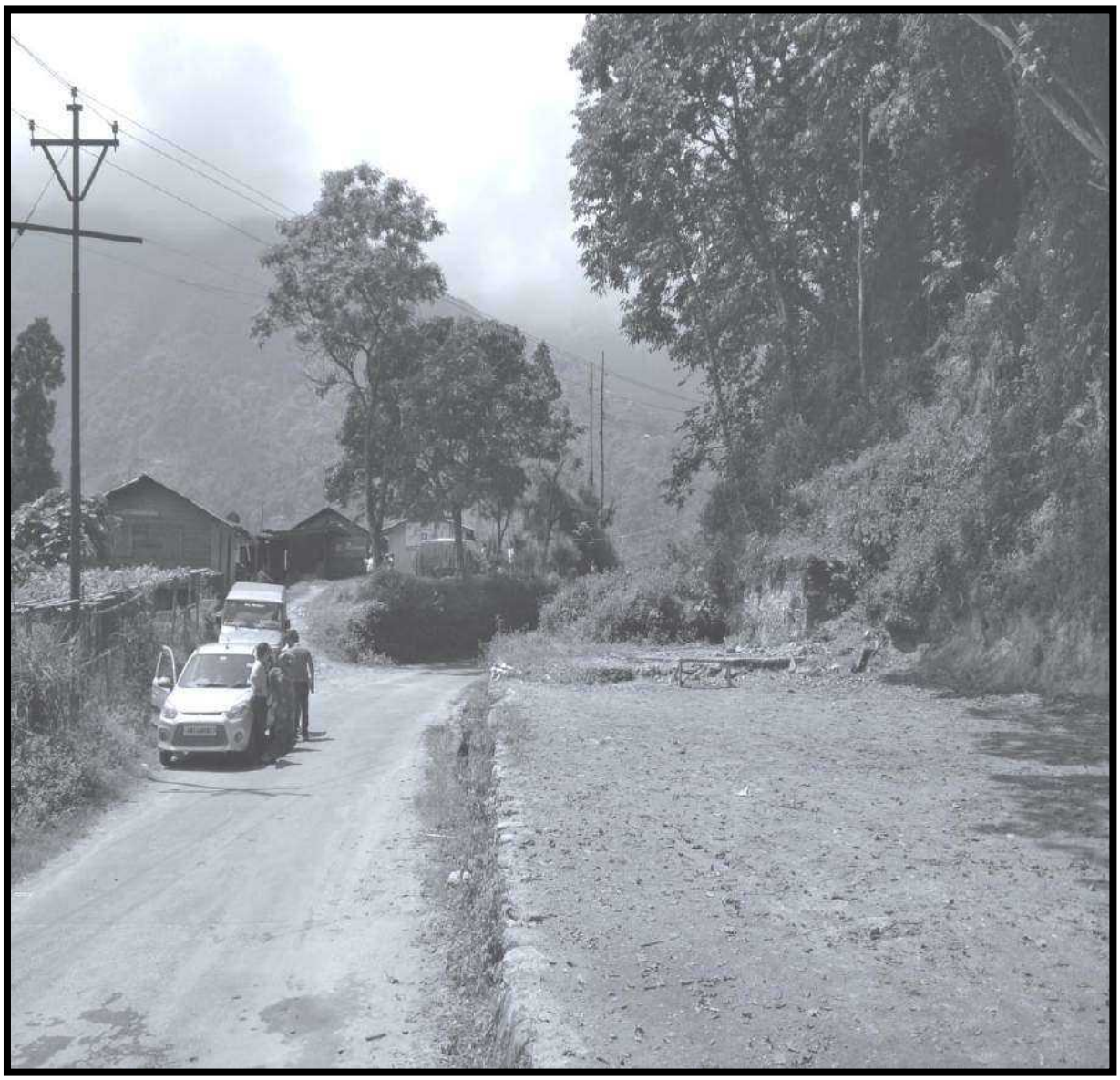
Vol – 1: 2nd CALL NOTICE INVITING E-TENDER

Design, Engineering, Construction, Supply, Erection, Testing and Commissioning of 10MW (2 x 5 MW) Lodhama–II Small Hydro-Electric Project in Darjeeling District, West Bengal including operation and maintenance for a period of 2(Two) years on Engineering, Procurement and Construction (EPC) contract basis



WEST BENGAL STATE ELECTRICITY DISTRIBUTION COMPANY LIMITED

(A Govt. of West Bengal Enterprise)

Planning, Investigation & Design Department, Vidyut Bhavan, Bidhannagar, Block DJ, Sector-II, Kolkata-700 091

Website: www.wbsedcl.in, CIN: U40109WB2007SGC113473

WBSEDCL

West Bengal State Electricity Distribution Company Limited
(A Government of West Bengal Enterprise)
Planning, Investigation & Design Department
VidyutBhavan (5th Floor, Block-B), Bidhannagar, Block DJ, Sector-II,Kolkata-700091
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Website: www.wbsedcl.in
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CIN : U40109WB2007SGC113473

E-NIT No.: PIDD/56/EPC/Lodhama II/2021-22/01 Date: 24/05/2021

2nd CALL NOTICE INVITING e-TENDER

(Local Competitive Bidding)

West Bengal State Electricity Distribution Company Limited (WBSEDCL), a Government of West Bengal Enterprise, intends to develop Lodhama–II Small Hydro-electric Project10 MW (2 x 5 MW) in Darjeeling District, West Bengal.

In this connection, the Chief Engineer, Planning, Investigation & Design Department (PIDD), WBSEDCL invites e-tender in two parts for the work of *following Project* from bona-fide, resourceful and technically sound developers having experience in execution of similar nature of work as per qualification criteria mentioned in this NIeT Document in the form of technical and financial proposals.

Name of the Work:	Design, Engineering, Construction, Supply, Erection, Testing and Commissioning of 10MW (2 x 5 MW) Lodhama–II Small Hydro-Electric Project in Darjeeling District, West Bengal including operation and maintenance for a period of 2(Two) years on Engineering, Procurement and Construction (EPC) contract basis
Location of the work Site:	The Project area is located in Darjeeling district, West Bengal near Lodhama village having latitude of 27^0 06'11" to 27^0 06'19" N and longitude of 88^0 06' 33" to 88^0 07'23" E.
Access to the Project:	The project Location is well connected by a network of PUCCA ROADS. The location can be approached by access roads namely, *Siliguri-Rammam via Mirik-Sukhiapokhri–Manebhanjan* or *Siliguri- Kurseong – Ghoom –Sukhiapokhri- Manebhanjan*. The nearest broad gauge railway station is *New Jalpaiguri* (*NJP*). Approximate Road distance from NJP Railway Station to Ghoom via NH-55 is 78 km and that from Ghoom to Lodhama by all-weather road is 60 km. The nearest airport for the project is Bagdogra.
Estimated Project Cost:	**Rs. 51.04 Crore (Rupees Fifty-one point zero four crore only) excluding GST.**
Provisional Sum	**Rs. 2.00 Crore (Rupees two crore only) excluding GST**
Tender Fee: (Non-refundable)	**Rs. 15000.00 plus 18% GST = Rs. 17,700.00 (Rupees seventeen thousand seven hundred only)**

Earnest Money / Bid Security:	**Rs 15,00,000.00 (Rupees Fifteen Lakh only)**
Validity of Earnest Money (In Case of Bank Guaranty:	**180 (One Hundred and Eighty) days** from the Bid submission start date with a claim period of three (03) months and subject to further extension, if, required.
Construction Period	**Thirty (30) months** from the date of handing over the site, to be reckoned as zero date.
Operation and Maintenance Period:	**Twenty-Four (24)months** post project completion and handing over.
Total duration of Project	**Fifty-Four (54) months** from the date of handing over the site
Bid Validity Period:	Bids shall remain valid for a period not less than **180 (One Hundred and Eighty) days** from the date of opening of **Financial Bid**. If the bidder withdraws the bid before the period of bid validity, the Earnest Money deposited by the Bidder(s) will be forfeited forthwith without assigning any reason thereof.

A. QUALIFICATION CRITERIA FOR PARTICIPATION IN THE BIDDING:

A.1. Technical Eligibility Criteria

The qualification will be subjected to bidder's fulfilment of the qualification criteria as stipulated hereunder, substantiated by authentic and relevant information and documents. Additional information in support of their claims of achievements may also be furnished.

The bidder(s) shall have to comply with any of the following techno-commercial eligibility criteria -

Options	Main Qualification Criteria	Additional Qualification Criteria for Joint Venture / Consortium Partners	
		Civil and Hydro-mechanical	Electro-mechanical
Option: 1	The bidder(s) shall have the experience of executing at least one (01) no. of Hydro Power Project complete in all respect upto successful commissioning having installed capacity of minimum five (05) MW in *Engineering, Procurement and Construction* (*EPC*) mode in the last Twenty five (25) years### as PRIME CONTRACTOR* Or, The bidder(s) shall have the experience of executing at least Two (02) nos. of Hydro Power Projects complete in all respect upto successful commissioning having installed capacity of minimum four (04) MW each in EPC (Engineering, Procurement and Construction) mode in the last Twenty five (25) years### as PRIME CONTRACTOR*	Not applicable	Not applicable

	Or, The bidder(s) shall have the experience of executing at least three (03) nos. of Hydro Power Projects complete in all respect upto successful commissioning having installed capacity of minimum three (03) MW each in EPC (Engineering, Procurement and Construction) mode in the last Twenty five (25) years### as PRIME CONTRACTOR*		
Option: 2	The bidder(s) shall have the experience of executing **Water Resource Projects#** of aggregated contract value of **Rs. 25.52 crore [50% of the Estimated Project Cost**]** or more in the last twenty five (25) years### as PRIME CONTRACTOR* or SUB-CONTRACTOR+	Not applicable	The Bidder(s) shall have to execute a Joint Venture / Consortium Agreement / Memorandum of Understanding (MoU) duly Notarised with an Agency having experience of executing Electro-mechanical Contract for Hydro-electric Power Projects## of **aggregated** contract value of **Rs.12.76 Crore [25% of Estimated Project Cost**]** or morein last Twenty (25) years### as PRIME CONTRACTOR* or SUB-CONTRACTOR+.

Option: 3	The bidder(s) shall have the experience of executing **Electro-mechanical Contract**## for Hydro-electric Power Project##of aggregated contract value of **Rs. 25.52 Crore [50% of Estimated Project Cost**]** (or morein last Twenty five (25) years### as PRIME CONTRACTOR* or SUB-CONTRACTOR+.	The Bidder shall have to execute a Joint Venture / Consortium Agreement / Memorandum of Understanding (MoU) duly Notarised with an Agency having experience of executing **Water Resource Projects#**of aggregated contract value of **Rs.12.76 Crore [25% of Estimated Project Cost**]** or more in the last twenty-five (25) years### as PRIME CONTRACTOR* or SUB-CONTRACTOR+	Not applicable
Option: 4	Companies/ Agencies/Consortium/JVs having experience of executing **Government Infrastructure** Projects in hilly regions of aggregated contract value of **Rs. 25.52Crore [50% of Estimated Project Cost**]** or more in last Seven (07) years### as PRIME CONTRACTOR*.	The bidder(s) shall have to execute a Joint Venture / Consortium Agreement / Memorandum of Understanding (MoU) duly Notarised with an Agency having experience of executing Electro-mechanical Contract for Hydro-electric Power Project and/or **Water Resource Projects#**of **aggregated** contract value of **Rs.20.416 Crore [40% of Estimated Project Cost**]** or morein last Twenty five (25) years### as PRIME CONTRACTOR*or SUB-CONTRACTOR+.	

*Prime Contractor means the main Contractor and/ or developer

* Any premier CPSU/ State PSU under the administrative control of Govt. Of India/ State may take up the subject work and execute the same through Sub-contractors for Civil, HM and E&M works in case it is selected for the subject work by WBSEDCL

** Estimated Project Cost indicates Project Cost of 10 MW (2x5 MW) Lodhama II SHP furnished in this Bid Document

** Aggregated contract value means cumulative value of similar work with more than single Job.

Design, Engineering and Construction of major Civil and/or Hydro-mechanical Components like Dam, Intake/ Barrage, Diversion Structures, Transfer Structure, De-silting Basin, Tunnel/ Channels, Forebay, Power House, Penstock, Gates etc. for development of Hydro Power and/ or Water Resource Projects

Design & Engineering, Manufacturing, Procurement, Supply, Installation/ Erection Testing and Commissioning of Major Electro-mechanical Equipment of a Hydro Power Projects like Turbine(s), Generator(s), Main Inlet Valve(s) etc.

The base date for calculating the time period shall be the date of uploading of this tender document

\+ Sub-contractor means the contractor who executes a portion of a contract from the principal contractor/ Prime Contractor/ Main Contractor.

Note:

1) The executed project(s) components should be in successful operation for minimum one (01) year from the date of final commissioning of the project i.e. the period of operation shall be reckoned from the date of final commissioning of the project till the uploading of this tender document. In support of the same, necessary documents clearly mentioning the current status shall be furnished by the bidder.
2) Under any aforesaid options of the qualification criteria, minimum contract value of **Rs. 5,00,00,000.00 (Rupees Five Crore Only)** for individual projects completed by the bidder and/ or Joint Venture / Consortium Partners shall only be considered for eligibility of the bidder and/ or Joint Venture / Consortium Partners.
3) The successful bidder should have its own Design and Engineering section or have to associate with a reputed design and consultancy firm having proven track record and experience in successfully handling in preparing of DPR, detailed design and engineering of complete Hydropower Projects, Water Resource projects or individual project components with contract value for design and Engineering of **Rs. 50,00,000.00 (fifty Lakh rupees only)** or more in last **25 years**. The bidder who have their own design section have to submit the requisite documents in support of their credentials. If the bidder is willing to engage a consultant then the bidder shall have to submit a declaration in a Non-judicial Stamp Paper of Rs. 100.00 (Form-16 of Forms & Proformas in Volume-8) mentioning the name of the eligible consultancy firm, credential sand the letter of consent from the proposed consultant.
4) The Form-2 and Form-3 provided in the Forms & Proformas Section shall be filled in as per applicability.

Bidders willing to participate under the qualification criteria mentioned in Option – 2 ,Option – 3 and Option – 4 above shall submit a declaration on the fulfilment of the eligibility criteria mentioned for their Joint Venture/ Consortium Partners in a Non-judicial Stamp Paper of Rs. 100/-(Form-3 of Forms and Proformas in Volume-8).

A.2. FINANCIAL CAPACITY

I. The bidder shall submit reports on the **financial standing** i.r.o. solvency of Bidder Company/ firm as certified by bankers and audit report for companies registered under Companies Act and Tax Audit Report for Partnership Firms for last three (03) Financial Years (FY) viz. **2017-18, 2018-19 and 2019-20.**

II. The bidder shall submit **Income Tax Return** for last three (03) Assessment Years (AY) viz. **2018-19, 2019-20 and 2020-21**.

III. TURN OVER

Average annual turnover of the bidder for last three (03) Financial Years (FY) i.e. **2017-18, 2018-19 and 2019-20** should not be less than **30% of the Estimated Project Cost.** Other income shall not be considered for calculation of annual turnover.

IV. NET WORTH

Net worth for each of the last three (03) Financial Years (FY) i.e. **2017-18, 2018-19 and 2019-20** should be positive. Net worth means the sum total of the paid up capital and free reserves (excluding reserves created out of revaluation) reduced by aggregate value of accumulated losses (including debit balance in profit and loss account for current year) and intangible assets.

V. WORKING CAPITAL

Working capital of the bidder in the year, preceding the year of bid submission i.e. **FY. 2019-20**, shall not be less than **15%of the Estimated Project Cost**.

Working capital will be calculated as difference between Current Assets and Current Liabilities.

If the Working capital calculated from the audited balance sheets is negative then such working capital shall be treated as zero (0).In case audited financial statement is not available for the immediate previous financial year i.e. 2019-20 then a provisional Balance Sheet is to be submitted duly certified by practicing Chartered Accountant (CA) with sign stamp and membership no.

In case there is a shortfall in the Working Capital as per the requirement mentioned above, the unutilized Credit Limits sanctioned to the bidder from a schedule bank in India shall be considered together with working capital. The statement displaying cash credit limits should not be more than three (03) months old as on the last date for submission of bids. In such case Bidder Company/ Firms etc. shall have to submit certificate as per prescribed 'Form No.-7 of Forms & Pro-forma' of the tender document, duly certified by transacting banks.

In case of JV/ consortium, Bank Solvency Certificate of the Lead Member will be sufficient.

VI. Any evidence of unfair trade practices including over charging, price fixing, cartelization, involve in any corruption, etc. as defined in various statutes, will automatically disqualify the bidders. A 'Self Declaration Certificate (duly notarized)' should be submitted in this regard as per 'Form No.-4 of Forms &Pro-forma' of this tender.

VII. Copies of orders & completion certificates issued by the owner shall have to be submitted as documents in support of credential (originals may have to be produced for verification, if asked for).

VIII. If bid is submitted by a Joint Venture (JV)/ Consortium, the bidder shall meet, individually, the financial eligibility criteria set forth at Para A.2.-I), II), and IV) above and collectively the financial eligibility criteria set forth at Para A.2.III) andV)above.

However,

- At least one partner shall meet, not less than 40% of the minimum criteria given at Para A.2 III) &V) above.

AND

- Each of the other partner(s) shall meet not less than 25% of the criteria given at Para A.2 III) &V)above.

A.3. OTHER QUALIFICATION CRITERIA

i) The bidder should be bona-fide, experienced & resourceful company registered under Companies Act, 2013/ read with Companies Act, 1956 (with amendment from time to time) or Partnership Firm registered as per Indian Partnership Act, 1932, LLP registered under LLP Act, 2008 barring Government Department as well as foreign bidders/ MNCs not registered and incorporated in India and those bidders, already placed under holiday listing and the term/ duration of such listing has not yet expired.

ii) A bidder shall not have a conflict of interest. Any bidders found to be having a conflict of interest shall be disqualified. The bidder shall be considered to have conflict of interest with one or more parties in this bidding process, if:

a. They have a controlling partner in common; or
b. They receive or have received any direct or indirect subsidy from any of them; or
c. They have the same legal representative for purpose of this bid; or
d. They have a relationship with each other, directly or through common third parties, that puts them in position to have access to information about or influence on the bid of another bidder, or influence the decisions of the employer regarding this bidding process; or
e. A bidder submits more than one bid in the bidding process, either individually or in any form, will result in disqualification of all such bids; or
f. A bidder or any of its affiliates participated as a consultant in the preparation of the design or technical specification of the materials and services/ works that are subject of the bid; or
g. The bidder, directly or indirectly shall not be a dependent agency of the WBSEDCL.

iii) The bidder should not have been banned / de-listed / black listed / debarred from business by any PSU / Govt. Department/WBSEDCL/WBSETCL or any other authorised institution. Self-declaration in this regard is to be submitted as per Proforma enclosed at Form-17 of Volume – 8: Forms & Proforma.

iv) Bids of only those Bidders who are meeting the Eligibility Criteria specified above will be considered for evaluation and award of the Contract. Bidders will submit requisite supporting documents and testimonials with their Bids to prove their credentials and claim of meeting the Eligibility Criteria.

Note:

- Mere downloading of Bid document by prospective bidder shall not be construed that such a bidder automatically fulfils the prescribed eligibility criteria. Whether the bidder meets the specific eligibility criteria or not, shall be checked or ascertained after opening their bids by scrutinizing documentary evidences furnished by them along with their bid.
- The Employer reserves the right to:
  - Amend the scope of work to be tendered.
  - Reject or accept any bid for reasons including national defence and security consideration; and
  - Cancel the bidding process and reject all bids, without assigning any reasons thereof.

