopped because its continuance would be unsafe or unacceptable to either party.

20.5 If, during the PERFORMANCE TEST PERIOD or any extended PERFORMANCE TEST PERIOD, the PLANT fails to pass any PERFORMANCE & GUARANTEE TESTS or if any such performance test is stopped before its completion in accordance with Sub-clause 20.4, such test shall, subject to Sub-clause 20.2 and 20.3, be repeated as soon as practicable thereafter. During the PERFORMANCE TEST PERIOD or any extended PERFORMANCE TEST PERIOD, the PLANT shall be under the care & custody of the CONTRACTOR. The CONTRACTOR shall make adjustments and modifications to any part of the PLANT before the repetition of any PERFORMANCE & GUARANTEE TESTS and shall, if required, shut down any part of the PLANT for such purpose and restart it after completion of the adjustments and modifications, which shall be made by the CONTRACTOR with all reasonable speed. After the PERFORMANCE TEST PERIOD or any extended PERFORMANCE TEST PERIOD, the timing of such shutdown shall be agreed between the CONTRACTOR and the ENGINEER-IN-CHARGE as elaborated in sub-clause 20.8 hereto.

The CONTRACTOR shall make such adjustments and modifications at his own cost and, if so required, submit to the ENGINEER-IN-CHARGE for his approval, details of the adjustments and modifications which he proposes to make.

20.6 The result of the performance tests shall be compiled and evaluated jointly by the OWNER and the CONTRACTOR.

20.7 If for reasons which are the responsibility of the CONTRACTOR, the PLANT does not meet the Works Cost Guarantee within the PERFORMANCE TEST PERIOD or any extended PERFORMANCE TEST PERIOD, the OWNER shall thereafter be free to take over the care and custody of the PLANT and operate the PLANT as deemed fit, provided that the results of the PERFORMANCE & GUARANTEE TESTS are within the limits of Works Cost Guarantee for the application of Mutually Agreed Damages specified in clause 29.3 of GCC. Upon payment or allowance of such sum, the CONTRACTOR shall become entitled to the issue of PRELIMINARY ACCEPTANCE CERTIFICATE stating that

the applicable Mutually Agreed Damages have been paid in respect of shortfall in performance with regard to Guaranteed Works Cost. However, it must be expressly understood that, failure to meet certain other Performance Guarantees related to PLANT capacity, product quality, emissions (pollution levels), noise, etc. and/or any other specific guaranteed parameter, mandated to be achieved without any tolerance in the maximum / minimum limits specified in the CONTRACT shall be considered as breach of CONTRACT, requiring the CONTRACTOR to “make good” the deficiency in the PLANT, irrespective of the cost involved, for which the CONTRACTOR shall not be relieved of his obligations under the CONTRACT by payment of any Mutually Agreed Damages.

If the results of the performance tests are outside the limits for application of Mutually Agreed Damages for Works Cost Guarantee specified in the CONTRACT, OWNER may at his option:

- a) instruct the CONTRACTOR to investigate or to co-operate with the ENGINEER-IN-CHARGE or others in the investigation of the reasons for the shortfall in performance.
- b) instruct the CONTRACTOR to propose remedial measures and work necessary to correct the shortfall whether as the result of any such investigation or not; and/or
- c) instruct the CONTRACTOR to carry out whatever remedial measures and work may be necessary to correct the shortfall.

Thereafter the ENGINEER-IN-CHARGE may require that a performance test for Works Cost Guarantee be repeated, the result of which shall be subject to this Sub-clause 20.7. The CONTRACTOR shall bear his own cost of work undertaken in accordance with (a), (b) or (c) above, including any other costs associated with a repeat performance test governed by the same conditions as applicable for the original test.

In the event works cost is more than 100% but equal to or less than 102.5% of the Guaranteed Works Cost then the CONTRACTOR will pay to OWNER Agreed Compensation as specified hereunder.

For every 0.50% increase in Works cost above the Guaranteed Works Cost or part thereof, CONTRACTOR will pay Agreed Compensation equal to 1.0% of the TOTAL CONTRACT PRICE.