    The Employer will not be liable for any such actions. However, the bidder(s), who wish to seek reasons for such decision of cancellation / rejection, shall be informed of the same by Employer unless its disclosure reasonably could be expected to affect the sovereignty and integrity of India; the security, strategic, scientific or economic interest of the State; relation with foreign state or lead to incitement of an offence.

A.4. SUBMISSION OF BID

Bids are to be submitted online through the website https://wbtenders.gov.in. All the documents uploaded by the Tender Inviting Authority form an integral part of the tender document. Bidders are required to upload the entire tender document along with the other required documents through the above website within the stipulated date and time as given in the NIeT.

The bid shall comprise of two parts and to be submitted simultaneously – One is Technical Proposal (Techno-commercial Bid) and other is Financial Proposal (Financial Bid).

The bidders need to download the documents, fill up the particulars in the designated cell and upload the same in PDF in the designated location of the Techno-commercial Bid.

The bidders need to download the Price Bid & Price Break up schedule as uploaded with this tender in .xls format, fill up the same and upload the filled up document in the designated location of the Financial Bid.

All The documents uploaded should be digitally signed using Digital Signature Certificate (DSC). Bidders should take note of all the addendum / corrigendum related to the bid and upload the latest documents as part of the bid.

The bidders shall submit a hard copy of their **TECHNO-COMMERCIAL BID ONLY** within the stipulated last date of offline submission of the technical bid as per **Cl. No. A5 of NIeT**.

Bidders are requested to go through **Cl. No. 1.2 of ITB** to understand the online bidding process.

A.5. KEY DATES & TIME:

Date of uploading of NIeT documents (online):	24/05/2021 at 14:30 Hrs
Documents download start date:	25/05/2021 after 14:30 Hrs
Site visit:	From 07/06/2021 to 22/06/2021 from10:00Hrs to 17:00Hrs
Last date for submission of Pre-bid queries, if any:	29/06/2021 up to 17:00 Hrs

Date of pre-bid meeting:	08/07/2021 at 11:30 Hrs
Bid submission (technical & financial) beginning date:	22/07/2021 after 15:00Hrs
Bid submission (technical & financial) closing date:	06/08/2021 up to 13:00 Hrs
Last date of offline submission of required documents (including tender fee and EMD in original)	06/08/2021 up to 15:00 Hrs
Date for opening of technical bid:	12/08/2021 at 16:00 Hrs
Date for opening of financial bid:	To be informed after evaluation of technical bid

A.6. IMPORTANT TERMS & CONDITIONS:

I. **Pre-Bid Meeting:** The bidders or their authorized representatives are requested to attend the Pre-bid Meeting at the stipulated date and time. Pre-bid queries, if any, shall be submitted on or before **29/06/2021 up to 17:00 Hrs** through email to wbsedclhpc@gmail.com.

II. **Tender Fee :**The cost of the Tender Document Shall be as per Clause no 4.of ITB. No bidders will be allowed for exemption of cost of bidding document.

III. **Earnest Money Deposit:**The amount and mode of deposition of Earnest Money shall be as per clause no18 of the ITB. Exemption on earnest money/ bid security will not be allowed to any bidder(s).

IV. **Contract Performance Security**: The contract performance security for the successful bidder shall be as per 'Clause No.-13 of General Conditions of Contract (GCC)'.

V. Financial proposals of the bidders, declared techno-commercially eligible, will be opened electronically by the Tender Inviting Authority from the e-tender portal stated above on the prescribed date. The decision of the tender inviting authority will be final &absolute in this respect and no challenge against such decision will be entertained. In any circumstance or whatever may be the outcome of the present invitation of the bid, cost of the bidding will not be reimbursed/ returned by WBSEDCL. The list of techno-commercially qualified bidder(s) will be uploaded in the e-tender portal.

VI. **Defect Liability Period :**The term 'defect liability period' shall be as per Clause no.53 of GCC. If any defect is found within the defect liability period, the contractor shall be liable to promptly make good the defect or replace at their own cost and responsibility.

VII. The intending bidder(s) shall quote their rates online only in their Financial Bid as per specified format / BOQ provided with this NIeT Document. No price information for this tender shall be mentioned in the Techno-commercial Bid.

VIII. Conditional/ incomplete bid will not be accepted under any circumstances.

IX. The Tender Inviting Authority reserves the right to modify, amend or supplement this Tender Document. Any corrigendum, notification concerned to this NIeT will be published in the e-tender portal https://wbtenders.gov.in. The bidders are therefore advised to follow the e-portal regularly for such corrigendum, notification etc.

X. All documents, as submitted, will be property of WBSEDCL & will not be returned to the bidders under any circumstances. However, the EMD of the unsuccessful bidders

will be returned within **45 (forty five) days** after finalization of this tender for which a request letter shall be initiated by the concerned unsuccessful bidder(s).

XI. Any evidence of unfair Trade Practices including over charging, price fixing, cartel formation etc. as defined in various statutes, will automatically disqualify the bidders as per terms and conditions of this bidding document.

XII. For detailed information and terms and conditions of this tender, Bidders are requested to go through Instruction to Bidders (ITB), Information for Bidders (IFB), General Conditions of Contract (GCC), Special Conditions of Contract (SCC), Technical Specifications of Civil, Hydro Mechanical and Electro Mechanical, Tender Drawings, Forms and Proformas, BOQ, Salient Features, Geological Report and Soil Report provided with this tender.

XIII. Issuance of Bid documents will not be construed to mean that such Bidders are automatically considered qualified. WBSEDCL will not be bound to award the job to the lowest bidder.

XIV. Registration of Bidder: Intending eligible bidders, desirous of participating in the tender will have to be enrolled and registered with the Government of West Bengal e-procurement system and may download the tender document from the website https://wbtenders.gov.in directly with the help of Digital Signature Certificate (DSC). The tender can be searched by typing WBSEDCL in the search engine provided in the above mentioned website.

XV. Digital Signature Certificate (DSC): Bidders willing to take part in the process of e-tendering are required to obtain Class-II or Class-III Digital Signature Certificate (DSC) in the name of person who will sign the tender, from any authorized Certifying Authority (CA) under the Controller of Certification Agencies (CCA), Govt. of India. The bidders are required to register the fact of possessing the digital signature certificates through the registration system available in the website. Tenders shall be submitted online and intending bidders should download the tender documents from the website stated above, directly with the help of the DSC. This is the only mode of collection of tender documents.

XVI. The Tender inviting Authority reserves the right to accept or reject any/ all offer without assigning any reason what-so-ever and is not liable for any cost that might have been incurred by the bidder at the stage of bidding.

A.7. CONTACT PERSON:

The Chief Engineer
Planning, Investigation & Design Department (PIDD),
West Bengal State Electricity Distribution Company Limited (WBSEDCL)
Vidyut Bhavan, 5th Floor, B – Block, Block – DJ, Sector – II,
Salt Lake, Kolkata – 700 091, West Bengal, India

Corporate Identification No (CIN): U40109WB2007SGC113473

Website	:	www.wbsedcl.in
Contact No.	:	+913323345853/ 8900793360
Email id	:	wbsedclhpc@gmail.com

Sd/-
Chief Engineer
Planning, Investigation & Design Department (PIDD)

VOL – 2- INSTRUCTION TO BIDDERS

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1. NAME OF THE WORK

Design, Engineering, Construction, Supply, Erection, Testing and Commissioning of 10MW (2 x 5 MW) Lodhama–II Small Hydro-Electric Project in Darjeeling District, West Bengal including operation and maintenance for a period of 2 (Two) years on *Engineering, Procurement and Construction* (*EPC*) contract basis

2. REGISTRATION OF BIDDER/ TENDERER

Any bidders willing to take part in the process of e-tendering will have to enrol and register with the Government of West Bengal e-procurement system. Through logging in to **https://wbtenders.gov.in,** the contractor has to go for the e-tendering link as given on the web portal.

3. DIGITAL SIGNATURE CERTIFICATE (DSC)

Each bidder is required to obtain Class-II or Class-III Digital Signature Certificate (DSC) for submission of bids from the approved service provider of the National Information's Centre (NIC), authorized by the Controller of Certifying Authority (CCA) of Govt. of India on payment of requisite amount.

4. TENDER FEE

The cost of the tender document will be **Rs.17,700.00 [Rs.15,000.00 plus 18% GST] (Rupees seventeen thousand seven hundred only)**payable in the form of Banker's Cheque (BC)/CTS 2010 compliant Demand Draft (DD)on any scheduled bank with validity of 03 (three) months to be drawn in favour of '**WEST BENGAL STATE ELECTRICITY DISTRIBUTION COMPANY LIMITED' payable at KOLKATA**. The cost of tender document submitted by the bidder is 'NON-REFUNDABLE'. The bidder shall have to deposit the tender fee physically at the office of '***The Chief Engineer, Planning, Investigation & Design Department, WBSEDCL, 5th Floor, B-Block,Vidyut Bhavan, Sector-II, Block-DJ, Salt Lake, Kolkata-700091'*** under separate sealed cover as per stipulated scheduled date & time mentioned at **Clause no. A.5** of NIeT. Payment for the tender fee in any other form will not be accepted. Scanned copy of Banker's Cheque (BC)/ Demand Draft (DD) has to be uploaded in the given website with the bid. In any circumstances, tender fee shall not be reimbursed and/ or returned by WBSEDCL to the applicant.

5. SITE VISIT

The bidder(s), at his/ their own responsibility and risk may inspect and examine the site of work and its surroundings and obtain all information necessary for preparing bid for the work as mentioned in the NIeT, before submitting offer with full satisfaction. The bidder(s) should inform in writing or through e-mail to this office at least **03 (Three) days** before undertaking the site visit. The cost of visiting the sites shall be borne by bidder(s). The Bidder(s) interested to see and inspect the sites of work on the prescribed date(s) as mentioned in the key date's schedule of 'Clause No.-A.5.of Notice Inviting e-tender (NIeT)', may inform ***The Chief Engineer, Planning, Investigation & Design Department, WBSEDCL, 5th Floor, B-Block, Vidyut Bhavan, Sector-II, DJ-Block, Salt Lake, Kolkata-700091 through Email address: wbsedclhpc@gmail.com'***.

6. ELIGIBILITY CRITERIA FOR PARTICIPATION IN THE BIDDING

6.1. GENERAL:

- The bidder should be bona-fide, experienced & resourceful companies registered under Companies Act, 2013/ read with Companies Act, 1956 (with amendment from time to time) or Partnership Firm registered as per Partnership Act, 1932 or Statutory Body or LLP Act, 2008 barring Government Department as well as foreign bidders/ MNCs not registered

and incorporated in India and those bidders, already placed under holiday listing and the term/ duration of such listing has not yet expired.

- A bidder shall not have a conflict of interest. Any bidders found to be having a conflict of interest shall be disqualified. The bidder shall be considered to have conflict of interest with one or more parties in this bidding process, if:

i. They have a controlling partner in common; or
ii. They receive or have received any direct or indirect subsidy from any of them; or
iii. They have the same legal representative for purpose of this bid; or
iv. They have a relationship with each other, directly or through common third parties, that puts them in position to have access to information about or influence on the bid of another bidder, or influence the decisions of the employer regarding this bidding process; or
v. A bidder submits more than one bid in the bidding process, either individually [including bid submitted as agent/ authorized representative on behalf of one or more manufacturer(s) or through Licensee – Licensor route, wherever permitted as per the provision of qualification requirement for bidders] or as partner in a joint venture, except for alternative offers permitted under invitation to bid. This results in disqualification of all such bids. However, this does not limit the participation of a bidder as a sub-contractor in another bid, or of a firm as a sub-contractor in more than one bid; or
vi. A bidder or any of its affiliates participated as a consultant in the preparation of the design or technical specification of the materials and services/ works that are subject of the bid; or
vii. The bidder, directly or indirectly shall not be a dependent agency of the WBSEDCL.
viii. A Power of Attorney, duly notarized, indicating that the person(s) signing the bid has (ve) the authority to sign the bid and thus that the bid is binding upon the bidder during full period of its validity. The above stated requirements are a minimum and WBSEDCL reserves the right to request for any additional information and also reserves the right to reject the proposal of any bidder, if in the opinion of employer, the qualification data is incomplete or the bidder is found not qualified to satisfactorily perform the contract.

6.2. TECHNICAL ELIGIBILITY CRITERIA:

i. Refer to Clause no. A1 of NIeT
ii. Letter of Award along with Satisfactory Commissioning/ Completion Certificates duly endorsed by the Employer or his Authorized Persons (along with contact number, e-mail ID) in support of execution of the work mentioned above and present status of the Plant shall have to be submitted as Credentials.
iii. Bid(s) may also be submitted by joint venture firm/consortium having not more than 03 (three) partners with 01 (one) partner as lead partner with requisite technical qualification of the Members of the JV as mentioned below:

a) At least 01 (one) of the partner(s) of the Joint Venture (JV)/ Consortium should fulfil the requirements set forth in technical criteria.

Or

b) All the partners should jointly meet qualification requirements set forth in the technical criteria.

iv. Bidder shall have to submit in support of the eligibility credential of (JV)/ Consortium partners, the list of projects executed alongwith requisite documents as per Sl. No. 6.2 ii, iii b) above.
v. Bidder should submit a list of contracts similar to eligibility credentials presently under execution giving details of client with contact nos., completion time, scope, value of work and their present status. The bidders should submit details in this regard as per 'Form no. - 18 of 'Forms and Proformas' of this tender document.
vi. A list of key professionals is to be furnished by the bidder as the project team structure for the proposed work mentioning their experience and qualification.

vii. Bids submitted by joint venture firms/consortium having not more than 03 (three) partners with 01 (one) partner as lead partner with requisite technical qualification of the members of the JV shall comply with the following requirements:

- One of the partners shall be authorized by the other members of the JV/ Consortium, for performing key role in execution of the contract and shall be designated as Lead Member; this authorization shall be evidenced by submitting with the bid a Power of Attorney signed by legally authorized signatories as per 'Form No.-15 of Forms & Pro-forma of this tender.
- The bid shall be signed by the authorized representative of the Lead Member.
- The Contractor shall ensure that each member of the Consortium shall be bound by any decision, communication, notice, action or inaction of the Lead Member on any matter related to this Agreement and the Authority shall be entitled to rely upon any such action, decision or communication of the Lead Member. The Authority shall have the right to release payments solely to the Lead Member and shall not in any manner be responsible or liable for the inter se allocation of payments among members of the Consortium.
- .All partners of the joint venture/ consortium shall be liable jointly and severally for the execution of the contract in accordance with the contract terms.
- A joint venture/ consortium agreement entered into by the partners shall be submitted with the bid as per 'Form No.-14 of Forms & Proformas in Volume-8 of this tender, including inter-alia delineation of responsibilities and obligations of each partner appended thereto, notwithstanding the joint and several liabilities.
- The joint venture/consortium agreement should indicate precisely the responsibility of all members of JV/ consortium in respect of planning, design, manufacturing, supply, installation, commissioning and training.
- All members of JV/ consortium should have active participation in execution during the currency of the contract. The Contractor shall ensure that no change in the composition of the Consortium is affected without the prior consent of the Authority
- In order for a joint venture/ consortium to qualify, each of its partners or combination of partners must meet the minimum criteria listed in 'Clause No.-6.2 of Instructions to Bidders (ITB)' for an individual Bidder for the component of the contract they are designated to perform. Failure to comply with those requirements will result in rejection of the joint venture bid.
- A firm can be a partner in only one joint venture/ consortium; bids submitted by joint ventures/ consortium including the same firm as partner will be rejected.
- Lead member/ partner of joint venture firms/ consortium should be an Indian bidder and should comply all the requisite qualification described in 'Clause No.-6.2 vii) of Instructions to Bidders (ITB)' of this tender document.

6.3. FINANCIAL ELIGIBILITY CRITERIA:

I. The bidder shall submit reports on the **financial standing** i.r.o. solvency of Bidder Company/ firm as certified by bankers, audit report for companies registered under Companies Act and Tax Audit Report for Partnership Firms for last three (03) Financial Years (FY) viz. **2017-18, 2018-19 and 2019-20**.

II. The bidder shall submit **Income Tax Return** for last three (03) Assessment Years (AY) viz. **2018-19, 2019-20 and 2020-21**.

III. **TURN OVER**

Average annual turnover of the bidder for last three (03) Financial Years (FY) i.e. **2017-18, 2018-19 and 2019-20** should not be less than **30% of the Estimated Project Cost.** Other income shall not be considered for calculation of annual turnover.

IV. NET WORTH

Net worth for each of the last three (03) Financial Years (FY) i.e. **2017-18, 2018-19 and 2019-20** should be positive. Net worth means the sum total of the paid up capital and free reserves (excluding reserves created out of revaluation) reduced by aggregate value of accumulated losses (including debit balance in profit and loss account for current year) and intangible assets.

V. WORKING CAPITAL

Working capital of the bidder in the year, preceding the year of bid submission i.e. **FY. 2019-20**, shall not be less than **15%of the Estimated Project Cost**.

Working capital will be calculated as difference between Current Assets and Current Liabilities.

VI. If the Working capital calculated from the audited balance sheets is negative then such working capital shall be treated as zero (0).In case audited financial statement is not available for the immediate previous financial year i.e. 2019-20 then a provisional Balance Sheet is to be submitted duly certified by practicing Chartered Accountant (CA) with sign stamp and membership no.

In case there is a shortfall in the Working Capital as per the requirement mentioned above, the unutilized Credit Limits sanctioned to the bidder from a schedule bank in India shall be considered together with working capital. The statement displaying cash credit limits should not be more than three (03) months old as on the last date for submission of bids. In such case Bidder Company/ Firms etc. shall have to submit certificate as per prescribed 'Form No.-7 of Forms/ Pro-forma Section' of the tender document, duly certified by transacting banks.

In case of JV/ consortium, Bank Solvency Certificate of the Lead Member will be sufficient.

VII. Any evidence of unfair trade practices including over charging, price fixing, cartelization, involve in any corruption, etc. as defined in various statutes, will automatically disqualify the bidders. A 'Self Declaration Certificate (duly notarized)' should be submitted in this regard as per 'Form No.-4 of Forms/ Pro-forma Section' of this tender.

VIII. Copies of orders & completion certificates issued by the owner shall have to be submitted as documents in support of credential (originals may have to be produced for verification, if asked for).

IX. If bid is submitted by a Joint Venture (JV)/ Consortium, the bidder shall meet, individually, the financial eligibility criteria set forth at Clause6.3.-I), II), and IV) above and collectively the financial eligibility criteria set forth at Clause6.3.III) andV)above.

However,

- At least one partner shall meet, not less than 40% of the minimum criteria given at Clause6.3 III) &V) above.

AND

- Each of the other partner(s) shall meet not less than 25% of the criteria given at Clause6.3 III) &V)above.

6.4. OTHER QUALIFICATION CRITERIA

i) The bidder should be bona-fide, experienced & resourceful company registered under Companies Act, 2013/ read with Companies Act, 1956 (with amendment from time to time) or Partnership Firm registered as per Indian Partnership Act, 1932, LLP registered under LLP Act, 2008 barring Government Department as well as foreign bidders/ MNCs not registered and

incorporated in India and those bidders, already placed under holiday listing and the term/ duration of such listing has not yet expired.

ii) A bidder shall not have a conflict of interest. Any bidders found to be having a conflict of interest shall be disqualified. The bidder shall be considered to have conflict of interest with one or more parties in this bidding process, if:

a. They have a controlling partner in common; or

b. They receive or have received any direct or indirect subsidy from any of them; or

c. They have the same legal representative for purpose of this bid; or

d. They have a relationship with each other, directly or through common third parties, that puts them in position to have access to information about or influence on the bid of another bidder, or influence the decisions of the employer regarding this bidding process; or

e. A bidder submits more than one bid in the bidding process, either individually or in any form, will result in disqualification of all such bids; or

f. A bidder or any of its affiliates participated as a consultant in the preparation of the design or technical specification of the materials and services/ works that are subject of the bid; or

g. The bidder, directly or indirectly shall not be a dependent agency of the WBSEDCL.

iii) The bidder should not have been banned / de-listed / black listed / debarred from business by any PSU / Govt. Department/WBSEDCL/WBSETCL or any other authorised institution or statutory body. Self-declaration in this regard is to be submitted as per Proforma enclosed at Form-17of Volume – 8: Forms & Proforma.

iv) Bids of only those Bidders who are meeting the Eligibility Criteria specified above will be considered for evaluation and award of the Contract. Bidders will submit requisite supporting documents and testimonials with their Bids to prove their credentials and claim of meeting the Eligibility Criteria.

Note:

- Mere downloading of Bid document by prospective bidder shall not be construed that such a bidder automatically fulfils the prescribed eligibility criteria. Whether the bidder meets the specific eligibility criteria or not, shall be checked or ascertained after opening their bids by scrutinizing documentary evidences furnished by them along with their bid.

- The Employer reserves the right to:

  - Amend the scope of work to be tendered.

  - Reject or accept any bid for reasons including national defence and security consideration; and

  - Cancel the bidding process and reject all bids, without assigning any reasons thereof.

The Employer will not be liable for any such actions. However, the bidder(s), who wish to seek reasons for such decision of cancellation / rejection, shall be informed of the same by Employer unless its disclosure reasonably could be expected to affect the sovereignty and integrity of India; the security, strategic, scientific or economic interest of the State; relation with foreign state or lead to incitement of an offence.

7. LANGUAGE OF THE BID

The offer prepared by the bidder and all correspondence and documents relating to the bid exchanged by the bidder and WBSEDCL shall be written in ENGLISH. The desired documents and any other document submitted by the bidder shall be written in ENGLISH.

8. CLARIFICATION OF BIDDING DOCUMENTS AND PRE-BID MEETING

a) Bidders shall be deemed to have carefully examined the bidding document and also to have been satisfied himself as to the nature and character of the system to be supplied and installed against the contract, and all relevant matters & details should there be any discrepancy or, obscurity in the meaning of any of these clauses of the e-tender documents or if there be any query of the intending bidder, the bidder shall set forth such discrepancies, doubt, obscurity or queries and submit the same through **email-id wbsedclhpc@gmail.com** or physically at **Planning, Investigation & Design Department, WBSEDCL, 5th Floor, Vidyut Bhavan, Sector-II, DJ-Block, Salt Lake, Kolkata-700091** on or before 29/06/2021 upto 17:00 Hrs. (through e-mail) as per 'Form No.-13 of Forms & Proformas Volume-8 section' mentioned in NIeT for necessary clarification by WBSEDCL & further action in this regard.

b) To assist in the examination, evaluation and comparison of bids, WBSEDCL may ask the bidder individually for a clarification of his bid including break up of item rate(s).

c) The pre-bid meeting will be held on scheduled date and time as mentioned in'Clause No.-A.5of Notice Inviting e-Tender (NIeT)' at the office of 'The Chief Engineer, Planning, Investigation & Design Department, WBSEDCL, 5th Floor, Vidyut Bhavan, Sector-II, DJ-Block, Salt Lake, Kolkata-700091'.

d) Non-attendance at pre-bid discussion will not be a cause for disqualification of bidders. The clarification given in the pre-bid discussion shall be final and binding on the bidder, being a part the original bid document.

9. AMENDMENT OF BIDDING DOCUMENTS

The tender inviting authority reserves the right to modify, amend or supplement this tender document. Any corrigendum, notification concerned to this NIeT will be published in the e-tender portal https://wbtenders.gov.in. Bidders are, therefore, advised to follow the website regularly for such corrigendum, notification etc. Any such amendments shall be part of the bidding document.

10. SUBMISSION OF BIDS

Bids are to be submitted online through the website https://wbtenders.gov.in. All the documents uploaded by the tender inviting authority form an integral part of the contract. Bidders are required to upload all the tender documents along with the other documents, as asked for in the tender, through the above website within the stipulated date and time as given in the 'Clause No.-A.5.of Notice Inviting e-tender (NIeT)'. Bids are to be submitted in two folders- one is TECHNICAL BID and other is FINANCIAL BID. The bidder shall carefully go through the documents and prepare the required documents and upload the scanned documents in Portable Document Format (PDF) to the portal in the designated locations of technical bid.

Bidder needs to download the forms, fill up the particulars in the designated cell and upload the same in the designated location of technical bid. Bidder will download the Bill of Quantities (BOQ), fill up the rates of items in the BOQ in the designated cell and upload the same in the designated location of financial bid. The documents uploaded shall be virus scanned and digitally signed using the Digital Signature Certificate (DSC). Bidders should take note of all the addenda/corrigenda related to the tender and upload the latest documents as part of the tender.

In addition, a complete set of hard copy with un-priced BOQ maintaining the sequence as per 'Form A (Check List) of Forms & Proformas Volume-8' in spiral binding of all the documentary evidences qualifying for their bid, duly stamped and signed by the authorized person of the bidder as uploaded in the website https://wbtenders.gov.in shall have to be submitted along with the hard copy of EMD and TENDER FEE with super-scribing of the NIeT no., name of the bidder, name of the work etc. in separate sealed envelopes.

In case of any discrepancies between the uploaded documents and the hard copy documents, the uploaded documents will be considered for evaluation.

11. TECHNICAL PROPOSAL

The technical proposal shall contain scanned copies and/or declarations in the following standardized formats in 02 (two) covers (folders).

A. STATUTORY COVER

a. TO BE SUBMITTED IN 'DRAFTS' FOLDER

i. Tender Fee

Scanned copy of CTS 2010 Compliant Demand Draft/ Banker's Cheque towards tender fee as prescribed in the NIeT, in favour of West Bengal State Electricity Distribution Company Limited payable at Kolkata.

ii. Earnest Money Deposit (EMD)

Scanned copy of CTS 2010 Compliant Demand Draft/ Banker's Cheque/ Bank Guarantee (as per Specimen Copy of Form No.-8 in Forms & Proformas of Volume-8)towards EMD as prescribed in the NIeT, in favour of West Bengal State Electricity Distribution Company Limited payable at Kolkata.

b. TO BE SUBMITTED IN 'NIeT' FOLDER

i. Notice Inviting e-Tender (NIeT).

ii. Addenda/Corrigenda, if published.

NOTE: Bidders are to keep track of all the Addendum/Corrigendum issued with this particular tender and upload all the above digitally signed along with the NIeT. Tenders submitted without the Addendum/Corrigendum will be treated as informal and liable to be rejected.

c. TO BE SUBMITTED IN 'FORMS' FOLDER

i. Check List (Form No.-A)of Forms & Proformas Volume-8)

ii. Certificate regarding summary statement of yearly turnover (as per Form No.-1 of Forms & Proformas Volume-8)

iii. Statement of Works Executed by the Main Contractor in Compliance with Option 1 of the Qualification Criteria for the participation of the Bid in the last Twenty-five (25) Years(as per Form No.-2 of Forms & Proformas Volume-8)

iv. Statement of works executed by the Contractor In compliance with Option-2, Option-3 And Option-4 of the Qualification Criteria for the participation of the Bid in the last Twenty-five (25) Years(as per Form No.-3 of Forms & Proformas Volume-8)

v. Proforma for undertaking to be submitted by the bidder (as per Form No.-4 of Forms & Proformas Volume-8)

vi. Format of letter of bid (as per Form No.-5 of Forms & Proformas Volume-8)

vii. Declaration by bidder (as per Form No.-6 of Forms & Proformas Volume-8)

viii. Statement of current contract commitments (as per Form No.-18of Forms & Proformas Volume-8)

B. NON-STATUTORY COVER

a. TO BE SUBMITTED IN 'COMPANY DETAILS' FOLDER

i. Proof of Company Incorporation/ Trade License

ii. Power of Attorney (duly notarized), indicating that the person(s) signing the bid has the authority to sign (Form No.-15 of Forms & Proformas Volume-8Section).

iii. JV/Consortium Agreement, Power of Attorney/ Lead Partner Agreement (as per Form No. -14 of FormsProformas Volume-8)

b. TO BE SUBMITTED IN 'CERTIFICATES' FOLDER

i. PAN Card details.

ii. Current Professional Tax (PT) registration challan along with Enrollment Challan.

iii. ESI registration certificate (wherever applicable)

iv. EPF registration certificate

v. Exemption Certificate, if any, issued by any competent authority

c. TO BE SUBMITTED IN 'CREDENTIAL' FOLDER

Copy of the Work Order(s)/ LOA(s)/ Contract Agreement(s), Completion Certificates shall be submitted in support of minimum eligibility criteria as per 'Clause No.-6 of Instructions to Bidders (ITB)'.

d. TO BE SUBMITTED IN 'FINANCIAL INFORMATION' FOLDER

i. Copy of IT returns for Assessment Year 2018-19, 2019-20 and 2020-21.
ii. Average annual turnover during financial years 2017-18, 2018-19 and 2019-20.
iii. Audited annual reports on accounts along with auditor's certificate for financial years 2017-18, 2018-19 and 2019-20.
iv. Unutilised Credit facility from any scheduled bank in India to make up any short fall in working capital (as per Specimen Copy of Form No.-7of Forms & Proformas Volume-8)

e. TO BE SUBMITTED IN 'DECLARATION' FOLDER

i. List of key personnel proposed to be engaged for the project mentioning their experience and qualification.
ii. List of orders in hand with financial information.
iii. List of Plant and Machineries.
iv. Undertaking to be submitted by the bidder for carrying out design and drawing (as per Specimen Copy of Form No.-16of Forms & Proformas Volume-8)
v. Declaration of Black listing/Holiday listing (as per Specimen Copy of Form No.-17ofForms&Proformas Volume-8)

NOTE: In case of JV/ Consortium, the non-judicial stamp papers should be purchased in the name of Lead Partner.

12. OPENING OF TECHNICAL PROPOSAL

Technical proposals of the bidders will be opened electronically by the tender inviting authority (authorized representative of WBSEDCL) from the web portal stated above on the prescribed date & time.

a) Intending bidders may remain present if they so desire.
b) Cover (folder) for STATUTORY DOCUMENTs will be opened first and if found in order, cover (folder) for NON-STATUTORY DOCUMENTs will be opened. If there is any deficiency in the statutory documents the bid will summarily be rejected.
c) In case of any deficiency in non-statutory cover, the bid will not qualify for opening of financial proposal.
d) Pursuant to scrutiny & decision of WBSEDCL, the list of eligible bidders will be uploaded in the web portal.

13. FINANCIAL PROPOSAL

The financial proposal should contain the following documents in one cover.
BILL OF QUANTITIES (BOQ)
The intending bidder(s) are requested to quote their Price through online against the specified format of the BOQ.
Only downloaded copies of the above documents are to be uploaded, virus scanned and digitally signed by the bidder.

14. SUBMISSION OF ORIGINAL DOCUMENTS OF TENDER FEE AND EARNEST MONEY

i. SUBMISSION OF TENDER FEE AND EARNEST MONEY

Tender Fee must be submitted in the form of CTS 2010 compliant Bank Draft (DD)/ Bankers Cheque (BC) of any scheduled Bank of India. Earnest Money must be submitted in the form of Bank Draft (DD)/ Bankers Cheque (BC)/ Bank Guarantee (BG) of any scheduled Bank of India. Payment in any other form will not be accepted.

ii. PROCEDURE OF SUBMISSION

All the documents shall be submitted as per date and time mentioned in 'Clause No.-A.5.of Notice Inviting e-tender (NIeT)'to the place of submission as per following instruction:

Envelope-1:

Shall contain TENDER FEE & EARNEST MONEY instruments in original [Sl. No. 4&5 of 'Form No.-A of Forms & Proformas Volume-8' of this tender (Checklist)].

Envelope-2:

Shall contain rest of the documents except PRICE BID mentioned in the 'Form No.-A of Forms & Proformas Volume-8' of this tender (Checklist) maintaining proper sequence.

iii. PLACE OF SUBMISSION

The original Demand Draft/ Bank Guarantee, towards Tender Fee, Earnest Money Deposit and 01 (One) hard copy of the Techno-commercial bid as detailed in 'Clause No.-11,14 of Instructions to Bidders (ITB)' shall be submitted at the following office:

Office of the Chief Engineer,
Planning, Investigation & Design Department (PIDD),
West Bengal State Electricity Distribution Company Limited,
Vidyut Bhavan, 5th Floor, B-Block,
Block-DJ, Sec-II, Bidhannagar, Kolkata – 700 091

iv. TIME OF SUBMISSION

The original Bank Guarantee/Demand Draft/Banker's Cheque against Tender Fees and Earnest Money Deposit (EMD) must be submitted physically at the office of ***The Chief Engineer, Planning, Investigation & Design Department (PIDD), WBSEDCL, 5th floor, B Block, Vidyut Bhavan, Block-DJ, Sector-II, Salt Lake, Kolkata-700 091***, under sealed cover super-scribing the name of the work with NIeT no., name of the bidder etc. within the scheduled date & time as specified in the '**Clause No.-A.5**.of Notice Inviting e-tender (NIeT)'.

If any bidder fails to submit the original copies within the due date & time his tender will not be opened and his bid will be rejected.

15. DISQUALIFICATION/ INELIGIBILITY OF BIDDERS

Even if the bidders meet the qualifying criteria, they shall be disqualified if they:

- have submitted the bid without or inadequate earnest money and/ or,
- have been involved in the corrupt/ fraudulent/ collusive/ coercive practices and/or,
- have made misleading or false representation(s) in the forms, statements and attachments submitted in proof of the qualification requirements and/or,
- have found to be guilty in formation of cartel for submitting their bids and/or,
- have any Record of poor performance such as abandoning the work, not properly completing any contract, inordinate delays in completions, serious litigation history, or financial failures etc. and/or,
- have been declared ineligible for poor performance/failure issued by the Govt.OfIndia/ StateGovt.Dept./ PSUs/ SNAs and other Statutory Organizations etc.

16. TIME SCHEDULE

The basic consideration and the essence of the contract shall be the strict adherence to the time schedule specified in the bidding document and incorporated in the contract for the proposed work. The work shall be carried out as specified in 'Clause No.-6 of General Conditions of Contract (GCC)'

17. PROCESS TO BE CONFIDENTIAL

After opening of bids information relating to the examination, clarification, evaluation of comparison of bids and recommendations concerning the award of contract shall not be disclosed to bidders or other person not officially concerned with such process until the award of the contract to the successful bidder has been announced. Any effort by a bidder to influence WBSEDCL in the process of examination, clarification evaluation and comparison of bids, and in decisions concerning the award of contract may result in the rejection of his bid.

18. EARNEST MONEY

The Earnest Money shall have to be submitted in the form of CTS 2010 complaint Demand Draft (DD)/ Banker's Cheque (BC) on any scheduled bank approved by RESERVE BANK OF INDIA(RBI) with validity of 03 (three) months drawn in favour of '**WEST BENGAL STATE ELECTRICITY DISTRIBUTION COMPANY LIMITED**' payable at KOLKATA or in the form of an irrevocable and unconditional Bank Guarantee (BG) on any scheduled bank in India, initially valid for 06 (six) months from the bid submission start date with a claim period of another 03 (three) months and subject to further extension if required.
The amount of EMD against the project shall be **Rs.15, 00,000/- (Rupees Fifteen Lakh only).** The bidder shall not claim any interest on Earnest Money Deposit (EMD). Earnest Money in any other form or amount will not be accepted. EMD shall have to be submitted by the bidder as stipulated herein above. The EMD amount shall be released to the successful bidder after receiving 'Contract Performance Security' in the form of a Bank Guarantee (BG) as per the employer's pro-forma, amounting to **03% (Three percent)** of the contract value of the work (as mentioned in the Letter of Award/ Order) for faithful and due fulfilment of all obligations under the terms and conditions of the contract within **28 (twenty Eight) days** of the placement of the Letter of Award/ Order.
However the EMD of the unsuccessful bidders will be refunded within **Forty Five (45) days** after finalization of this contract for which a request letter has to be submitted by the concerned unsuccessful bidders to '***The Chief Engineer, Planning, Investigation & Design Department (PIDD), WBSEDCL, 5th floor, B-Block, Vidyut Bhavan, Block-DJ, Sector-II, Salt Lake, Kolkata-700 091'***.In case, WBSEDCL cancels the tender for any reason, the EMD submitted by the bidders will be returned without any interest subsequently, for which a request letter has to be submitted by the authorized tender applicant.

19. FORFEITURE OF EMD

EMD shall be forfeited, if

a) The bidder modifies/withdraws the bid after bid opening and during the period of bid validity and/or,
b) The bidder has been found practicing corrupt or fraudulent or collusive or coercive practices during bidding process and/or,
c) The bidder has been found guilty of formation of cartel.
d) The successful bidder fails within the specified time limit to sign the contract agreement and/or,
e) The successful bidder fails within the specified time limit to submit the contract performance security in the form of a Bank Guarantee (BG) of amounting to 10% (ten percent) of the contract value of the work.
f) The successful bidder fails to submit unconditional acceptance of LOA within the specified time limit.

20. VALIDITY OF OFFER

The offer against tender should remain valid for a minimum period of **180 (One hundred eighty) days** from the date of opening of **Financial Bid**. However, WBSEDCL may, on the merit of case, request extension of validity of the offer for a further suitable period without any change in terms & conditions of the offer.

21. DETERMINATION OF RESPONSIVENESS

a) Prior to detailed evaluation of bids, WBSEDCL will determine whether each bid substantially responsive to the requirements of the bidding documents.
b) For the purposes of this clause a substantially responsive bid is one which conforms to all the terms, conditions and specifications of the bidding documents without material deviation or reservation. A material deviation or reservation is one which affects in any substantial way the scope, quality or performance of the works, or which limits in any way the responsibilities or liabilities of the Bidders or any right of the employer as required in the bidding documents and the rectification of which deviation or reservation would affect unfairly the competitive position of other bidders presenting substantially responsive bids.
c) If a bid is not substantially responsive to the requirements of the bidding documents it will be rejected by WBSEDCL and shall not subsequently be made responsive by the bidder having corrected or withdrawn the nonconforming deviation or reservation.

22. OPENING AND EVALUATION OF FINANCIAL PROPOSAL

i) Financial proposals of the bidders, declared techno-commercially eligible, will be opened electronically by the Tender Inviting Authority (authorized representative of WBSEDCL) from the web portal stated above on the prescribed date & time.
ii) The encrypted copies will be decrypted and the rates will be read out to the bidders remain present at that time of opening of financial bid.
iii) After opening of the financial proposal, the preliminary summary result containing inter-alia, name of the bidder and the rates quoted by him will be uploaded.
iv) The proposal will be evaluated on the basis of techno-commercial and financial proposal for the entire scope of work covered under this bid document.
v) The bidder whose offer has been accepted will be finalized after the evaluation procedure as mentioned in 'Clause No.-24 of Instructions to Bidders (ITB)' and will be notified by the TENDER INVITING AUTHORITY (authorized representative of WBSEDCL) through Letter of Award.
vi) WBSEDCL has the right to reject the bid if the bidder unable/disagree to produce the same.
vii) Conditional or any mode of rebate, if any, offered by any bidder shall not be considered in Bid evaluation.
viii) Incomplete tenders are liable to be summarily rejected.