If the Works Cost as demonstrated during the performance test is more than 102.5% of the Guaranteed Works Cost then it shall be breach of CONTRACT requiring corrective action by CONTRACTOR irrespective of the cost involved.

20.8 If the PLANT fails to pass any PERFORMANCE & GUARANTEE TEST within the specified PERFORMANCE TEST PERIOD and CONTRACTOR in consequence proposes to make any adjustment or modification thereto, the ENGINEER-IN-CHARGE shall notify the CONTRACTOR that the OWNER will:

- (a) extend the PERFORMANCE TEST PERIOD by a specified period, in which case CONTRACTOR shall repeat the PERFORMANCE AND GUARANTEE TEST in accordance with Sub-clause 20.5, it being expressly understood that the PLANT shall remain under the care and custody of the CONTRACTOR; or
- (b) issue a conditional PRELIMINARY ACCEPTANCE CERTIFICATE (provided that the PLANT has been continuously tested for at least 72 hours at full designed load), clearly stating the deficiency(ies)/shortfall in performance of the PLANT, which need to be rectified/" made good" by CONTRACTOR within agreed timelines and take-over the care & custody of the PLANT and operate the PLANT, as deemed appropriate. The operating risks of the PLANT under the care & custody of the OWNER during such operation and the risks associated with testing and defect rectification supervised by the CONTRACTOR, shall be covered under a 6-months Continuity Cover of the CONTRACTOR's Erection All Risks (EAR) policy, the premium for which shall be equally shared between the CONTRACTOR and OWNER as elaborated in Clause 27.7 of GCC.

However, it is expressly understood that a conditional PRELIMINARY ACCEPTANCE CERTIFICATE issued under clause 20.8(b) above:

- i) does not entitle the CONTRACTOR to claim or obligate the OWNER to release the last tranche of payment for Supplies, Spares, Construction Materials and Services, as per



the Terms of Payment specified in Clause 16.3 of SCC on achievement of the milestone of PRELIMINARY ACCEPTANCE of PLANT

ii) does not entitle the CONTRACTOR to claim or obligate the OWNER to release the PERFORMANCE BANK GUARANTEE of 10% of the TOTAL CONTRACT PRICE on achievement of the milestone of PRELIMINARY ACCEPTANCE of PLANT

iii) deems the commencement of the DEFECTS LIABILITY PERIOD, subject to the condition that DEFECTS LIABILITY PERIOD of the EQUIPMENT or part thereof which is repaired, rectified or replaced by the CONTRACTOR, as required to correct the deficiency(ies) / short-fall in performance of the PLANT so stated in the conditional PRELIMINARY ACCEPTANCE CERTIFICATE, shall be deemed to be 12 months from the date the DEFECT therein is rectified by the CONTRACTOR, subject to Sub-clause 19.8 of SCC.

Deferment of the timing of any repair, rectification or replacement by the CONTRACTOR, as required to correct the deficiency(y)ies / shortfall in performance of the PLANT so stated in the conditional PRELIMINARY ACCEPTANCE CERTIFICATE, shall be at the sole discretion of the OWNER. The OWNER's exclusive right to exercise such discretion is, however, limited to a maximum deferment period of 150 days if the PLANT needs to be shut-down or 90 days if no shut-down is required to make the adjustment or modification in the PLANT, commencing from the date on which the CONTRACTOR informs the OWNER of his readiness to make adjustment or modification in the PLANT.

In case the OWNER is unwilling to stop the PLANT after expiry of the said 150 days of the maximum deferment period or does not provide access to the CONTRACTOR within the said 90 days period for carrying out the said adjustment or modification in the PLANT, the CONTRACTOR shall have the exclusive right to make all necessary adjustments or modifications to correct the deficiency(y)ies and demonstrate the performance of the PLANT. On fulfilment of the conditions stated in the conditional PRELIMINARY ACCEPTANCE CERTIFICATE and satisfactory demonstration of the PLANT performance by the CONTRACTOR after making necessary adjustments or modifications in the PLANT

or denial of the opportunity to do so beyond the maximum deferment period as stated above, the OWNER shall issue the PRELIMINARY ACCEPTANCE CERTIFICATE without demur.

Upon issuance of the PRELIMINARY ACCEPTANCE CERTIFICATE, OWNER shall release the last tranche of payment for Supplies, Spares, Construction Materials and Services, as per the Terms of Payment specified in Clause 16.3 of SCC on achievement of the milestone of PRELIMINARY ACCEPTANCE of PLANT and the PERFORMANCE BANK GUARANTEE shall be reduced to 5% of the TOTAL CONTRACT PRICE as set out in Sub-clause 8.1 of GCC. However, if the CONTRACTOR fails to “make good” the deficiency/ies/short-fall in performance of the PLANT or after making necessary adjustments or modifications in the PLANT, fails to demonstrate the satisfactory performance of the PLANT, the OWNER shall have the option of further deferment of repair / rectification work by the CONTRACTOR by a reasonable period at the sole discretion of the OWNER, or alternatively, forfeit/encash the PERFORMANCE BANK GUARANTEE without any further reference to the CONTRACTOR.

- 20.9 If, for reasons attributable to the CONTRACTOR, the results of any performance test for Works Cost Guarantee within the PERFORMANCE TEST PERIOD or any extended PERFORMANCE TEST PERIOD as envisaged in Sub-clause 20.8, are outside the limits of Mutually Agreed Damages prescribed in subclause 29.3 of GCC as demonstrated by a repeat performance test or tests, OWNER shall proceed with encashment of Performance Bank Guarantee without notice to the CONTRACTOR. If during the extended PERFORMANCE TEST PERIOD the performance of the PLANT is brought within the limits of Mutually Agreed Damages, the liability of the CONTRACTOR shall be limited to the payment of Mutually Agreed Damages in accordance with Clause 29.3 of GCC.
- 20.10 If the PLANT has been prevented from passing through some of the PERFORMANCE AND GUARANTEE TESTS within the PERFORMANCE TEST PERIOD for any reason which is not the responsibility of the CONTRACTOR, the CONTRACTOR may apply to the ENGINEER-IN-CHARGE for the issue of PRELIMINARY ACCEPTANCE CERTIFICATE in



respect of the PLANT. The ENGINEER-IN-CHARGE shall thereupon issue such a certificate to the CONTRACTOR and the OWNER shall take-over the care and custody of the PLANT if:

- a) the ENGINEER-IN-CHARGE accepts the claim by the CONTRACTOR that, but for reasons beyond the CONTRACTOR's control the PLANT would have passed the performance tests within the PERFORMANCE TEST PERIOD and OWNER is of the opinion that such uncompleted PERFORMANCE AND GUARANTEE TESTS are not adversely affecting the overall performance of the PLANT; and
- b) the CONTRACTOR, if required by the OWNER, has provided a bond or guarantee to the OWNER in the prescribed format on the terms stated in Sub-clause 20.11.

The PRELIMINARY ACCEPTANCE CERTIFICATE shall list the unsatisfied or uncompleted PERFORMANCE AND GUARANTEE TESTS. In the event the ENGINEER-IN-CHARGE does not issue the PRELIMINARY ACCEPTANCE CERTIFICATE pursuant to Sub-clause 20.10; then the ENGINEER-INCHARGE shall be obliged to promptly notify the CONTRACTOR that the OWNER has extended the PERFORMANCE TEST PERIOD in the conditions set out in Sub-Clause 20.8 (a).