23. CORRECTION OF ERRORS

No correction shall be allowed in BOQ. Arithmetical error, if any, may be considered.
The amount stated in the Bid form will be adjusted by WBSEDCL in accordance with the quoted item rate for the correction of errors and shall be considered as binding upon the Bidder, if the bidder does not accept the corrected amount of Bid, his Bid will be rejected and the Bid Guarantee will be forfeited.

24. FINANCIAL PROPOSAL AND EVALUATION OF BID

i) Financial proposal of the techno-commercially eligible bidders will be evaluated on least quoted price basis.
ii) After opening of the Price bids of the techno-commercially eligible bidders, the tender evaluating authority of WBSEDCL will evaluate the Price Bid.
iii) WBSEDCL will determine and evaluate the Bid price of each Bid by adjusting the Bid price as follows.
a) Making any correction for errors pursuant to 'Clause No.-23 of Instructions to Bidders (ITB)'.
b) Making an appropriate adjustment for any other acceptable quantifiable deviations subject to responsiveness test at 'Clause No.-21 of Instructions to Bidders (ITB)'.

iv) PENALTY FOR SUPPRESSION/ DISTORTION OF FACTS

If any bidder fails to produce the original hard copies of the document like completion certificate and any other documents on demand of the department within a specified time frame or if any deviation is detected in the original copies from the uploaded soft copies, it may be treated as submission of false documents by the bidder and action may be referred to the appropriate authority for prosecution as per relevant act.

25. REJECTION OF BID

The employer (tender accepting authority) reserves the right to accept or reject any bid and to cancel the bidding processes and reject all bids at any time prior to the award of contract without thereby incurring any liability to the affected bidder or bidders or any obligation to inform the affected bidder or bidders of the ground for employer's (tender accepting authority) action.

26. AWARD OF CONTRACT

Bidder whose bid has been accepted will be notified by the tender inviting & accepting authority through Letter of Award (LOA). 'Planning, Investigation & Design Department (PIDD), WBSEDCL' will award the job to the successful bidder by placement of Letter of Award (LOA) before the expiration of the period of validity of the Bid and after receiving all the requisite documents, if the whole tender is not cancelled/ postponed by '***The Chief Engineer, Planning, Investigation & Design Department (PIDD), WBSEDCL, 5th floor, B Block, Vidyut Bhavan, Block-DJ, Sector-II, Salt Lake, Kolkata-700091'.***

27. CONTRACT AGREEMENT

The agreement as per enclosed format specified in 'Form No.-10 of Forms & Proformas Volume-8' of this tender will incorporate all agreements between the tender accepting authority and the successful bidder. All the tender documents including NIeT and BOQ will be part of the agreement. After acceptance of Letter of Award, the successful bidder shall have to submit requisite copies of contract documents stated as per 'Clause No.-7 of General Conditions of Contract (GCC)'.

28. HOLIDAY LISTING

The holiday listing policy of WBSEDCL shall be applicable to the participating bidders in the e-tendering in case of any deviation is found from normal contractual conduct. A declaration as per 'Form No.-17 of Forms & Proformas Volume-8'of the tender document is to be submitted by the bidders.

29. CORRESPONDENCE

Clarification, if any, in respect to this bid shall be addressed to '***The Chief Engineer, Planning Investigation & Design Department, WBSEDCL'***, at the address mentioned in 'Clause No.-A.7.of Notice Inviting e-tender (NIeT)' by e-mail upto 29/06/2021 up to 17:00 Hrs. WBSEDCL will clarify against all such response in the pre bid meeting and subsequent uploading of MOM of the said meeting and such clarifications shall form integral part of tender document.

30. UNIT OF MEASUREMENT

The unit of measurement to be followed under this contract is SI Unit.

VOL – 3- GENERAL CONDITIONS OF CONTRACT

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1. DEFINITIONS

The following words and expressions shall have the meanings hereby assigned to them:

'Contract' means the contract agreement entered into between the WBSEDCL and the contractor, together with the contract documents referred to therein.

'Contract Documents' means the documents listed in Clause No.-7 of General Conditions of Contract (GCC) (Contract Agreement) of the Form of Contract Agreement (including any amendments thereto).

'GCC' means the General Conditions of Contract.

'SCC' means the Special Conditions of Contract.

'Day' means calendar day.

'Month' means calendar month.

'Permanent works' means the work to be executed by the contractor in accordance with the contract and includes materials, equipment and things of all kinds (other than contractor's equipment and machinery) provided and work to be done by the contractor

under the contract at the cost offered by the Contractor in the tender and accepted by the employer.

'Temporary Works' means all temporary works of every kind required in connection with the execution, completion and maintenance of the works and the remedying any defects therein by the contractor at his cost and risk.

'Employer' / 'Client' / 'Owner' means WEST BENGAL STATE ELECTRICITY DISTRIBUTION COMPANY LIMITED (WBSEDCL), having its Corporate Office at Vidyut Bhavan, 7th Floor,Block-DJ, Sector- II, Salt Lake City, Kolkata- 700 091, CIN:U40109WB2007SGC113473.

'Engineer-in-charge/ Controlling Officer' means the person appointed by the employer in the manner (Engineer-in-Charge/ Controlling Officer) hereof to perform the duties delegated by the employer.

'Contractor' means the bidder whose bid to perform the contract has been accepted by the employer and is named as such in the contract agreement, and includes the legal successors in title to such bidder.

'Contractor's Representative' means any person nominated by the contractor and approved by the employer to perform the duties in respect of this contract.

'Contract Price' means the sum specified in the Letter of Award and includes adjustments in accordance with contract.

'Work' means all the activities as mentioned in the scope of work for generating electricity by water, includes Civil, Hydro-mechanical, Electro-mechanical work and operation & maintenance for a period of Two (02) years. This includes supply of all required Materials, Equipment, Construction, Erection and installation services to be carried out by the Contractor under the contract.

'Plant and Equipment' means permanent plant, equipment, machinery, tools, apparatus, articles and things of all kinds to be provided and incorporated in the work by the contractor under the contract (including the spare parts to be supplied by the contractor), but does not include contractor's equipment.

'Contractor's Equipment' means all plant, equipment, machinery, tools, apparatus, appliances or things of every kind (like Excavator, Roller, Mini Batching plant, Different testing apparatus of materials, testing laboratory as necessary, Welding facilities, etc.) required in or for installation, completion and maintenance of work that are to be provided by the contractor, but does not include plant and equipment under Clause 1.13 of General Conditions of Contract (GCC).

'Site' means the land and other places upon which the works are to be installed, and such other land or places as may be specified in the contract as forming part of the site.

'Effective Date' or 'Date of Commencement' means the date of handing over of site to the contractor. The time of completion of the work shall be counted from this date.

'Time for Completion' means the time within which completion of the work as a whole is to be attained in accordance with the relevant provisions of the contract.

'Completion' means that the work has been completed functionally, operationally and structurally and put in a tidy and clean condition, and that all work in respect of pre-commissioning of the work or such specific part thereof has been completed; and commissioning has been attained as per technical specifications.

'Guarantee Test(s)' means the test(s) specified in the technical specifications and any additional Tests as required to be carried out to ascertain whether the work or a specified part thereof is able to attain the functional guarantees specified in the technical specifications.

'Commissioning' means successful completion of site tests, satisfactory operation of all items/ Equipment/ system covered under the scope of this contract and shall mean that the

complete plant is ready to Operate/ Generate commercially having been duly certified by the EIC.

Concept of this project is to utilize the monsoon flow from Lodhama River in general for power generation. If the project work is completed during non-monsoon period and commissioning process is delayed due to non-availability of water, the contractor shall have to take up the said activity as soon as the water is available for performing 'Guarantee Test(s)' successfully as mentioned in the clause 1 of GCC.

'Defect Liability Period' shall mean the period starting with the go ahead letter for O&M after taking over/handing over, observing all related contractual obligations and continue upto **24 months**.

'Letter of award (LOA)' means the order placed by the employer to the contractor for execution of the work. The contractor shall submit in writing unconditional acceptance of the LOA within 10 (ten) days from the date of placement of Letter of Award (LOA)/ Order.

'Joint Venture (JV)/Consortium' shall refer to a group of entities, collectively submitted the bid in accordance with the provisions of this tender.

'Lead Partner of the JV/ Consortium or Lead Partner' shall mean an entity which represents the JV, with relation to the project.

2. INTERPRETATION

In interpreting these conditions of contract, singular also means plural, male also means female or neuter and the other way around, except where the context otherwise requires. Headings have no significance. The headings and marginal notes in the General Conditions of Contract (GCC) are included for ease of reference, and shall neither constitute a part of the contract nor affect its interpretation.

The words incorporating Person(s) or Party(ies) shall include Firms, Corporations, Government Entities and other Bodies whether incorporated or not but having legal entity. Words have their normal meaning under the language of the contract unless specifically defined.

3. LANGUAGE AND GOVERNING LAW

The ruling language of the contract and the language for communication shall be 'ENGLISH' which shall be the binding and controlling language for all matters relating to the meaning or interpretation of this contract.

This contract, its meaning and interpretation, and the relation between the Parties shall be governed by the applicable laws prevailing in West Bengal/India. The contract shall be executed according to the acts/ laws/ regulations in force in West Bengal/India.

4. CONTRACT

A formal agreement shall be entered into between the contractor and the employer **within 28 (twenty-eight) days** from the date of placement of Letter of Award (LOA)/Order for the proper fulfilment of the contract as per standard pro-forma given in 'Form-10 of Forms/ Proforma Section'.

The contract constitutes the entire agreement between the employer and contractor with respect to the subject matter of contract and supersedes all communications, negotiations and agreements (whether written or oral) of parties with respect thereto made prior to the date of contract.

The award of the contract shall not in any way dilute the responsibility of the contractor for the successful completion of the facilities as per specifications. Breach in the contract shall confer a right on the employer to recover liquidated damages from the contractor as per **Cl.**

No. 52 of GCC, levied on total contract price and/or to terminate the contract at the risk and the cost of the contractor.

The contract will be signed in **Two (02)** originals and the contractor shall be provided with one signed original copy and the rest will be retained by the employer.

Where the employer hands over his equipment to the contractor for executing the contract, if such case occurs, then the contractor shall, at the time of taking delivery of the equipment furnish trust receipt for plant, equipment and materials and shall also execute an indemnity bond in favour of the employer in the form acceptable to the employer for keeping the equipment in safe custody and to utilise the same exclusively for the purpose of the said contract.

5. SCOPE OF THE WORK

5.1 GENERAL

5.1.1 The contractor shall study the Geological report, Soil investigation report, Tender drawings and other relevant information provided in this Bid Document and satisfy himself with the understating of the scheme and volume of the work and provide a detailed project execution plan with bar chart showing various stages of work to complete within the specified completion time of the project. The plan should also include list of machineries/equipment to be used for time bound execution of the stated work, construction materials survey report and number of manpower to be involved at various stages of work.

5.1.2 The contractor will conduct detailed construction stage topographical survey along the project layout and establish different control points at fields and necessary geotechnical investigation and other investigations as per the requirement of design &engineering of the entire project work and submit all the investigation reports to WBSEDCL. Any additional investigation work the contractor needed to assess and to be carried out the same at no additional cost.

5.1.3 The tender drawing has been provided in the tender document for reference only. If not otherwise mentioned the contractor have to take up Detail Engineering Design &Drawing report of the entire project as per technical specifications, Soil report and Geological report provided with the tender and the outcome of other investigation work carried out by the contractor. The design should be in line with the applicable Indian Standard, Guide lines, Manuals, WB PWD schedule etc. If Foreign standards to be used, necessary approval for the same to be taken from WBSEDCL. The design report should be clear to understand and self-explanatory and should include reference of relevant IS codes and or other documents as and where applied. The contractor will have to provide all the reports in editable format showing all the calculations etc. Drawings and Design calculations in PDF format are accepted. However, soft versions (editable) should be made available on demand during checking/ scrutiny The structural analysis should be done preferably in STAAD PRO, if any other analysis software is used then prior approval from WBSEDCL is required and the same software original licensed shall be procured and supplied by the contractor to the employer. The agency shall have to furnish the detailed analysis, which should be used entirely for this project only and will not be reproduced by the contractor for any other purpose in any form. The contractor shall arrange competent design personnel physically available to WBSEDCL as and when required during scrutiny of the reports for proper clarification of any query, if arises.

5.1.4 The contractor will prepare and submit Drawings for review and comments from the Employer and subsequently submit construction drawings for approval with comments 'Released for Construction' from the Employer side.

5.1.5 The contractor will arrange all the necessary construction facilities, temporary approach roads to different sites etc. necessary for construction and erection works.

Construction Water shall be arranged by the Contractor and power tapping may be followed as per cl. 62 of GCC.

5.1.6 The contractor will also arrange Safety Items like Hand Gloves, Shock Treatment Charts, Rubber Mats, Danger / Caution Boards etc. at sites during construction and other associated activities. The contractor shall adhere to safety practices during erection, testing, commissioning and training of Employer's personnel including fire prevention.

5.1.7 The contractor shall adhere to the statutory environmental norms during construction.

5.1.8 The contractor shall clean all the Debris from the site before final commissioning of the plant and as and when directed by the EIC. However, the public thoroughfare in the adjacent road is to be maintained.

5.1.9 All reports/ design/ drawings etc. submitted by the contractor is to be approved by the WBSEDCL prior to taking up construction work by the Contractor.

5.1.10 Uphill/ downhill slope stabilization, Protection work (DRM, CRM, Sausage wire netting etc), foundation treatment, Contact Grouting in ADIT tunnel (2 kg pressure), Grouting (e.g. Cement, bentonite etc.) for Soil stabilization to be carried out as per the relevant IS code, approved detail design drawing and as per the direction of EIC in consultation with the Geological Survey of India (GSI) engaged by WBSEDCL.

5.1.11 All type of concreting work in connection with the Hydro-mechanical and Electro-mechanical work shall be taken up.

5.1.12 All submittals should be made in **06 (Six)** hard copies (or as otherwise specified) along with editable soft copy (Word/excel/AutoCAD etc as applicable)

5.1.13 Any additional work/changes/modification as required during execution of work at different sites due to bad Geological conditions encountered, advise of the Geological Survey of India/ Design Consultant during the contract period, as endorsed by the Employer will have to be followed by the contractor and no additional payment will be made for the same.

5.1.14 The contractor will submit As Built drawings of the project after completion of the work.

5.1.15 Any approval given by the owner for the contractor's Design, Engineering, Drawings, Equipments, materials, specifications shall not relieve the contractor for any part of the contractor's obligation to meet all the requirements for successful completion of the job or of the responsibility for the correctness of the contractor's drawing and designs.

5.1.16 The works mentioned in the Scope of Work are not exhaustive, any additional work required for successful completion of the work need to be carried out by the contractor

5.1.17 Maximum Ten Thousand (10,000) Cement bags for Contact Grouting in ADIT-II tunnel and one Thousand Five Hundred (1500) Cement bags in foundation grouting are to be considered during price quotation. Cement to be used already has been referred in Clause no. 10.3 under Vol. 6 part 1. The quantity mentioned is indicative without any financial deviation for change in the actual quantity.

5.2 **CIVIL WORK:**

5.2.1 ADIT-II Tunnel Repairing:

The tunnel repairing work should be carried out as stated in the DPR stage Geological Investigation report provided with the tender document. Detail design drawing, as applicable to be prepared by the agency for approval. The work includes replacing/repairing of damaged Steel Ribs and precast Concrete laggings, Rock Bolting, providing Drainage Holes, fabrication & installation of new Steel Ribs, placing precast Concrete laggings, backfilling with concrete, removal of detached rock mass from tunnel crown and sides, shotcrete etc. as required. To assess the volume of repairing job for existing ADIT-II kindly refer to Geological report provided under volume 10 and Refer Drawing no. Lodhama-II/Civil/FB/1/Rev-4

5.2.2 Water Conductor from Transfer Structure to Forebay:

The agency will prepare detail design, drawings of the RCC water conductor system from the intersection of Lodhama Main tunnel with ADIT tunnel to forebay including the Diversion arrangement. The work includes cleaning of tunnel bed, excavation in all sorts of soil and rock, foundation treatment, shoring& shuttering, concreting, plastering etc. including finishing work complete in all respect. The work also includes uphill/downhill slope stabilization and protection work, Jhora/ nala/ pathway/ causeway crossing, drainage work, temporary diversion of existing road to facilitate movement of vehicles, if necessary and repairing of road damaged due to the proposed construction of water conductors as and where applicable.

5.2.3 Forebay

The agency will prepare detail design, drawings of the RCC Forebay structure with off-take chamber and spillway structure with energy dissipation arrangement. The work includes cleaning of area, excavation in all sorts of soil and rock, foundation treatment, grouting, boulder stitching, shoring, shuttering, concreting, plastering etc. including finishing work complete in all respect. The work also includes uphill/downhill slope stabilization and protection work, Jhora/ nala/pathway/ causeway crossing, drainage work, temporary diversion of existing road to facilitate movement of vehicles, if necessary and repairing of road damaged due to the proposed construction of Forebay as and where applicable.

5.2.4 Spillway Channel

The agency will prepare detail design, drawings of the RCC Spillway channel from the spillway structure to nearest outlet point. The work includes cleaning compound premises, excavation in all sorts of soil and rock, foundation treatment, shoring, shuttering, concreting, plastering etc. including finishing work complete in all respect. The work also includes uphill/downhill slope stabilization and protection work, Jhora/ nala/ pathway/ causeway crossing, drainage work, diversion of existing road to facilitate movement of vehicles, if necessary and repairing of road damaged due to the proposed construction of Spillway Channel as and where applicable. The spillway channel outfall structure downhill of existing road with suitable road crossing arrangement to be designed and constructed to channelize the spilled water from Forebay and should be well protected from uphill boulder/debris thrust when occurs. The distance along with elevation at which spillway channel to be terminated is to be assessed by the bidder through site visit and related survey.

5.2.5 Penstock Support System

The agency will prepare detail design, drawings of the RCC Penstock support system such as Saddle support, Anchor Blocks etc. The work includes cleaning compound premises, excavation in all sorts of soil and rock, foundation treatment, grouting soil nailing, boulder stitching, shoring, shuttering, concreting, plastering etc. as required including finishing work complete in all respect. The work also includes uphill/downhill slope stabilization and protection work, Jhora/ nala/ pathway crossing, drainage arrangement along the penstock to ensure no water pondage around the concrete structures, Inspection pathways along penstock, Road crossing arrangement of penstock pipe including temporary diversion of existing road during construction with traffic management and repairing of the same, damaged due to proposed construction, construction of temporary structures/approach road/pathways for construction purposes/erection facility of penstock pipes/support systems as and where applicable.

5.2.6 Power House

The agency will prepare detail design, drawings of the G+3 RCC Power House building compound. The work includes cleaning of the area, excavation in all sorts of soil and rock, foundation treatment, grouting, river training work, boulder stitching, shoring, shuttering, concreting, plastering etc. including finishing work complete in all respect. The work also includes uphill/downhill slope stabilization and protection work, drainage arrangement to ensure no unwanted water pondage within the premises, sewerage work, water supply arrangement to Power House from identified water source (near by jhora) for drinking and other purpose, construction of boundary wall, entrance gate, security room, construction of temporary structures/approach road/pathway for construction/erection facility as and where applicable.