20.11 The CONTRACTOR shall, if required by the OWNER in accordance with Sub-clause 20.10, provide the OWNER with a guarantee valid until the PERFORMANCE AND GUARANTEE TESTS have been successfully completed or discharged or until the end of the DEFECTS LIABILITY PERIOD, whichever is the later, from a bank acceptable to the OWNER guaranteeing:

- a) the repayment by the CONTRACTOR any sum that may have become payable to him under the CONTRACT upon the issue of the PRELIMINARY ACCEPTANCE CERTIFICATE in the event of the PLANT subsequently failing to pass the uncompleted performance tests; and



- b) the payment by the CONTRACTOR of any Mutually Agreed Damages that may become payable in the event of the PLANT failing to meet the Works Cost Guarantee as per Clause 29.3 of GCC. The cost of such a guarantee shall be borne by the CONTRACTOR.

20.12 All unsatisfied or uncompleted performances tests shall be carried out by OWNER's personnel acting under the overall control and supervision of the CONTRACTOR as soon as practicable after the issue of the PRELIMINARY ACCEPTANCE CERTIFICATE in accordance with the Sub-clause 20.10 or within the maximum deferment period defined in Sub-clause 20.8 as notified by the ENGINEER-IN-CHARGE, permitting such tests to demonstrate performance of the PLANT. If matters beyond the CONTRACTOR's control continue to prevent the carrying out of the performance tests throughout the remainder of the DEFECTS LIABILITY PERIOD, then at the end of the said period such tests shall be deemed to have been satisfied, unless it is otherwise established that the PLANT was throughout the period incapable of passing any of the performance test by reason of some default of the CONTRACTOR.

21. FINAL ACCEPTANCE CERTIFICATE

21.1 Subject to Sub-clause 19.8, 21.2 and 21.3, as soon as DEFECTS LIABILITY PERIOD for the PLANT has expired or the CONTRACTOR has made good all DEFECTS that have within such period appeared in the PLANT or a Section and been notified to CONTRACTOR within such period in accordance with Clause 19 (Liability for Defects), whichever is later, the ENGINEER-IN-CHARGE shall issue a certificate (FINAL ACCEPTANCE CERTIFICATE) to the CONTRACTOR stating that the PLANT or Section and any related work have finally been completed and the date of that completion. If OWNER fails to issue the FINAL ACCEPTANCE CERTIFICATE or provide written notice stating the reasons for refusing to issue the FINAL ACCEPTANCE CERTIFICATE within 15 DAYS of CONTRACTOR'S written request, the same shall be deemed to have been issued.

21.2 If Sub-clause 19.4 continues to apply to any part of the PLANT, the ENGINEER-IN-CHARGE shall as soon as Sub-clause 21.1 is otherwise satisfied, issue a FINAL

ACCEPTANCE CERTIFICATE for the remainder of the PLANT or Section in which the repair or part is included, provided that such repair or part is then free from DEFECTS which the CONTRACTOR is bound to make under Clause 19. Such repair or part shall then be treated as if it were a separate Section and shall be the subject of separate FINAL ACCEPTANCE CERTIFICATE.

21.3 If at the time a FINAL ACCEPTANCE CERTIFICATE is due to be issued in accordance with Sub-clause 21.1 or 21.2 the results of any performance test have not been agreed and resolved in accordance with the Sub-clauses 20.7 and 20.9, a qualified FINAL ACCEPTANCE CERTIFICATE shall be issued in respect of the PLANT or Section to which that test relates. A further FINAL ACCEPTANCE CERTIFICATE shall be issued in respect to the PLANT or Section when the results of all its performance tests have been agreed and resolved and CONTRACTOR has paid or agreed any Mutually Agreed Damages or other compensation that may become payable in respect of the failure of any test.

21.4 The FINAL ACCEPTANCE CERTIFICATE shall constitute conclusive evidence for all purposes and in any proceedings whatsoever between the OWNER and the CONTRACTOR that the CONTRACTOR has completed that part of the PLANT and made good all DEFECTS therein in all respects in accordance with his obligations under the CONTRACT. Where there is more than one FINAL ACCEPTANCE CERTIFICATE the last to be issued shall be identified as being the last FINAL ACCEPTANCE CERTIFICATE.

No FINAL ACCEPTANCE CERTIFICATE shall be conclusive as stated above if it or any other FINAL ACCEPTANCE CERTIFICATE was issued in reliance upon any fraudulent act, misrepresentation or concealment.

22. SUPPLIER CODE OF CONDUCT

Contractor's business activities are governed by a set of commitments, values and ethics which are expressed in the HIL's Supplier Code of Conduct. Similarly, we expect from our business partners including but not limited to suppliers/Contractors to share the commitments, values and ethics expressed in the HIL's Supplier Code of Conduct. The Aditya Birla Group of Companies has taken the chance to express the governing commitments, values and ethics



applicable to its suppliers in the HIL's Supplier Code of Conduct ("HILCOC") which is enclosed with the enquiry documents.

Supplier represents and covenants that it shall at all times during and/or in connection with the term of this Order / Contract comply with the HIL's Supplier Code of Conduct and the commitments, values and ethics expressed therein.

In the event that Supplier violates the HIL's Supplier Code of Conduct and/or the commitments, values and ethics expressed therein, such violation shall be considered a material breach of Supplier's obligations. Furthermore, Supplier shall indemnify Purchaser from any claim, damage, demand, etc. made, incurred, and/or raised against or by Purchaser.

Purchaser may at any reasonable time conduct or have conducted audits in order to investigate Supplier's Contractor's compliance with the HIL's Supplier Code of Conduct and/or the commitments, values and ethics expressed therein. Contractor undertakes to fully cooperate with Purchaser in this matter. As a confirmation of their acceptance to the above Code of Conduct, Contractor shall submit the scan copy duly signed & stamped by Contractor's authorized Signatory with their bid.

23. ORDER OF PRECEDENCE

1. For all technical matters, in the event of an irreconcilable contradiction between the Technical documents forming a part of the Tender Enquiry and the Special Conditions of Contract, the General Conditions of Contract or any other document, to the extent that these documents cannot co-exist or be read together, then Scope of Work & Supply, Drawings /Technical Specifications, and Time Schedule, HSE & Site Requirements mentioned in Section C4 shall supersede the Special Conditions of Contract & the General Conditions of Contract..
2. However, for all commercial matters, in the event of any irreconcilable contradictions between the General Conditions of Contract and the Special Conditions of Contract, such that the two documents cannot co-exist or be read together, then the **Special Conditions of Contract** shall supersede the General Conditions of Contract but only to the extent that such contradictions between the two documents cannot exist or be read together.



24. ANNEXURES to SCC:

Annexure-I	Priced Bid Format (Schedule of Prices)
Annexure-II	Performance Guarantee
Annexure-III	Time Schedule
Annexure-IV	Format of Advance Bank Guarantee (ABG)
Annexure-V	Format of Performance Bank Guarantee (PBG)
Annexure-VI	Format of Contract Performance Bank Guarantee (CPBG)
Annexure-VII	Check List for the Contractors for Compliance under Various Acts
Annexure-VIII	Supplier Code of Conduct
Annexure-IX	Qualification & Experience for Key Construction Personnel
Annexure-X	Work During Monsoon

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Project : **ADITYA ALUMINA REFINERY PROJECT**
OWNER : **Hindalco Industries Limited (HIL) LSTK**
Package : _____
Bidding Document : _____ No.
Inquiry No. : _____
Bidder's Offer : _____ (Bidder to write their offer reference and date)

Annexure-I Schedule of Prices (SP Form) / Priced Bid Format
Foreign Currency (Currency shall be quoted by Bidder) _____