5.2.7 Approach Road to Power house building

The agency will prepare detail design, drawing of the concrete approach road to power house compoundfrom existing road as per section as defined in relevant IRC guidelines (IRC SP-48). The work includes cleaning compound premises, excavation in all sorts of soil and rock, preparing base, finishing etc. complete in all respect duly approved by Employer. The work also includes uphill/downhill slope stabilization and protection work, drainage arrangement, cross drainage works etc. as and where required.

5.2.8 Tail Race Channel

The agency will prepare detail design, drawings of the RCC Tail Race Channel. The work includes cleaning of the area, excavation in all sorts of soil and rock, foundation treatment, grouting, river training work, boulder stitching, shoring, shuttering, concreting, plastering etc. including finishing work complete in all respect. The work also includes uphill/downhill slope stabilization and protection work, River Joining work, Energy Dissipation arrangement at TRC outfall.

During execution of the work WBSEDCL seek advice, suggestion of GSI as and when required and the decisions of the employer conveyed in this respect shall have to be followed in the prevailing situation as referred in the Geological and Geotechnical Report attached in this tender. However in case of any 'geological surprises' encountered during execution stage duly endorsed by GSI the matter will be dealt separately.

5.3 **HYDRO MECHANICAL WORKS:**

5.3.1 **Penstock HM work including Air vent Pipe: -**Design, Drawing, fabrication, supply, erection, testing and commissioning of Penstock Pipe of about 1.1m internal dia. upto bifurcation and about 0.78m dia. **after bifurcation with ASTM A 537 class I grade steel with required varying thickness** at different sections including bifurcation piece, bend piece, Air vent pipe at Forebay, expansion joint, manhole, saddle plates, stiffener plates, bypass valve at Power House, bulk heads etc. with all finishing work complete in all respect.

5.3.2 Stop log gates at Lodhama Inter-connection Tunnel and the proposed Water Conductor at ADIT-II Tunnel with hoisting arrangement:

Design, Drawing, fabrication, supply, erection, testing and commissioning of inter changeable hydraulic Stop log gates(in 3 or 4 horizontal segments or as suitable) for lifting manually with hoisting arrangement by Chain Pulley block fitted on a monorail or any other Mechanical arrangement with finishing work complete in all respect.

5.3.3 Vertical sliding Screw Hoist Gate at the proposed Water Conductor within ADIT-II Tunnel

Design, Drawing, fabrication, supply, erection, testing and commissioning of Vertical sliding type hydraulic gate with manually operated screw hoisting arrangement with all finishing work complete in all respect.

5.3.4 Trash Rack including Silt flushing valve at Forebay

Design, Drawing, fabrication, supply, erection, testing and commissioning of Steel Trash Rack with all embedded materials and Silt Flushing valve (2 nos.) fitting & fixed in position with operational arrangements from top of Forebay with all finishing work complete in all respect.

5.3.5 Penstock Gate at Forebay with hoisting arrangement

Design, Drawing, fabrication, supply, erection, testing and commissioning of one no. Penstock Gate with all embedded work and electrically operated screw hoisting arrangement with provision of manual operation with all finishing work complete in all respect.

5.3.6 TRC Gate with hoisting arrangement

Design, Drawing, fabrication, supply, erection, testing and commissioning of 2nos. TRC hydraulic Gate vertical sliding type with electrically operated screw hoisting arrangement with provision of manual operation and one number Stop-log gate with chain pulley arrangement for using the stoplog gate in both TRC (with all embedded work and all finishing work complete in all respect.

5.4 ELECTRO-MECHANICAL WORKS

Design & engineering, material selection, manufacturing, assembly, testing at manufacturer's works, supply, delivery, storage at site, erection, testing, trial run and commissioning of following various electro-mechanical item(s) / equipment(s) / system(s) complete with all fittings, accessories, instrumentation, controls and safety devices including mandatory spares, special tools and testing devices, which are essential for installation, operation and maintenance for five (05) years trouble free operation of the plant, even though these are not individually or specifically stated in this specification but recommended by the respective manufacturers.

5.4.1 Hydro Turbines and associated auxiliary & ancillary equipments:

Two (02) nos. horizontal shaft Pelton Turbine and associated auxiliary & ancillary equipments viz. governing equipment, main inlet valves (MIV), equipment for auxiliary systems such as compressed air, cooling water, drainage & dewatering system, lubrication system, oil, water & air piping with valves & fittings, instrumentation, control and safety devices etc.

5.4.2 Generator and Auxiliaries

Two (02) nos. of horizontal shaft alternating current Synchronous Generators of capacity 5883 kVA with 10 % continuous overload, 11 kV, 50 Hz, 0.85 (lagging) power factor complete with all fittings, accessories, instrumentation, controls and safety devices, auxiliaries such as excitation system, voltage regulating equipment, neutral grounding cubicle, cabling, terminal equipments including CTs, PTs, surge protection device, lubricating system, oil, water and air piping, valves etc.

5.4.3 11 kV Indoor Switchgears and Station Auxiliary Transformer

11 kV, 1250 Amp. Indoor Switchgear comprising of bus bar, 3 nos. of 11 kV Vacuum Circuit Breaker (VCB) (2 nos. of 630 Amp. + 1 nos. of 1250 Amp.), 2 nos. of load break switch, CTs, PTs, indicating meters, protection and control equipments, annunciation, indicating lamp, terminal blocks, control wiring,

integration with SCADA system etc., Neutral Grounding Cubicle, LAVT Cubicle, Synchronizing panel, 2 nos. of 11/0.415 kV, 250 kVA, 3 phase, indoor type Station Auxiliary Transformer etc.

5.4.4 Main Transformer

1 no. of 3 phase, 12.5 MVA, 11/33 kV, 50 Hz., ONAN / ONAF, YNd11 Step-up Transformer with OLTC (+5% to –15% @1.25%) and complete with all accessories and fittings.

5.4.5 33 kV Power Evacuation System

33 kV, 630 Amp. Indoor Switchgear comprising of bus bar, 1 no. of 33 kV Vacuum Circuit Breaker (VCB), CTs, PTs, indicating meters, protection and control equipments, annunciation, indicating lamp, terminal blocks, control wiring, integration with SCADA system etc.; 33 kV Power evacuation system complete with all equipments and accessories viz. Isolator / Disconnecting Switch, Lightning Arrestor (9 kV and 42 kV), ACSR Dog Conductor, Cable-conductor jointing kit (11 kV and 33 kV) Civil structures, insulator, hardware, fittings etc., Cable trench, all civil works related to the transformer yard; 33 kV Transmission line having length of approximately 3 km. etc.

5.4.6 LT Switchgear

415V LT Switchgear comprising of 2 nos. of incoming feeder from station auxiliary transformers, 1 No. incoming feeder from diesel generator set, 2 nos. of bus sectionalizing breakers, suitable no. of outgoing feeders with provision of spare bays, complete with all accessories and SCADA compatibility.

5.4.7 DC System

110 V, 300 Ah capacity, lead acid, Plante type storage battery, complete in all respects with fittings and accessories, electrolyte for initial filling with 20% extra in non- returnable containers, supporting racks for battery, cable terminal arrangement (for connecting to battery chargers etc.; Charging equipment comprising of one float charger and one float cum boost charger; Special treatment (floor, wall etc.) to be made for battery room; 110 Volt, DC distribution board complete with MCBs / MCCBs, meters, relays, indication, annunciation and other accessories etc.

5.4.8 Diesel Generator Set

200 kVA, 415V, 0.80 pf, 50 Hz., 3 phase Diesel Generator Set with class F insulated windings, housed in an acoustic enclosure for sound proofing as per statutory norms of the pollution & environmental control board complete with fuel oil tank, fuel piping, excitation system, wiring cabling, AMF panel with all protection and metering arrangements, 24 V DC system, air intake and exhaust system etc.

5.4.9 Supervisory Control and Data Acquisition System (SCADA)

5.4.10 Cables, Cable Racks & Trays

5.4.11 Earthing system for power house and transformer yard

5.4.12 Ventilation System for power house

5.4.13 40 / 10T EOT Crane for power house with all accessories

5.4.14 Illumination System

5.4.15 Fire Protection System

5.4.16 Communication, Supervision and Surveillance System

5.4.17 Mechanical and electrical workshop with required items / equipments

5.4.18 Completeness of equipment / system

All items, equipments, fittings and accessories etc. for any specified equipment / system that may not be specifically mentioned in the technical specification but necessary for completeness of the system for commissioning and running the power station shall have to be covered under the scope of this contract. No extra charges will be paid to the contractor for the same.

Note:

Capacity, rating and quantity mentioned for various item(s) / equipments(s) / system(s) mentioned in the technical specifications for electro-mechanical works are indicative and provided for the tender purpose only. These shall be finalised based on the design as submitted by the contractor and approved by the employer during detailed engineering stage

5.5 OPERATION AND MAINTENANCE

a. Operation of the 10 MW (2 x 5 MW) Lodhama-II SHEP for a period of two (02) years from the date of final commissioning and subsequent taking over/ handing over of the plant, as certified by the Engineer-in-charge.

b. No part of the work will be used except Junction of Adit tunnel with Lodhama Tunnel, which may be required for existing Rammam Stage-II HEP operation

c. Daily, periodical and annual inspection & round-the-clock maintenance of turbo-generator sets (2 x5 MW) and other electrical and mechanical auxiliaries as mentioned below at Lodhama-II SHEP.

- Cooling water system
- Duplex filter – super flow duplex strainers
- C.W. pipe lines
- Pneumatic air compressor
- Drainage dewatering pumps and motor
- Operation and maintenance of cranes
- General maintenance related with turbines including governing system, lubrication system, pressure oil system, runner, Main Inlet Valve, deflector servo, nozzle servo & all other hydraulic operated valves etc.
- Regular maintenance of generators
- Regular maintenance of 11 kV indoor switchgears
- Batteries and DC system
- 200 kVA DG set
- Intercom
- Any other work as instructed by the Controlling Officer etc.

d. Daily, periodical and annual inspection & round-the-clock maintenance of 11/33kV transformer yard including step-up transformer, isolator, cable termination kit and other equipment, accessories & structures at the substation associated with Lodhama-II SHEP.

e. Daily, periodical and annual inspection & round-the-clock maintenance of the transfer structure, all gates, water conductor system, forebay, forebay gates, penstocks, tailrace gates etc. alongwith other associated civil, hydro-mechanical and electro-mechanical equipment, structures and accessories at Lodhama-II SHEP.

f. Daily, periodical and annual inspection & round-the-clock maintenance of the 33 kV transmission line from Lodhama-II SHEP to Rammam Stage-II HEP switchyard.

g. No. of Persons & Category Required for O&M of Electro Mechanical Equipment as well as of O&M of Civil structures, Hydro Mechanical works and Roads will be assessed by the bidder for successful O&M work. The persons to be engaged by the bidder should be experienced one and aware of safety aspects for execution of related work.

Job Involvement

a) The jobs are to be performed by Contractor as per scope of work, schedule of work and schedules of inspection and maintenance.

b) Rectification of faults/troubles found during inspection of the equipment/ systems or reported by Lodhama-II SHEP (WBSEDCL) representative are to be carried as part of Maintenance work. This contract covers routine and periodical maintenance as per convention of hydroelectric power stations. This also includes replacement/repair of components and parts of the equipment, filtration of transformer oil (minor and urgent nature)/turbine oil. Spares for replacement shall be provided by WBSEDCL. Fabrication, machining and allied job i.r.o. defective parts/spares shall also be a part of maintenance under this contract. The details of maintenance/inspection work furnished in this tender document are not exhaustive.

6. COMMENCEMENT AND COMPLETION TIME OF THE WORK

6.1 The contractor shall commence the work from the effective date of the work as per clause 1 of GCC herein and the contractor shall thereafter proceed the work in accordance with the time schedule as approved by the engineer-in-charge or his nominee and complete the work by the completion date as per clause no. 1 of GCC herein. Upon unconditional acceptance of the LOA, submission of the contract performance security and the contract agreement, the site shall be handed over to the contractor latest by 35 (thirty- five) days from the date of placement of letter of award (LOA)/ order.

6.2 The contractor shall attain completion of the work (or a part of the work where a separate time for completion of such part is specified in the contract) within the time stated in the NIeT or within such extended time to which the contractor shall be entitled, hereof.

6.3 The whole work must be completed within 30(Thirty) months from the date of handing over of the site (Effective Date).along with The operation and maintenance for a period of 2 years shall be taken up after commissioning and subsequent/ handing over of the plant

7. CONTRACT AGREEMENT DOCUMENTS

7.1 All documents forming part of the contract (and all parts thereof) are intended to be correlative, complementary and mutually explanatory. The contract shall be read as a whole. If any ambiguity or discrepancy is found in documents, the Engineer-in-Charge shall issue any necessary clarification or instruction and shall be final and binding to the contractor.

7.2 The contract Agreement will be signed within Twenty Eight (28) days from the date of issuance of LOA. The contractor shall have to prepare contract agreement as per prescribed Proforma in Vol-8 Form no.10 and submit in two originals to the employer for joint signature. The contractor shall be provided with one signed original agreement and the other will be retained by the employer.

7.3 Cost of stamp duties and other charges, if any, in the execution of the contract agreement shall be borne by the contractor.

8. SUBLETTING OF CONTRACT

The contractor shall not, without the written consent of WBSEDCL, assign or sublet any part thereof, other than for raw materials, or for any part of the work provided that any such consent shall not relieve the contractor from any obligation, duty or responsibility under the contract. In the event of sub-letting of contract or any part thereof is permitted, the fact that such permission has been accorded shall not establish any contractual relationship between the approved sub-vendor and WBSEDCL of any of his liabilities and obligations under the contract.

9. MODIFICATION/AMENDMENT

Modification of the terms and conditions of this contract, including any modification of the scope of the work, may only be made by written agreement between the Employer and the contractor and shall not be effective until the consent of both the parties have been obtained. However, each party shall give due consideration to any proposals for modification made by the other party.

No amendment or other variation of the contract shall be effective unless it is in writing, is dated, expressly refers to the contract, and is signed by a duly authorized representative of each party hereto.

10. CONTRACT PRICE

10.1 The contract Price shall be the quoted amount of the successful bidder accepted by the employer against this tender.

10.2 The contractor shall be deemed to have satisfied itself as to the correctness of the contract price, which shall, except as otherwise provided for in the contract, covering all its obligations under the contract.

10.3 However, a Provisional Sum amounting to **Rs.2.00 crore** (**Rupees two crore only**) has been kept in the BOQ sheet which is not taken for price comparison of the bidder. Applications of this sum will be determined for contingent provisions as per discretion of the E.I.C.

11. TERMS OF PAYMENT

11.1 The contractor shall submit R/A bills in triplicate detailing therein the claimed amount supported by measurements jointly taken with the employer's representative along with a forwarding letter. On the basis of such prayer, progressive R/A bills in triplicate duly certified by the Controlling Officer shall be released after deducting the amount already paid and other deductible amounts as per provision of contract. However, each gross billed amount shall not be less than **Rupees 1.0 (One) crore** or as deemed justified by the Controlling Officer.

11.2 The R/A bills shall be released normally within 45 (forty-five) days of submission of bill with necessary documents and upon fulfillment of all formalities as per terms of contract.

11.3 The final bill shall be released on completion of the work in all respect with satisfaction of the Engineer-in-charge and fulfillment of all contractual obligations by the contractor.

11.4 The employer reserves the right to recover/ enforce recovery of any overpayments detected after payment as a result of post-payment audit or technical examination or by any other means, notwithstanding the fact that the amount of disputed claims, if any, of the contractor exceeds the amount of such overpayment and irrespective of the fact whether such disputed claims of the contractor are subject matter of any court of law or not. The amount of such overpayments shall be recovered from the subsequent bill(s), under the contract, failing that from contractor's claim under any other contract with the employer or from the contractor's Performance security retained in the form of Bank Guarantee or from the amount retained or the contractor shall pay the amount of overpayment on demand.

11.5 The payment for **Civil & Hydro-mechanical** work are as follows: -

Sl. no.	Item (in brief)	Payment Terms
	A. Civil Work:	
1	Proposal of Repairing work duly approved and **Repairing of ADIT-II Tunnel** complete as per GSI observations and decision of EIC, complete in all respect	• 20% - chainage 0 to 150 m • 15 % - chainage 150 to 330 m • 35% - chainage 330 to 506 m • 20% - Remaining chainage • 10% - After successful commissioning of the plant
2	Design& Drawings duly approved and Construction of **Water Conductor** from junction of Lodhama tunnel with ADIT tunnel to Forebay including uphill (u/h) & downhill (d/h) slope stabilization& protection work, if required, cross drainage work and repairing of existing road, damaged due to proposed construction of Water Conductor, complete in all respect	• 20% - On completion of chainage 0 to 250m within ADIT Tunnel (measured in chainage) from transfer structure • 20% - On completion of remaining portion within ADIT Tunnel (measured in chainage) • 25% - On completion of 1st 250m outside ADIT Tunnel measured from Portal • 25% - On completion of remaining portion outside ADIT Tunnel work including total finishing work • 10% - After successful commissioning of the plant
3	Design& Drawings duly approvedand Construction of **Forebay** with spillway structure including u/h & d/h slope stabilization and Protection work, if required, temporary diversion of existing road during construction and repairing of the same damaged during construction, complete in all respect	• 30% - On completion of Forebay Base slab Casting including associated activities • 20% - On completion upto a height of 1.50m from bottom level of foundation • 20% - On completion up to another 2.50m height • 20 % - On completion of rest work including finishing work • 10% - After successful commissioning of the plant
4	Design& Drawings duly approved and Construction of **Spillway Channel** including u/h& d/h slope stabilization and Protection work, if required, repairing of existing road damaged during construction, complete in all respect	• 40% - On completion of chainage 0 to 250m (measured in chainage from Forebay) including associated activities • 50% - On completion of remaining portion (measured in chainage) including total finishing work • 10% - After successful commissioning of the plant
5	Design& Drawings duly approved and Construction of **Penstock Support System** (e.g anchor block, saddle support etc) includingu/h & d/hslope stabilization and protection work along penstock alignment, if required, temporary approach road/ pathways/ steps for construction of support system, erection of penstock and other construction facility, Diversion and crossing of Road, as required etc., complete in all respect	• 15% - On completion of chainage 0 to 200m chainage of penstock measured from Forebay including associated activities • 15% - On completion of next 200m chainage of penstock including all associated activities • 15% - On completion of another 350m of penstock including all associated activities • 30% - On completion of rest length of penstock • 15% - After erection of penstock and 2nd stage concrete including total finishing activities • 10% - After successful commissioning of the plant
6.a	Construction of **Approach road** to power	• 20% - On completion of 40% of total length • 20% - On completion of further 30% of total

	house including drainage, culvert, protection work etc., complete in all respect	length • 20% - On completion of further 30% of total length • 15% on completion of Power House building upto Gantry Level • 15% on completion of Civil work of Power House Building • 10% - After successful commissioning of the plant
6.b	Design& Drawings duly approvedand Construction of **Boundary wall**, Gate, SecurityRoom,Surfacedrainagework as required with associated civil work surrounding Power House area, complete in all respect	• 30% - upto NSL level • 60% - Rest work(Further Break up needed) • 10% - After successful commissioning of the plant
6.c	Design& Drawings duly approvedand Construction of **Power House Building**, Machine foundations and associate works including u/h & d/hslope stabilization includingRiver Protection work of Power House Complex and allied foundation treatment, complete in all respect	• 25% - Excavation, sub-soil stabilization and 1st stage concrete complete up to machine hall floor level • 20% - Power House building up to gantry level complete • 15% - Remaining work including truss, roofing and 2nd stage concrete • 10% - u/h protection work if required andd/h river protection work including Jhora training work if required. • 20%- Finishing work complete in all respect • 10% - After successful commissioning of the plant
6.d	Design & Drawings duly approved and Construction of **Water supply arrangement** from source to Power House for drinking purpose, complete in all respect	• 90% -after completion of full work • 10% - After successful commissioning of the plant
7	Design& Drawings duly approved and Construction of **Tail Race Channel** and associate river training work including slope stabilization and Protection work as required, complete in all respect	• 45% - On completion of chainage 0 to 30m of length • 45% - On completion of rest length • 10% - After successful commissioning of the plant
B. Hydro-Mechanical Work:		
1	Design, Drawing, fabrication, supply, erection, Painting, testing and commissioning of **Penstock HM work** including Bend Piece, Bifurcation piece, Manhole, Expansion Joint, Air-vent Pipe and other accessories, fitting, fixing etc as per the Direction of EIC complete in all respect	• Supply of fabricated penstock pipe with necessary fittings received at site after necessary factory inspection & Testing as applicable- 60% - payment to be made on pro-rata basis measured in Metric Ton (MT) ➢ Erection of penstock pipe after necessary field testing and inspection, as applicable, including total finishing work- 30% - payment to be made on pro-rata basis measured in MT ➢ 10% - After successful commissioning of the plant