S. No.	Description	Unit	Prices	
			Foreign Currency	Indian Currency in INR
1	Supply of equipment / materials forming part of the Package including but not limited to Process Engineering, Hazop Study with participation by HIL / TCE, Detailed Engineering, Project Management, Total Procurement, Fabrication, Manufacturing, Quality Assurance, Inspection & Expediting, Third Party Inspection (TPI), Supplies, Obtaining all Statutory Approvals (except Environment Clearance which has been obtained by OWNER), including spares with Final and “As Built” documentation to HIL on single point responsibility basis (Lump Sum Turn Key – LSTK- Basis), based on tender documents provided by TCE, for Setting up of 0.85 MTPA Aluminum Refinery for M/S HINDALCO INDUSTRIES LIMITED (HIL) at Kansariguda, Odisha, India. (Including Commissioning Spares and Initial fill of Lubricants & Consumables)			
1.1.1	Material Handling Equipment	LS		
1.1.2	Static Equipment	LS		
1.1.3	Rotating Equipment	LS		
1.1.4	Piping Material (Including piping supports)	LS		
1.1.5	Supply of material for Civil Work	LS		
1.1.6	Supply of Pre-fabricated Structural material for Structural Work including shot blasting, painting.	LS		
1.1.7	Electrical Items	LS		
1.1.8	Instrumentation Items	LS		
1.1.9	Proprietary Equipment / items	LS		
1.1.10	Mandatory Spares	LS		
1.1.11	Commissioning Spares	LS		
1.1.12	Special Tools and Tackles	LS		
1.1.13	Any other item not covered above but required for the completion of work.	LS		
1.2.1	For Imported Supply – Total FOB, International Sea port / Airport of Exit Price (Contractor shall mention the Port in their Bid) (Sum of 1.1.1 to 1.1.13)			
1.2.2	Ocean Freight	LS		
	Sub Total - Imported (The CFR/CIF/CIP/CPT Value of Imported Material)			
1 2 3	Sub-Total (Procurement & Other Charges,)	LS		

1.2.4	Inland Transportation, Custom Clearances, Port Loading / Unloading etc. for Imported Materials up to Kansariguda, Odisha HIL Construction Site.	LS		
	TOTAL - Imported (FOR-HIL Construction Site)			
1.3.1	For Indigenous Supply - Total Ex-Works price. (Sum of 1.1.1 to 1.1.13)			
1.3.2	Inland Transportation for Indigenous Materials up to Kansariguda, Odisha HIL Construction Site	LS		
	<u>TOTAL - Indigenous (FOR-HIL Construction Site)</u>			
1.4	TOTAL SUPPLY (IMPORT + INDIGENOUS)			
2	INSTALLATION, TESTING, COMMISSIONING & PGTR/PAT etc. Pre-fabrication, fabrication, erection, construction, installation, testing, pre-commissioning, mechanical completion, commissioning and conducting PGTR/PAT, for completing and establishing the entire package under Contractor's scope as a fully functional and operative UNIT, including (but not limited to) providing all labour and manpower, resources, transportation, store management, construction equipment, tools, tackles and aids, safety devices, testing devices, insurance, facilities, utilities, communication systems, material and other reconciliations, Watch & Ward, Insurance, Local shifting of materials to construction site, Implementation of Safety Procedure, handing over of final drawings / documents / manuals, obtaining and satisfying all statutory licenses, clearances, Removal of any project left out materials / derbies etc. consents, no objections, approvals and certificates and complying with all statutory formalities etc. and all other services whatsoever required (but excluding the supply of materials required for permanent incorporation in the works) for completing the works in all respects of the entire Package in accordance with the Bidding Documents and Direction of Engineer-in charge.			
2.1.1	Civil Work	LS		
2.1.2	Structural Work	LS		
2.1.3	Mechanical Work.			
2.1.3.1	Pipe fabrication, erection & testing including erection of Mechanical / All Piping items.	LS		
2.1.3.2	Insulation	LS		
2.1.3.3	Painting	LS		
2.1.3.4	Static Equipment	LS		
2.1.3.5	Rotating Equipment	LS		

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Project **PROJECT** : **ADITYA ALUMINA REFINERY**

OWNER : **Hindalco Industries Limited (HIL)**

LSTK Package : _____

Bidding Document : _____ R00

No. _____

Inquiry No. : _____

Bidder's Offer : _____ (Bidder to write their offer reference and date)