2	Design& Drawings duly approved, fabrication, supply, erection, painting, testing and commissioning of 2 nos. **Stop log gate** at Lodhama Main Tunnel and ADIT-II tunnel at the junction of Lodhama with ADIT-II tunnel with hoisting arrangement, complete in all respect	• 60% - Supply at site after necessary factory inspection & Testing as applicable • 15% - Erection after necessary field testing and inspection as applicable including total finishing work • 7.5 % -After successful trial operation of the Gate- Dry condition • 7.5 % -After successful trial operation of the Gate- Wet condition • 10% - After successful commissioning of the plant
3	Design& Drawings duly approved, fabrication, supply, erection, painting, testing and commissioning of one number **Vertical slide Screw Hoist** (Manual operation)**Gate at ADIT-II** Tunnel, complete in all respect	• 60% - Supply at site after necessary factory inspection & Testing as applicable • 15% - Erection after necessary field testing and inspection as applicable includingtotal finishing work • 7.5% after successful trial operation of the Gate- Dry condition • 7.5 % -After successful trial operation of the Gate- Wet condition • 10% - After successful commissioning of the plant
4	Design& Drawings duly approved, fabrication, supply, erection, paintingtesting and commissioning of **Trash Rack** at Forebay, complete in all respect	• 60% - Supply at site after necessary factory inspection & Testing as applicable • 30% - Erection after necessary field testing and inspection as applicable includingtotal finishing work • 10% - After successful commissioning of the plant
5	Design, Drawing, fabrication, supply, erection, testing and commissioning of 2 nos. **Silt flushing valve** at Fore-bay, complete in all respect	• 60% - Supply at site after necessary factory inspection & Testing as applicable • 30% - Erection after necessary field testing and inspection as applicable includingtotal finishing work • 10% - After successful commissioning of the plant
6	Design& Drawings duly approved, fabrication, supply, erection, painting testing and commissioning of Vertical slide **Penstock Gate** at Forebay with hoisting arrangement (Electrically operated Screw Hoist with provision of manual operation), complete in all respect	• 60% - Supply at site after necessary factory inspection & Testing as applicable • 15% - Erection after necessary field testing and inspection as applicable includingtotal finishing work • 7.5% after successful trial operation of the Gate- Dry condition • 7.5 % -After successful trial operation of the Gate- Wet condition • 10% - After successful commissioning of the plant
7	Design& Drawings duly approved, fabrication, supply, erection, painting testing and commissioning of 2 nos. **vertical slide TRC Gate** with hoisting arrangement (Electrically operated Screw Hoist with provision of manual operation), complete in all respect	• 60% - Supply at site after necessary factory inspection & Testing as applicable • 15% - Erection after necessary field testing and inspection as applicable includingtotal finishing work • 7.5% after successful trial operation of the Gate- Dry condition • 7.5 % -After success sful trial operation of the Gate- Wet condition

		• 10% - After successful commissioning of the plant
8	Design& Drawings duly approved, fabrication, supply, erection, painting testing and commissioning of one number **Stop-log Gate at TRC** for using in both the TRC gate with hoisting arrangement, complete in all respect	• 60% - Supply at site after necessary factory inspection & Testing as applicable • 15% - Erection after necessary field testing and inspection as applicable including total finishing work • 7.5% after successful trial operation of the Gate- Dry condition • 7.5 % -After successful trial operation of the Gate- Wet condition • 10% - After successful commissioning of the plant

Preparation and submission of Bills by the contractor after completion of work in line with payment schedule, joint checking at site etc. to be incorporated

All items of work carried out by the contractor in accordance with the provision of the contract having a financial value shall be entered in the Measurement Book/Log Book/Inspection Sheet etc. as prescribed by the employer so that a complete record is obtained of all work performed under the contract and the gross value of total work carried out can be ascertained and determined there -from.

11.6 The payment for **Electro-mechanical** works are as follows:

The Employer shall pay the Contractor in the following manner and at the following times, on the basis of the Price Breakdown given in Price Schedules (Schedule 1, Schedule 2 and Schedule 3), submitted by the Contractor with his Financial Bid (BOQ_XXXX.xls). The Payments shall be made to the Contractor in Indian Rupees only.

11.6.1 **PAYMENTS UNDER PRICE SCHEDULE NO. 1**

List of Items:

Sl. No. 1.1 of Price Schedule No. 1: Horizontal shaft, Pelton type Turbines, each suitably rated to provide 5.00 MW generator output with 10% continuous overload (COL) at rated design head of 354 m, rated discharge of 1.7 cumec and rated speed of 600 / 750 rpm, directly coupled to generator, complete with all necessary auxiliary and ancillary equipments.

Sl. No. 1.2 of Price Schedule No. 1: Spherical type Main Inlet Valves (MIV) complete with piping, controls and operating mechanism and necessary auxiliaries.

Sl. No. 2.1 of Price Schedule No. 1: Horizontal shaft, 3 phase, 11 kV, 0.85 pf (lagging), 50 Hz., 600 rpm / 750 rpm, AC Synchronous Generators complete with all accessories and auxiliaries having rated output of 5000 kW / 5883 kVA and maximum output of 5500 kW / 6471 kVA (@110% of the Rated Output) at an elevation of 1066 m above MSL

Sl. No. 4.1 of Price Schedule No. 1: 3 phase, 12.5 MVA, 11/33 kV, 50 Hz., ONAN / ONAF, YNd11 Step-up Transformer with OCTC (+5% to –15% @1.25%) and complete with all accessories and fittings.

Schedule No. 1: Supply of Equipment and Materials including mandatory Spare Parts, tools, Plants &Equipment

A(i). FIVE PERCENT (05%) of the Total Price for the above mentioned items (under clause 11.6.1) of Price Schedule No. 1 of Financial Bid shall be released to the contractor after obtaining approval (go ahead for construction after incorporating the observations of WBSEDCL) of DESIGN DRAWINGS from the Owner.

FIFTTY PERCENT (50%) of the Total or Pro-Rata Price for the above mentioned items (under clause 11.6.1) of Price Schedule No. 1 of Financial Bid shall be released after successful shop testing, issuance of delivery instruction by the Controlling Officer and subsequent submission of the respective E-WAY Bills to the Owner.

FIFTEEN PERCENT (15%) of the Total or Pro-Rata Price for the above mentioned items (under clause 11.6.1) of Price Schedule No. 1 of Financial Bid shall be released after delivery of respective materials / items / equipment at the site, and received in good condition and fulfilment of safe site storage done by the agency, insurance and other requisite criteria as detailed in this tender document.

A(.ii). SEVENTY PERCENT (70%) of the Total or Pro-Rata Price for entire items [except those mentioned in the above list under clause 11.6.1] of Price Schedule No. 1 of Financial Bid shall be released after delivery of respective materials / items / equipment at the site, and received in good condition and fulfilment of safe site storage done by the agency, insurance and other requisite criteria as detailed in this tender document.

100% of GST against Supply of Equipment and Materials including mandatory Spare Parts, tools, Plants & Equipment shall be paid.

Recovery of Mobilization Advance, if applicable, along with interest shall be made at this stage of Payment.

B. TEN PERCENT (10%) of the Total Price for the items of Price Schedule No. 1 of Financial Bid shall be released after successful completion of installation and mechanical run of the units.

C. TEN PERCENT (15%) of the Total Price for the items of Price Schedule No. 1 of Financial Bid shall be released after successful completion of site testing including performance guarantee tests, trial run and final commissioning of complete plant including each item / equipment / system. The payment under this section shall be released after issuance of Taking over Certificate for the complete plant by the Controlling Officer / Engineer-in-charge.

D. Balance TEN PERCENT (05%) of the Total Price for the items of Price schedule No.1 of Financial Bid shall be released after Handing-over of Documents including Operation and Maintenance (O&M) manual, completion of training of owner's personnel and successful running of machines in 01(one) monsoon period (June to Sep).

11.6.2 PAYMENTS UNDER PRICE SCHEDULE NO. 2

Schedule No. 2: Local Transportation and Insurance Charges

ONE HUNDRED (100%) of the Total or Pro-Rata Local Transportation and Insurance Charges (under Schedule No. 2 of Financial Bid) upon delivery of the materials/ items/ equipment to the site.

11.6.3 PAYMENTS UNDER PRICE SCHEDULE NO. 3

Schedule No. 3: Installation Services

a. SEVENTY PERCENT (70%) of the Total or Pro-Rata Contract Price for the Installation Services (under Schedule No. 3 of Financial Bid) on the measured value of work performed by the Contractor during the preceding three (03) months, as certified by the Supervising Officer(s) and approved by the Controlling Officer / Engineer-in-charge, shall be paid quarterly.

b. TWENTY PERCENT (20%) of the Total Contract Price for the Installation Services (under Schedule No. 3 of Financial Bid) shall be released after successful completion of installation, site testing including performance guarantee tests, trial run and final commissioning of complete plant including each item / equipment / system. The payment under this section shall be released after issuance of Taking over Certificate for the complete plant by the Controlling Officer / Engineer-in-charge.

c. Balance TEN PERCENT (10%) of the Total Contract Price for the Installation Services (under Schedule No. 3 of Financial Bid) shall be released after Handing-over of Documents including Operation and Maintenance (O&M) manual and successful completion of training of owner's personnel.

11.7 The payment for **Operation and Maintenance** works are as follows:

The payment under this head shall be made quarterly after successful completion of required job which shall be duly certified by E.I.C.

11.8 E.I.C shall have the sole discretion in modifying the percentage of payment for Civil, Hydro-Mechanical and Electro-Mechanical work mentioned above as per site condition.

12. MOBILISATION ADVANCE

Interest Bearing Mobilization Advance of total 10% of the Contract Price + GST component on such (as per prevailing rate) in two equal instalments i.e. 5% of the contract price + GST component on such (as per prevailing rate) each will be paid to the contractor. The interest rate on advance payment shall be at SBI's Base rate at the time of issue of NIeT/Bid Document.The advance shall be made against submission of BG on any scheduled bank in India, equivalent to 110% of the payable Mobilization Advance (including GST component) as per following sequences:

(i) 1st Instalment of mobilization advance @ 5% of the contract price + GST component on such (as per prevailing rate) of the contract price of the work will be paid to the contractor subject to fulfilment of the following criteria:

(a) Unconditional acceptance of the LOA

(b) Taking over of site from WBSEDCL

(c) Execution of Contract Agreement

(d) Submission of Performance Bank Guarantee on any scheduled bankin India. In the PBG there must be provision for payment at Kolkata in case of invoking.

(e) Submission of duly authenticated 'Activity Schedule' showing the entire execution of work

(f) Submission of Bank Guarantee (BG) equivalent to 110% of 1st instalment of mobilisation advance including GST component on such (as per prevailing rate) in the prescribed format of WBSEDCL along with a request letter.

The said 5% Advance shall be recovered in two equal instalments along with its accrued interest from the first two (o2) consecutive R/A bills since disbursement of Mobilization Advance.

Bank Guarantee submitted for 5% of the contract price + GST component on such (as per prevailing rate) for 1st mobilization advance will be released after full recovery of the same (with interest) and on receipt of written request of the contractor for release of the Bank Guarantee (BG).

(ii) 2ndInstalmentof Mobilization Advance @ 5% of the contract price + GST component on such (as per prevailing rate) of the contract price of the work will be paid to the contractor subject to fulfilment of the following criteria:

(a) Complete recovery of 1st Mobilization Advance including GST component on such (as per prevailing rate)

And

(b) On submission of Bank Guarantee (BG) equivalent to 110% of 2nd instalment of Mobilisation Advance + GST component on such (as per prevailing rate) on any scheduled bank in India, against 2nd Advance amount in the prescribed format along with a request letter.

Recovery of the second 5% advance will be made in two equal instalments along with its accrued interest from the very next two (o2) consecutive R/A bills after payment of Mobilization Advance (2nd Instalment) in full. The Bank Guarantee (BG) thereof would be refunded following same formalities as in the case of (i) above.

13. CONTRACT PERFORMANCE SECURITY

13.1 The contractor shall have to furnish an irrevocable and unconditional' Contract Performance Security' in the form of a Bank Guarantee (BG)on any **scheduled** bank in India, as per the employer's pro-forma, amounting to **3% (three percent)** of the contract value of the work (as mentioned in the Letter of Award/ Order) for faithful and due fulfillment of all contractual obligations under the terms and conditions of the contract within 28 (twenty eight) days of the placement of the Letter of Award (LOA)/ Order.

13.2 The employer reserves the right to invoke the bank guarantee with 15 (fifteen) days' from the receipt of the notice for non-performance of the contractual obligations.

Upon such encashment and appropriation from the Performance Security, the Contractor shall, within 45(forty five) days thereof, replenish, in case of partial appropriation, to its original level of the Performance Security, and in case of appropriation of the entire Performance Security provide a fresh Performance Security, as the case may be, and the Contractor shall, within the time so granted, replenish or furnish fresh Performance Security as aforesaid, failing which the WBSEDCL shall reserve the right to terminate the Agreement in accordance. Upon replenishment or furnishing of a fresh Performance Security, as the case may be, as aforesaid, the Contractor shall be entitled to an additional Cure Period of **60 (Sixty) days** for remedying the Contractor's Default, and in the event of the Contractor not curing its default within

such Cure Period, the Authority shall be entitled to encash and appropriate such Performance Security as Damages and shall be entitled to terminate this Agreement.

13.3 The performance guarantee will initially be valid for **57 months**(30 months of construction period+24 months of defect liability period +additional 3 months period) with a claim period of another 03 (three) months. The contract performance guarantee may be released after satisfactory execution of the contract and upon receipt of a written request from the contractor in this regard. Contract Performance guarantee is to be suitably extended when informed by the controlling officer and if the situation so arises. The case shall be guided as per prevailing banking norms covering 57 months Performance Guarantee period.

13.4 Bank Guarantee shall be on non-judicial stamp paper of appropriate value. The relevant format attached herein 'Form-9 of Forms/ Proforma Section' of this tender document.

13.5 After submission of performance BG and execution of contract agreement, EMD of the successful bidder will be released on submission of written prayer by the successful bidder.

14. TAXES AND DUTIES

14.1 Prices of the Service/materials/ equipment are inclusive of all taxes, duties and CESS except GST.

14.2 GST as applicable will be paid extra as per GST Act, 2017.

14.3 The changes of rates of taxes, levies and duties, introduction of new taxes, levies and duties after the last date of submission of the tender shall be considered as unforeseen events and will be covered under provisional sum as per clause no. 63 of GCC.

14.4 TDS and STDS GST will be applicable as per prevalent rules & regulations. BOCWW@ 1% will be applicable as per prevalent rules & regulations.

14.5 GST Tax invoices are required to be submitted for raising claim under the contract in accordance with the provisions of the GST Act, 2017.

14.6 Local taxes, Royalty on fine/ coarse aggregate and levies are to be assessed and arranged by the bidder from appropriate authority.

14.7 Full GST for Supply of materials & Services will be released alongwith first part bill in respect of EM & HM work only (As per line items of LoA).

15. NON-WAIVER

15.1 No relaxation, forbearance or delay by employer or contractor in enforcing any of the terms and conditions of the contract or the granting of time by the employer to the other shall prejudice, affect or restrict the rights of that party under the contract, nor shall any waiver by either party of any breach of contract will operate as waiver/ acquiescence of any subsequent or continuing breach of contract.

15.2 Any waiver of a party's rights, powers or remedies under the contract must be in writing, must be dated and signed by an authorized representative of the party granting such waiver, and must specify the right and the extent to which it is being waived.

16. SEVERABILITY

The validity of the contract shall not be affected in case one or more of its stipulations be or become legally invalid so long as such stipulation is severable from and not fundamental to obligations of contract. In such case both the Party(ies) shall mutually agree to replace invalid article/Clause by a stipulation which is in accordance with the applicable law.

17. NOTICES

17.1 Unless otherwise stated in the contract, all notices to be given under the contract shall be in writing, and shall be sent by personal delivery, Registered post, special courier, e-mail to the address of the relevant party.

17.2 Any notice sent by post or special courier shall be deemed (in the absence of evidence of earlier receipt) to have been delivered within 10 (ten) days after despatch. In proving the fact of despatch, it shall be sufficient to show that the envelope containing such notice was properly addressed, stamped and conveyed to the postal authorities or courier service for transmission by post or special courier.

17.3 Any notice delivered personally shall be deemed to have been delivered on date of its despatch.

17.4 Either party may change its postal, or addressee for receipt of such notices by **10 (ten) days'** notice to the other party in writing.

17.5 Notices shall be deemed to include any approvals, consents, instructions, orders and certificates to be given under the Contract.

18. SETTLEMENT OF DISPUTES

18.1 The Parties shall use their best efforts to settle amicably all disputes arising out of or in connection with this contract or the interpretation thereof. However, in case any dispute still stands unsettled, aggrieved party may appeal to Hon'ble High Court, Calcutta for redressal of the grievances.

18.2 Notwithstanding any reference to the matter of court proceedings, the parties shall continue to perform their respective obligations under the contract unless they agree otherwise.

19. EMPLOYER'S RESPONSIBILITY

19.1 At the commencement of work, the employer shall provide the site of work free from any encumbrances. However, any temporary structures existing within the site shall have to be removed by the contractor at his own cost and responsibility.

19.2 The contractor shall submit Preliminary drawings/ inception report after detailed site investigation.

19.3 The employer shall provide the tender drawing for reference and the contractor shall have to prepare detailed design & engineering and related approval stage/ construction drawings of Civil, Hydro-mechanical, and Electro Mechanical works at his own capacity. Based on the tender drawing the contractor shall submit draft design drawings phase wise for approval from the employer. The contractor shall have to prepare and submit 06 (Six) sets construction drawings to the employer for approval. After completion of the project the contractor shall have to submit "As Built" drawing.

19.4 Basic survey network consisting of reference points in the project area shall be provided by the employer.

19.5 DPR stage Geotechnical & Geological report is provided in this Tender.

19.6 The employer shall provide due assistance to the contractor for obtaining permits, licence, clearances etc. from government departments, local bodies or any other statutory bodies as is required for compliance of different statutes & laws.

19.7 Land related matter such as acquisitions, relocations, of human and other habitant will be settled by WBSEDCL

19.8 The employer shall make payment to the contractor as per 'Clause No.-11 of General Conditions of Contract (GCC)'.

20. CONTRACTOR'S RESPONSIBILITIES

20.1 The contractor will be deemed to have confirmed that it entered into this contract on the basis of a proper examination of the data relating to the work and on the basis of information that the contractor could have obtained from a visual inspection of the site and of other data readily available to it relating to the work as on the date of bid submission. The contractor will also be considered as having acknowledged that any failure to acquaint itself with all such data and information shall not relieve its responsibility for properly estimating the difficulty or cost of successfully performing the work.