Annexure-I Schedule of Prices (SP Form) / Priced Bid Format				
Foreign Currency (Currency shall be quoted by Bidder) _____				
S. No.	Description	Unit	Foreign Currency	Prices Indian Currency in INR
2.1.4	All Electrical Equipment/ Items.	LS		
2.1.5	All Instrumentation items	LS		
2.1.6	All Package Units	LS		
2.1.7	Installation of proprietary items	LS		
2.1.8	3-D Modelling	LS		
2.1.9	Special Studies / Testing (in lab / other places) if any	LS		
2.1.10	Pre-commissioning & Commissioning	LS		
2.1.11	Performance Guarantee Test Run (PGTR) / Performance Acceptance Test (PAT)	LS		
2.1.12	Any other activity not covered above but required for completion of the work.	LS		
	Sub Total - Installation, Testing, Commissioning & PGTR / PAT etc. (Total from 2.1.1 to 2.1.12)			
3	Taxes & Duties			
3.1	Goods & Service Tax on Supply Portion (GST)			
3.2	Goods & Service Tax on Services portion (GST)			
3.3	Others (Please specify)			
	Sub Total (Taxes & Duties)			
4	Contract Price (Sub-Total of 1, 2 & 3)			
5	Less Creditable Portion of GST Contractor shall furnish the detailed break-up of GST (Creditable and non			
	Creditable) along with the Ceiling Prices			
6	Contract Price (Net of Creditable Portion of GST)			

7	LIST FOR TWO (2) YEARS NORMAL OPERATION AND MAINTENANCE SPARES (Other than commissioning & Mandatory required during the defect liability period) The contractor shall attach equipment wise complete list of spares with quantities and unit rates with validity of 1 year from the date Commissioning of LSTK Package. <i>Same Incoterms shall be applicable as quoted/confirmed by the Contractor in Sr. No. 1 above.</i>			

Notes:

No column should be left blank. Wherever any Price/tax component is not applicable or Nil, please mention NA/Nil in appropriate place.

2 Detailed break-ups of Taxes & Duties and respective Ceiling amounts shall be indicated separately.

Bidder's Details

Signature

Stamp

Name

Designation



Client – Hindalco Industries Ltd
Project - Aditya Alumina Refinery

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SPECIAL CONDITIONS OF CONTRACT (SCC) For LSTK
TENDER PACKAGES
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QUALIFICATION AND EXPERIENCE FOR KEY CONSTRUCTION PERSONNEL

[ANNEXURE IX TO SPECIAL CONDITIONS OF CONTRACT]



Client – Hindalco Industries Ltd
Project - Aditya Alumina Refinery

TCE.13647A-000-0-TS-0006, Rev 0



SPECIAL CONDITIONS OF CONTRACT (SCC) For LSTK
TENDER PACKAGES

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Annexure-IX

QUALIFICATION AND EXPERIENCE FOR KEY CONSTRUCTION PERSONNEL

KEY CONSTRUCTION PERSONNEL:

CATEGORY	QUALIFICATION & EXPERIENCE
RESIDENT CONSTRUCTION MANAGER / RESIDENT ENGINEER / SITE-IN-CHARGE	Degree in Engg. with a total experience of 20 Years. minimum 7 years relevant refinery experience as RCM in Construction.
LEAD DISCIPLINE ENGINEER	Degree in relevant Engg. discipline with minimum 7 years' experience in Construction or Diploma in relevant Engg. Discipline with minimum 10 years' experience in Construction.
LEAD WELDING / NDT ENGINEER	Degree in Mechanical Engg. / Metallurgy with 5 years' experience in Welding / NDT (Non-Destructive Testing) Plus Level – II in RT (Radiographic Testing) or Diploma in Mechanical Engg. / Metallurgy with 15 years' experience in Welding / NDT Plus Level – II in RT.
LEAD QA / QC ENGINEERS	Degree in Engg. with 5 years' Construction Experience of which 2 - 3 years should be as a QA Manager.
LEAD PLANNING ENGINEER	Degree in Engg. with 5 years' Experience in large Refinery as Planning Manager with proficiency of primavera 8.2 version
LEAD SAFETY OFFICER	Degree in Science/Diploma in Engineering and Diploma in Industrial Safety with min. 3 years relevant experience in Construction Safety.
WAREHOUSE-IN-CHARGE MATERIALS MANAGER	/ Graduate in Science or Diploma in Engg. / Materials Management with 3 – 4 years' experience in Warehousing / Stores Management of similar nature.
HSE MANAGER	Recognized Degree in Science/Diploma in Engineering and Diploma in Industrial Safety with min. 15 years' experience



Client – Hindalco Industries Ltd
Project - Aditya Alumina Refinery

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WORK DURING MONSOON

[ANNEXURE X TO SPECIAL CONDITIONS OF CONTRACT]



WORK DURING MONSOON

- 1.0 Contractor must take due cognizance of the presence of rainy season / days in his scheduled completion period and accordingly, shall take all necessary actions to protect, reorganize and progress the work, uninterrupted during the monsoon period.
- 2.0 Contractor to collect all meteorological data from the local authority and collect necessary information about the intensity, frequency and period of rainy season.
- 3.0 No extension of time due to interruption /suspension of work, water logging, reduced /slowing down of progress, non-availability of manpower etc., whatsoever may be the reason, shall be tenable on account of monsoon and further no claim for stand-by of manpower and equipment, other resources etc. shall be paid for.
- 4.0 The successful bidder shall be required to submit within 15 days of Letter of Acceptance of offer / award of work, to the Engineer-in-Charge / OWNER his contingency plan for work during monsoon clearly stating their methodology / strategy to progress uninterrupted during monsoon mentioning the deployment of resources viz, numbers, capacity, category of equipment and manpower on a weekly basis for approval. The contingency plan shall include all provisions for constructing and maintaining temporary infrastructure like approach road, temporary drains in and around work area, dewatering whether natural or forced to keep the work area free from water logging so as to maintain the same always in a state worthy of vehicular, human and equipment movement. The work area shall be so isolated as to restrict run-of from the adjacent areas in the work area / site.
- 5.0 Contractor shall put up temporary sheds for fabrication of formwork and reinforcement. For fabrication of steelwork / piping proper rainproof shed with concretized floor of adequate area shall be made.



- 6.0 Additionally, localized (structure wise) monsoon protection shall be provided in order to facilitate work.
- 7.0 The contractor must indicate the structures / areas that he would like to progress (as per the project schedule and priority) particularly during the monsoon clearly indicating the sub-phases of construction like foundation / sub structure, superstructure etc.
- 8.0 Contractor shall procure and stock sufficient quantities of materials (if required, out side the plant premises, the land for which is to be arranged by the contractor at his cost and expenses) viz. coarse and fine aggregates, bricks etc. adequate for the planned volume of the work during the monsoon, well in advance of the onset of same so that progress of work is not affected on this account. The Engineer-in-charge shall be free to inspect such storing arrangement (particularly at places outside of the plant areas), at any appropriate time as deemed fit by him.
- 9.0 All electrical installations, equipment shall be placed on plinths above ground under proper rain shed to avoid any inundation, short circuit and hazards of electrocution.
- 10.0 Contractor shall organize his work particularly for the underground activities in foundation, excavation in a way that instead of opening up fronts everywhere and in scattered locations (provided there is no priority concern) only those many structures and /or areas should be worked where concerted and continuous effort and resources could be engaged to bring the work up to the desired level expeditiously to minimize any rework resulting from water accumulation / rain
- 11.0 To maintain the standard welding quality and progress, localized welding booth in sufficient numbers as per instruction of Engineer- in charge shall be installed for protection against wind and rain.



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12.0 Contractors item rates shall be including all costs and expenses including supply of materials required for monsoon protection like tarpaulins, shed, structural, GI sheet etc. for the above provisions and no separate payment shall be made on this account.

13.0 Contractor should have sufficient numbers of diesel operated pump for monsoon looking at the last ten years of rainfall data.