20.2 The contractor shall be deemed to have inspected and examined the site conditions and its surroundings and information available in connection there with and to have satisfied himself (so far as is practicable, having regard to considerations of cost and time) before submitting his tender, as to:

a. The form and nature thereof, including the sub-surface conditions,

b. The contractor has to carry out pre-construction survey as detailed in 'Clause No.-4 of Technical Specification for Civil Work'.

c. The extent and nature of work and materials available and necessary for the execution and completion of the work and

d. The means of access to the site and the accommodation he may require and in general, shall be deemed to have obtained all necessary information, as above mentioned, as to risks, contingencies and all other circumstances which may influence or affect his tender.

20.3 The contractor shall acquire in its name all permits, approvals and/or licenses from all local, state or national government authorities or public service undertakings in India where the site is located that are necessary for the performance of the contract, including, without limitation, visas for the contractor's personnel and entry permits for all imported contractor's equipment. The contractor shall acquire all other permits, approvals and/ or licenses that are necessary for the performance of the contract.

20.4 The contractor shall comply with all laws in force in India and the state of West Bengal where the work is to be executed and where the installation services are to be carried out. The laws will include all national, provincial, municipal or other laws that affect the performance of the contract and binding upon the contractor. The contractor shall indemnify and hold harmless the employer from and against any and all liabilities, damages, claims, fines, penalties and expenses of any plant, material and services that will be incorporated in or be required for the work and other supplies, whatever nature arising or resulting from the violation of such laws by the contractor or its personnel and representatives.

20.5 Notwithstanding any approval, consent, advice or permission given by the controlling officer with respect to the contractors program, method of working, contractual plant, temporary work or materials for temporary work, whether required by the contract or not, the contractor shall remain responsible for execution of the working fulfilment of the contract even though no such approval, consent, advise or permission had been given and shall have no claim on the employer for additional payment in respect of any cost which was not approved by the employer earlier.

20.6 The contractor shall prepare and submit to the Engineer-in-Charge/ Controlling Officer a detailed Program/ Activity Schedule for the performance of the contract, made in the form of PERT/ CPM Network and showing the sequence, the contractor proposes to carry out the Work including each stage of ***Design, Engineering, Construction, Supply, Erection, Testing and Commissioning of 10MW (2 x 5 MW) Lodhama–II Small Hydro-Electric Project in Darjeeling District, West Bengal including operation and maintenance for a period of 2(Two) years on Engineering, Procurement and Construction (EPC) contract basis*** within the stipulated scope of the contract and general methods, arrangements, timing for all the activities and sequence of all tests to be carried out in the work along with monthly progress schedule.

21. INTELLECTUAL PROPERTY RIGHT

The copyright in all drawings, documents and other materials containing data and information furnished to the Employer by the contractor herein shall remain vested in the Contractor, or, if they are furnished to the employer directly or through the contractor by any third party, including suppliers of materials, the copyright in such materials shall remain vested in such third party. The employer shall however be free to reproduce all drawings, documents and other material furnished to the employer for the purpose of the contract including, if required, for operation and maintenance of the work and for all future purposes. Regarding intellectual property rights provision of Information technology Act 2000, Patents Act 1970, Copyrights Act 1958, Design Act 2000, etc. including subsequent amendments/ Acts, will be applicable at relevant places.

22. CONFIDENTIAL INFORMATION

The employer and the contractor shall keep confidential and shall not, without the written consent of the party, hereto, divulge to any third party any documents, data or other information furnished directly or indirectly by the other party hereto in connection with the contract, whether such information has been furnished prior to, during or following termination of the contract.

23. EMPLOYER'S REPRESENTATIVE

23.1 The persons, duly named in the contract document, will decide contractual matters between the employer and contractor in the role representing the employer.

23.2 Except where otherwise specifically stated, the Engineer-in-Charge/ Controlling Officer or his nominee as mentioned in the contract document shall be the employer's representative for all matters relating to execution of the contract at site for construction, erection & commissioning of the work.

23.3 The employer may from time to time change the Engineer-in-Charge/ Controlling Officer of the work. The Engineer-in-Charge/ Controlling Officer shall represent and act for the employer.

23.4 All notices, instructions, orders, certificates, approvals and all other communications under the Contract shall be given by the Engineer-in-Charge/ Controlling Officer, except as herein otherwise provided. All notices, instructions, information and other communications to be given by the contractor to the employer under the contract shall be given to the Engineer-in-Charge/ Controlling Officer, except as herein otherwise provided.

24. CONTRACTOR'S REPRESENTATIVE

24.1 The contractor shall employ the key personnel named in the schedule of key personnel to carry out the functions stated in the schedule.

24.2 The contractor's representative shall represent and act for the contractor at all times during the pendency of the contract and shall give to the Engineer-in-Charge/ Controlling Officer all the contractor's notices, instructions, information and all other communications under the contract.

24.3 All notices, instructions, information and all other communications given by the Employer or the Engineer-in-Charge/ Controlling Officer to the contractor under the contract shall be given to the contractor's representative.

24.4 Any act or exercise by any person of powers, functions and authorities so delegated to him or her shall be deemed to be an act or exercise by the contractor's representative.

24.5 The employer may by notice to the contractor object any representative or person employed by the contractor in the execution of the contract, who in the reasonable opinion of the employer, has behaved inappropriately, or is incompetent or negligent, or has committed a serious breach of the site regulations. The contractor shall remove such person from the work within 48 hours' notice.

24.6 If any representative or person employed by the contractor is removed in accordance with the contract, the contractor shall, where required, promptly appoint a replacement within 72 hours.

25. CONTRACTOR'S ORGANIZATION

The contractor shall provide to the Engineer-in-Charge/Controlling Officer a chart showing the proposed organization to be established by the contractor for carrying out the work. The chart shall include the identities of the key personnel together with the Curriculum Vitae of such key personnel to be employed within 21 (twenty-one) days of the Effective Date. The contractor shall promptly inform the Engineer-in-Charge/ Controlling Officer in writing of any revision or alteration of such an organization chart.

26. ACTIVITY SCHEDULE/PROGRAM

26.1 Within **28(twenty eight) days** after the date of placement of the letter of award of the contract, the contractor shall prepare and submit to the Engineer-in-Charge/ Controlling Officer a detailed Program/Activity Schedule for the performance of the contract, made in the form of PERT/CPM Network and showing the sequence, the contractor proposes to carry out the Work including each stage of ***Design, Engineering, Construction, Supply, Erection, Testing and Commissioning of 10MW (2 x 5 MW) Lodhama–II Small Hydro-Electric Project in Darjeeling District, West Bengal including operation and maintenance for a period of 2(Two) years on Engineering, Procurement and Construction (EPC) contract basis*** within the stipulated scope of the contract and general methods, arrangements, timing for all the activities and sequence of all tests to be carried out in the work along with monthly progress schedule.

26.2 The program so submitted by the contractor shall accord with the time schedule as per the contract agreement and any other dates and periods specified in the contract. The contractor shall update and revise the program as and when appropriate or when instructed by the Engineer-in-Charge/ Controlling Officer.

26.3 If the progress of the work does not conform to the approved programme, the employer's representative may instruct the contractor to update the programme showing the modifications necessary to achieve completion within the time for completion, including any change to the sequence of the activities. In such case, the contractor shall submit to the employer's representative an updated program for approval within **07 (seven) days** of such instruction.

27. PROGRESS REPORTING

27.1 The Contractor shall monitor progress of all the activities specified in the program, and supply a progress report to the Engineer-in-Charge/Controlling Officer every month.

27.2 The progress report shall be in a form acceptable to the Engineer-in-Charge/ Controlling Officer and shall also indicate:

a. Percentage of job completed Physical and financial compared with the percentage of job planned for each activity; and

b. In case any activity is behind the program, giving reasons and likely consequences and stating the corrective action(s) being taken.

27.3 If at any time the Contractor's actual progress falls behind the schedule program then the Contractor shall prepare and submit to the Engineer-in-Charge/ Controlling Officer a revised program, taking into account the prevailing circumstances, and shall notify the Engineer-in-Charge/Controlling Officer of the steps being taken to expedite progress so as to attain completion of the work within the stipulated time of completion as per contract or any extended period as may be agreed upon between the employer and the contractor.

28. WORK PROCEDURES

28.1 The contract shall be executed in accordance with the provisions of the contract.

28.2 The contractor shall be required to attend all periodical site progress review meetings organized by the 'Engineer-in-Charge/ Controlling Officer' or his authorized representative. The deliberations in the meetings shall inter alia include the weekly program, progress of work (including details of manpower, tools and plants deployed by the contractor vis-à-vis agreed schedule), inputs to be provided by the employer,

delays, if any and recovery program, specific hindrances to work and work instructions by the employer.

28.3 The minutes of the weekly meetings shall be recorded. These recordings shall be jointly signed by the 'Engineer-in-Charge/ Controlling Officer' or his authorized representative and the contractor and one copy of the signed records shall be handed over to the contractor.

29. SPECIFICATIONS AND DRAWINGS

The contractor shall execute the work as per detailed approved design&drawing, and specification of the work in compliance to the provisions of the contract.

The employer shall provide the tender drawing for reference and the contractor shall have to prepare detailed design & engineering and related approval stage/ construction drawings of Civil, Hydro-mechanical, and Electro Mechanical works at his own capacity.Based on the tender drawing the contractor shall submit draft design drawings phase wise for approval from the employer. The contractor shall have to prepare and submit 06 (Six) sets construction drawings to the employer for approval. After completion of the project the contractor shall have to submit "As Built" drawing.

The contractor shall be responsible for any discrepancies, errors or omissions in the specifications, drawings, design reports and other technical documents, that it has prepared, whether such specifications, drawings and other documents have been approved by the Engineer-in-Charge/ Controlling Officer or not.

30. CODES AND STANDARDS

Wherever references are made in the contract to codes and standards,in accordance with which the contract shall be executed, the prevalent codes and standards at the date of bid submission shall apply unless otherwise specified. During contract execution, any changes in such codes and standards shall be applied after approval by the employer.

31. TRANSPORTATION AND E-WAY BILL

31.1 The contractor shall at its own risk and expense transport all the materials, plant and equipment and the contractor's equipment to the site by the mode of transport that the contractor judges most suitable under all the circumstances.

31.2 Unless otherwise provided in the contract, the contractor shall be entitled to select any safe mode of transport operated by any person to carry the materials, plant and equipment and the contractor's equipment.

31.3 The contractor shall be responsible for obtaining, if necessary, approvals from the authorities for transportation of the plant and equipment and the contractor's equipment to the site. The employer shall use its best endeavours in a timely and expeditious manner to assist the contractor in obtaining such approvals, if requested by the contractor. The contractor shall indemnify and hold harmless the employer from and against any claim for damage to roads, bridges or any other traffic work that may be caused by the transport of the plant and equipment and the contractor's equipment to the site.

31.4 In case of movement of materials, e way bill if and when required must be generated by the contractor on their own. Copy of the said e way bill along with challans is to be submitted with the claim.

32. CUSTOMS CLEARANCE

The contractor shall, at its own expense, handle all imported plant and equipment and contractor's equipment if any at the point(s) of import and shall handle all formalities for customs clearance, on behalf of employer, provided that if applicable laws or regulations require any application or act to be made by or in the name of the employer, the employer shall take all necessary steps to comply with such laws or regulations.

33. LABOUR LICENSE

The contractor will have to obtain labour license if required, as per Contract Labour (Regulation & Abolition) Act, 1970 as early as possible.

34. COMPLIANCE OF LAWS RELATED WITH EMPLOYEES

Rules & Regulations:

The contractor shall comply with all the statutory provisions of the following prevailing labour laws in respect of employees engaged by them:

- Labour Licence as per Contract Labour (Regulation & Abolition) Act 1970
- Payment of Wages Act 1936
- Minimum Wages Act 1948
- Payment of Bonus Act 1965 and amended in 2015
- Employees Provident Fund and Miscellaneous provisions act 1952
- Employees Compensation Act 1923
- Employees State Insurance Act 1948

In addition to this, the under mentioned points need to be followed:-

- Successful bidder shall submit his employees' identification to the Controlling Officer. For this purpose, submission of photo employment card in duplicate in Form XIV (prescribed format) under Rule-76 of the Contract Labour (Regulation and Abolition) Central Rules, 1971 and amendments as applicable shall have to be done.
- Before undertaking the work, the entrusted agency shall have to obtain Work Permit from the department as and when required.
- The agency shall have to subscribe for ESI benefit for each of the employee engaged for the work. In case ESI is not possible, the agency shall have to arrange Mediclaim for each of the employee under GIC or its subsidiary. The subscriptions for ESI/ Mediclaim policy shall not be less than 3.25% of the basic wages.
- Other Statutory forms as and when required shall have to be submitted as per prevailing norms and Act.

35. SETTING OUT/SUPERVISION OF LABOUR

The contractor shall submit method statement of each item of work furnishing general description of the arrangements, equipment and methods which the contractor proposes to adopt for the execution of works for EIC approval 15 days prior to the execution of the work. No material alteration to the program shall be made without the approval EIC.

35.1 The Contractor shall be responsible,

a. For the true and proper setting-out of the Work in relation to original points, bench marks, lines & levels of reference provided by the Engineer-in-Charge/Controlling Officer or his representative in writing and

b. For the correctness of the position, levels, dimensions and alignment of all parts of the work and

c. For the provisions of all necessary instruments, appliances and labour in connection therewith.

If at any time during the progress of the work, any error appears or arises in the position, levels, dimensions or alignment of any part of the work, the Contractor shall rectify such error to the satisfaction of the Engineer-in-Charge/Controlling Officer or his representative.

35.2 The contractor shall give or provide all necessary superintendence during the execution and maintenance of the work and shall be constantly on the site to provide full-time superintendence of the work as the Engineer-in-Charge/ Controlling Officer may consider necessary for the proper fulfilment of the contractor's obligation under the contract. The contractor shall provide and employ only technical personnel who are skilled and experienced in their respective fields and supervisory staff who are competent adequately to supervise the work.

35.3 The contractor shall make his own arrangement for the engagement of all labourers and for their payment, housing, fooding and transport. The contractor shall comply with all the relevant labour laws applicable to the contractor's personnel, including laws relating to their employment, health, safety, welfare and shall allow them all their legal rights. The contractor shall require his employees to obey all applicable laws, including those concerning safety at work. Further, the contractor shall provide and maintain all necessary accommodation and welfare work for the contractor's personnel and shall not permit any of the contractor's personnel to maintain any temporary or permanent living quarters within the structures forming part of the works.

35.4 The contractor shall be responsible for obtaining all necessary permit(s) and/or visa(s) from the appropriate authorities for the entry of all labourers and personnel to be employed at the Site.

35.5 The contractor shall at all times during the progress of the contract use its best endeavours to prevent any unlawful, riotous or disorderly conduct or behaviour by or amongst its employees and the labourer.

35.6 The contractor shall, in all dealings with its labourer, pay due regard to all recognized festivals, official holidays, religious or other customs and all local laws and regulations pertaining to the employment of labour.

35.7 The contractor shall abide at all times with the provisions of the Payment of Wages Act 1936, Minimum ages Act, 1948, Employers' Liability Act, 1938. Workmen's Compensation Act, 1923, Industrial Disputes Act, 1947, Maternity Benefit Act, 1961, Mines Act, 1952, Contract Labour Regulation & Abolition Act, 1970, Employees Provident Funds and Miscellaneous Provisions Act 1952 etc. or any modifications hereof or any other law relating thereto and rules made there under from time to time either by the State or the Central Govt. or Local authorities.

36. CONTRACTOR'S EQUIPMENTAND MATERIALS:

All Contractors' Equipment and material brought by the Contractor onto the Site shall be deemed to be intended to be used for the execution of the Contract. The Contractor shall not remove the same from the Site without the consent in writing of the Engineer-in-Charge/ Controlling Officer. Unless otherwise specified in the Contract, upon completion of the Work the Contractor shall remove from the Site all equipment brought by the Contractor onto the Site and any surplus materials remaining thereon. The Employer shall not at any time be liable for the loss of or damage to any of the contractor's equipment.

37. SITE REGULATIONS, SAFETY AND SECURITY

37.1 The employer and the contractor shall establish site regulations, setting out the rules to be observed in the execution of the contract at the site and shall comply therewith. The contractor shall prepare and submit to the employer, proposed site regulations. Such site regulations shall include, but shall not be limited to, rules in respect of security, safety of the work.

37.2 The contractor throughout the execution and completion of the work and remedying of any defects therein, shall be responsible for the safety of all activities, all persons entitled to be upon the site and keep the site (so far as the same is under his control) and the work (so far as the same are not completed or occupied by the employer) in an orderly state for avoidance of danger.

37.3 The contractor shall provide and maintain at his own cost all lights, guards, fencing, warning signs and watching, when and where necessary or required by the Engineer-in-Charge/ Controlling Officer or by any duly constituted authority, for the protection of the work or for the safety and convenience of the public or others, and take all reasonable steps to protect the environment on and off the site and to avoid damage or nuisance to persons or to property of the public or others resulting from pollution, noise or other causes arising as a consequence of his methods of operation.

37.4 The contractor shall comply with the requirements provided in the "Safety Codes" as provided in technical specifications.

38. EMERGENCY WORK

If, by reason of an emergency arising in connection with and during the execution of the Contract, not due to any fault of the contractor, any protective or remedial work is necessary as a matter of urgency to prevent damage to the completed portion of the Work, the Contractor shall immediately carry out such work with prior consent of the Employer.

39. SITE CLEARANCE

39.1 In the course of carrying out the contract, the contractor shall keep the site reasonably free from all unnecessary obstruction and shall store in an orderly condition or remove any surplus materials, clear away any wreckage, rubbish or temporary works from the site, and remove any contractor's equipment no longer required for execution of the contract.

39.2 After completion of all parts of the work, the contractor shall clear away and remove all wreckage, rubbish and debris of any kind from the site, any temporary structure, office, stores, go-downs, quarters and hutments etc. built by him and shall leave the site clean and safe to the satisfaction of the Engineer-in-Charge.

40. WATCHING AND LIGHTING

The contractor shall, in connection with the work, provide and maintain at its own expense all lighting, fencing and watching when and where necessary or as required by the Engineer-in-Charge/Controlling Officer for the proper execution and the protection of the work or for the safety and convenience of the occupiers of adjacent property and for the safety of the public or others.

41. WORK AT NIGHT AND ON HOLIDAYS

Unless otherwise provided in the contract, no work shall be carried out during night and on public holidays without prior written consent of the employer, except where work is necessary or required to ensure safety of the Work or for the protection of life, or to prevent loss or damage to property, when the contractor shall immediately seek consent of the Engineer-in-Charge/ Controlling Officer, provided that provisions of this clause shall not be applicable to any work which is customarily carried out by rotary or double-shifts.

42. REMOVAL OF SUNKEN/ BURIED EQUIPMENTS AND MATERIALS

42.1 If any equipment (floating or otherwise) belonging to or hired by the contractor or any person employed by the contractor or any material or things therein or there from sunk/buried due to any cause whatsoever, it shall immediately be reported by the Contractor to the Engineer-in-Charge/ Controlling Officer and contractor shall forthwith, at his own cost, raise and remove any such equipment, materials or things or otherwise deal with the same as the Engineer-in-Charge/Controlling Officer may direct in this regard.

42.2 The fact that such sunken/ buried equipment, materials or things are insured or have been declared a total loss or do not represent any further value shall not absolve the contractor from his obligations under this Clause to raise and remove the same.

43. FOSSILS

All fossils, coins, articles of value or antiquity and structures and other remains or things of geological or archaeological interest discovered on the Site shall be deposited to the Employer. The Contractor shall take reasonable precautions to prevent his workmen or any other persons from removing or damaging any such article or thing and shall, immediately upon discovery thereof and before removal, acquaint the Engineer-in-Charge/ Controlling Officer of such discovery and carry out the Engineer-in-Charge/ Controlling Officer's instructions for dealing with the same. If, by reason of such instructions, the Contractor suffers delay then the Engineer-in-Charge/ Controlling Officer shall, after due consultation with the Contractor, determine any extension of time, if required.

44. TEST AND INSPECTION

44.1 The contractor shall at its own expense carry out all such tests and/or inspections of the Plant and Equipment and any part of the work as specified in the contract as per the instruction of the Engineer-in-Charge/ Controlling Officer at the place of manufacture and/or on the Site and/or any of such places as may be specified by the Engineer-in-Charge/ Controlling Officer.

44.2 The contractor and the Engineer-in-Charge/ Controlling Officer or their designated representatives shall be entitled to attend the aforesaid test and/or inspection, contractor shall bear all costs and expenses incurred in connection with such inspection including, but not limited to, all travelling, boarding and lodging expenses.

44.3 Whenever the contractor is ready to carry out any such test and/or inspection, the contractor shall give an advance notice of 10 (ten) days of such test and/or inspection and of the place and time thereof to the Engineer-in-Charge/ Controlling Officer.

44.4 The Contractor shall provide the Engineer-in-Charge/ Controlling Officer with a certified report of the results of any such test and/or inspection.

44.5 The Engineer-in-Charge/Controlling Officer may require the contractor to carry out any test not specified in the contract. Contractor's reasonable costs and expenses incurred in carrying out of such test shall be paid to the contractor. Any time taken for such additional tests shall be considered towards granting of extension of time of completion, if required.

44.6 If any plant and equipment or any part of the work fails to pass any test and/ or inspection, the contractor shall either rectify or replace such plant and equipment or part of the work and shall repeat the test and/ or inspection, at his own cost.

44.7 The contractor, at his own expense, shall allow the employer or his representative to access at any reasonable time to any place where the plant and equipment are being manufactured or the work are being installed, in order to inspect the progress and the manner of manufacture or installation, provided that the employer shall give the contractor a reasonable prior intimation.

44.8 The contractor agrees that neither the execution of a test and/or inspection of Plant and Equipment or any part of the work, nor the attendance by the employer or the Engineer-in-Charge/ Controlling Officer, nor the issue of any testcertificate shall release the contractor from any other responsibilities under the Contract.

45. INSPECTION OF CONTRACTOR'S RECORDS/ ACTIVITIES

The Engineer-in-Charge/ Controlling Officer or his authorized representative shall at all times have access to the work and to all workshops and places where work is being executed or from where materials, manufactured articles or machinery are being obtained for the work and the contractor shall afford every facility for and every assistance in or in obtaining the right to such access.The Contractor shall permit the Employer or his representative to inspect the Contractor's compliance of maintenance of records relating to the performance of the Contract. This, however, will not relive the Contractor from his responsibility for proper execution of the Contract in any manner whatsoever.

46. COMPLETION OF THE WORK

46.1 As soon as the work or any part thereof has, in the opinion of the contractor, been completed operationally and structurally and put in a tidy and clean condition as specified in the technical specifications, the contractor shall so notify the employer in writing.

46.2 As per schedule program with prior consent of the Engineer-in-Charge/Controlling Officer, the Contractor shall commence Pre-commissioning of the work or the relevant part thereof in preparation for Commissioning.

46.3 As soon as all work in respect of Pre-commissioning are completed and the Plant & Equipment or the work or any part thereof is ready for Commissioning, the Contractor shall commence the process of Commissioning as per procedures stipulated in Technical Specifications with prior approval of the Employer, and as soon as Commissioning is satisfactorily completed, the Contractor shall so notify the Engineer-in-Charge/ Controlling Officer in writing.

46.4 If the Engineer-in-Charge/ Controlling Officer notify the Contractor of any defects and/or deficiencies, the Contractor shall then commence rectification/mending of such defects and/or deficiencies, and shall intimate in writing to the Engineer-in-Charge/ Controlling Officer of having completed the rectification/mending work. The above procedure shall be repeated until the rectification/mending work is carried out up to the satisfaction of the Controlling Officer.

46.5 After substantial Completion, the Contractor shall complete all outstanding minor items of repair so that the Works are fully executed in accordance with the requirements of the Contract, failing same, the Employer will undertake such completion and deduct the costs thereof from any money owing to the Contractor.

46.6 All works under the contract must be completed by period of completion mentioned in L.O.A, while portions of work as per programme settled in consultation with the Controlling Officer shall be completed by the date stipulated in the said programme. It is to be noted that time is the essence of the contract and any default on the part of the contractor to complete the work within the stipulated date/ dates aforesaid or within the time as may be extended in writing by the Controlling Officer subject to payment of liquidated damages, the employer shall have the right, without prejudice to any other clauses, to terminate the contract forthwith and to take possession of the balance work/ materials and have the same allotted to any other agency and the contractor shall be liable to compensate the loss that may be occasioned to the employer on the account. Any letter in writing by the Controlling Officer shall be treated as conclusive on behalf of the employer.

47. CARE OF WORKS

47.1 The contractor shall be responsible for the care, custody and maintenance of the Work or any part thereof from the date of commencement of the work until the date of completion of the work pursuant to the provisions of the contract and shall make good at its own cost any loss or damage that may occur to the work or the relevant part thereof from any cause whatsoever except force majeure risks during such period as per instruction of the Engineer-in-Charge/ Controlling Officer, so that at completion the work shall be in good order and condition.

47.2 The contractor shall also be liable for any loss or damage to the work caused by him or his representative in the course of any work or operation carried out by him for the purpose of completing any outstanding work.

48. FORCE MAJEURE RISKS

48.1 DEFINITION

48.1.1 For the purposes of this Contract, "Force Majeure" means an event which is beyond the reasonable control of a Party, is not foreseeable, is unavoidable, and which makes a Party's performance of its obligations hereunder impossible or so impractical as reasonably to be considered impossible in the circumstances, and subject to those requirements, includes, but is not limited to, war, riots, terrorism, civil disorder, Pandemic situations as declared by statutory authority, earthquake, fire, explosion, storm, flood or other adverse weather conditions, strikes, lockouts or other industrial action (expect where such strikes, lockouts or other industrial action are within the power of the Party invoking Force Majeure to prevent), confiscation or any other action by Government agencies.

48.1.2 Force Majeure shall not include (i) any event which is caused by the negligence or intentional action of a Party or such Party's Experts, Sub-consultants/ Sub-contractors or agents or employees, nor (ii) any event which a diligent Party could reasonably

have been expected both to consider at the time of the conclusion of this Contract, and avoid or overcome in the carrying out of its obligations hereunder.

48.1.3 Force Majeure shall not include insufficiency of funds or failure to make any payment required hereunder.

49. NO BREACH OF CONTRACT

The failure of a Party to fulfil any of its obligations hereunder shall not be considered to be a breach of or default under, this Contract in so far as such inability arises from an event of Force Majeure, provided that the Party affected by such an event has taken all reasonable precautions, due care and reasonable alternative measures, all with the objective of carrying out the terms and conditions of this Contract.

50. MEASURES TO BE TAKEN

50.1 A Party affected by an event of Force Majeure shall continue to perform its obligations under the Contract as far as is reasonably practical, and shall take all reasonable measures to minimize the consequences of any event of Force Majeure.

50.2 A Party affected by an event of Force Majeure shall notify the other Party of such event as soon as possible, and in any case not later than fourteen (14) days following the occurrence of such event, providing evidence of the nature and cause of such event, and shall similarly give written notice of the restoration of normal conditions as soon as possible.

50.3 Any period within which a Party shall, pursuant to this Contract, complete any action or task, shall be extended for a period equal to the time during which such Party was unable to perform such action as a result of Force Majeure.

50.4 During the period of their inability to perform the Services as a result of an event of Force Majeure, the, contractor upon instructions by the Employer, shall either:

(i) demobilize, in which case the Contractor shall be reimbursed for additional costs they reasonably and necessarily incurred, and, if required by the Client, in reactivating the Services; or

(ii) continue the Services to the extent reasonably possible in which case the Consultant shall continue to be paid under the terms of this Contract and be reimbursed for additional costs reasonable and necessarily incurred.

50.5 In the case of disagreement between the Parties as to the existence or extent of Force Majeure, the matter shall be settled according to Clause 18 of GCC.

51. EXTENSION OF TIME FOR COMPLETION OF WORK

51.1 If the work is suspended or delayed due to reasons beyond the control of the contractor, the contractor shall immediately give information in writing within 07 (seven) days to the Engineer-in-Charge/Controlling Officer for each occasion. On receipt of such notice, the Controlling Officer may verify the matter and agree to extend the completion period as may be reasonable but without prejudice to other terms and conditions of thecontract as the case may be if the reasons behind the suspension/delay of Work are found to be justified.

51.2 Any extension of completion of time as may be granted, shall not affect the validity of this contract in any manner.

51.3 An extension of time without imposition of liquidated damage, may be granted for delay in execution of work provided there is no fault whatsoever on the part of the contractor. Such extension may only be granted on the basis of application to be submitted by the contractor and he has to establish that the extension of time required by him was not due to his fault.

51.4 Causes for Extension of time for completion: The Contractor may claim an extension of the time for completion if he is/ will be delayed in completing the Works by any of the following causes:

a. Suspension of work ordered in writing by the Employer
b. The employer's risks, if any, when they constitute the sole reason for the delay in completion of the work
c. Delay in handover of site by the employer of any project component
d. Force Majeure Risks

52. LIQUIDATED DAMAGE (LD)

52.1 If the contractor fails to complete the work successfully within the time specified in the contract or within the extended time of completion or deserts the site then the employer shall recover from the contractor as liquidated damages a sum of 0.5% (zero point five percent) of the contract value of work for such delay for each calendar week or part thereof which shall elapse between the time prescribed or extended time extended without imposition of LD, as the case may be and the date of actual completion of the work.

52.2 The total recovery against liquidated damage shall not exceed 10% (ten percent) of the contract value of the work.

52.3 The employer may, without prejudice to any other method of recovery, deduct the amount of such liquidated damages from any money in hand due or may become due to the contractor or from the Performance BG retained by the employer. Payment of such deduction of such damages shall not relieve the contractor from his obligations to complete the work or from any other of his obligations and liabilities under the contract.

53. DEFECT LIABILITY PERIOD

53.1 The term 'defect liability period' shall mean the period of **24 (Twenty-Four)** months including the operation and maintenance period from the date of final commissioning of the project. If any defect is found within the defect liability period, the contractor shall be liable to promptly make good the defect at their own cost and responsibility

53.2 Defects/ Rectification work as notified shall have to be attended and completed satisfactorily by the Contractor within the specified date or as deemed justified by the Controlling Officer. For faithful & due fulfillment of all obligations, this defect liability period shall be covered by the Security money/Performance Bond, already submitted by the contractor.

53.3 In case the Contractor is unable to make good the defect(s) before the end of the defect liability period, the defect liability period shall be extended for as long as the defect(s) remained to be rectified.

53.4 If the contractor has not corrected a defect within the time specified, the employer will assess the cost of having the defect corrected by themselves or through their assignees and shall then be entitled to recover all sums paid for such corrections of the work and the contractor will be liable to pay that amount.

53.5 After completion of defect liability period, and on completion of satisfactory rectification of defects, if any, reported within the defect liability period and on receipt of the application from the contractor the Controlling Officer of the work shall recommend for refund of the Security money/Performance Bond.

54. SUSPENSION

54.1 The employer may, by notice order the contractor to suspend performance of any or all of its obligations under the contract. Such notice shall specify the obligation of which performance is to be suspended, the effective date of the suspension and the reasons therefore. The contractor shall there upon suspend performance of such obligation (except those obligations necessary for the care or preservation of the works) until ordered in writing to resume such performance by the employer.

54.2 During the period of suspension, the contractor shall not remove from the site any plant and equipment, any part of the work or any contractor's equipment, without the prior written consent of the employer.

55. TERMINATION OF CONTRACT

55.1 The employer, without prejudice to any other rights or remedies it may possess, may terminate the contract forthwith in the following circumstances by giving a notice of termination and its reasons therefore to the contractor.

55.2 If the contractor becomes bankrupt or insolvent, has a receiving order issued against it, compounds with its creditors, or, if the contractor is a corporation, a resolution is passed or order is made for its winding up (other than a voluntary liquidation for the purposes of amalgamation or reconstruction), a receiver is appointed over any part of its undertaking or assets, or if the contractor takes or suffers any other analogous action in consequence of debt.

55.3 If the Contractor,

a. Has abandoned or repudiated the Contract, or

b. Without valid reason failed to commence work promptly as per requirement of work or has suspended the progress of contract performance for more than **28 (twenty-eight) days** after receiving a written instruction from the employer to proceed or

c. Persistently fails to execute the contract in accordance with the contract or persistently neglects to carry out its obligations under the contract without justified reasons or

d. Refuses or is unable to provide sufficient materials, services or labour to execute and complete the work in the manner specified in the program furnished under the contract that cannot give reasonable assurance to the employer that the contractor can attain completion of the work within the time for completion or within the extended time of completion,

The employer shall have right to terminate the order after giving notice in writing to the contractor. If the contractor fails, after **14 (fourteen) days** of such notice, to proceed with the work in the manner notified, the employer shall terminate

the contract and call the contractor to take joint measurement along with the Engineer-in-Charge/ Controlling Officer for the finished portion of the work. If the contractor does not appear for a joint measurement, ex-parte measurement by the employer will be taken as final. In the case of termination of contract by the employer, the employer shall take possession of the work site and may engage other agency to complete the work. Extra cost, if incurred, to get the unfinished work done through other agency, will be realized from the contractor, from his pending bills/ security money/ other securities or jointly of the contractor. If the contract is terminated as above, the contractor shall have no claim for compensation against the employer for any loss or deterioration of any materials that he may have collected or engaged or entered into on account of the work.

55.4 Upon receipt of the order of termination under the contract, the contractor shall,

a. Cease all further work, except for such work as the employer may specify in the order of termination for the sole purpose of protecting that part of the works already executed, or any work required to leave the Site in a clean and safe condition,

b. Deliver to the employer the parts of the work executed by the contractor up to the date of termination,

c. Deliver to the employer all drawings, specifications and other documents prepared by the contractor as on the date of termination in connection with the work

d. The contractor shall withdraw his equipment, machineries if the employer permits so and clean up the site as instructed by the employer

56. INDEMNIFICATION OF THE EMPLOYER BY THE CONTRACTOR

The contractor shall keep the employer, both during and after the term of this contract, fully and effectively indemnified against all losses, damage, injuries, deaths, expenses, actions, proceedings, demands, costs and claims, including, but not limited to, legal fees and expenses, suffered by the employer or any third party, where such loss, damage, injury or death is the result of a wrongful action, negligence or breach of contract of the contractor or his representatives, including the use or violation of any copyright work or literary property or patented invention, article or appliance.

57. INSURANCE

57.1 The Contractor is required to take necessary insurance policy from empanelled *insurance agencies of WBSEDCL* (*list is given below*) in the joint name of the employer and the contractor and bear all costs towards the same for the full period of execution of Work including the defect liability period for the Total Contract Price against all loss or damage from whatever cause arising other than the risks for which the Contractor is responsible under the terms of the contract and in such manner that the employer and the contractor are covered during the period of construction of work and/or also covered during the period of defect liability for loss or damage.

Other agencies shall not be accepted.

List of empanelled agencies of WBSEDCL:

SL No 1.
To
The Head - Corporate Marketing (Kolkata)
Bajaj Allianz General Insurance Co. Ltd.
Mani square, 6th Floor, Premises- #4,
164/1 Manicktala main Rd Canal circle Rd,
Kolkata- 700054

SL No 2.

The Business Head- Kolkata Commercial
IFFCO- TOKIO General Insurance Co. Ltd.
42A, Shakespeare Sarani, 3rd Floor,
Kolkata- 700017

SL No 3.

The Sr. Divisional Manager
The New India Assurance Co. Ltd.
LCBO Kolkata-950000,
4, Mango Lane,
Kolkata-700001

SL No 4.

The Sr. Divisional Manager,
SBI General Insurance Co. Ltd.,
1st Floor, Horizon Buiding,
57, Chowringhee Road ,
Kolkata-700071.

SL No 5.

The Area Head
HDFC ERGO General Insurance Co. Ltd.
Metro Towers, 10th Floor,
1 Ho Chi Minh Sarani,
Kolkata-700071.

SL No 6.

The Business Head - Corp. Solution
ICICI Lombard General Insurance Co. Ltd.
3rd Floor, Block-B, J K Millennium Centre,
46 D, Chowringhee Rd,
Kolkata- 700071.

SL No 7.

The Corporate Relationship Head- Kolkata
Reliance General insurance co. Ltd.,
4th Floor, Thapar House ,
163, S.P.Mukherjee Road,
Kolkata- 700026

SL No 8.

The Sr. Divisional Manager,
TATA AIG General Insurance Co. Ltd.,
2nd Floor, Constantia Building,
11, Dr. UN Bramhachari Road,
Kolkata-700017.

57.2 The contractor on awarding of the contract shall arrange, secure and maintain all insurances as may be pertinent to the work and obligatory in terms of law in force to protect the interest of the Employer against all perils. The contractor shall be solely responsible to maintain adequate insurance coverage at all times during the period of contract.

57.3 Whenever required by the employer, the contractor shall produce the policy or the policies of insurance and the receipts for payment of the current premium. The contractor shall submit the insurance / policy document to the employer for verification of the same before finalization.

57.4 The contractor is required to take insurance cover under the Employee Compensation Act, 1923 amended from time to time from empanelled insurance company of WBSEDCL and pay premium charges thereof.

57.5 If the contractor shall fail to effect and keep in force the insurance referred to above or any other insurance which may be required to effect under the terms of the contract, then and in any such case the employer may effect and keep in force any such insurance and pay such premium(s) as may be necessary for that purpose and deduct the amount so paid by the Employer from any amount due or may become due to the contractor or recover the same from performance security.

57.6 The contractor shall at all times indemnify the employer against all claims, damages or compensation under the provision of Payment of Wages Act- 1936, Minimum Wages Act-1948, Employer's liability Act-1938, Industrial Disputes Act-1947 and Maternity Benefit Act-1961 or any modifications thereof or any other law in force or as consequence of any accident or injury to any workman or other persons in or about the works, whether in the employment of the contractor or not, against all costs, charges and expenses of any suit, action or proceedings arising out of such incident or injury and against all sum or sums which may with the consent of the contractor be paid to compromise or compound any such claim. Without limiting his obligations and liabilities as above provided, the contractor shall insure against all claims, damages or compensation payable under the Employee Compensation Act 1923 or any modification thereof or any other law relating thereto.

57.7 It will be the responsibility of the Contractor to lodge, pursue and settle all claims with the insurance company in case of any damage, loss, theft, pilferage or fire during execution of Contract and Employer shall be kept informed about it. The Contractor shall replace the lost/damaged materials promptly irrespective of the settlement of the claims by the underwriters and ensure that the work progress is as per agreed schedules. The losses, if any, in such replacement will have to be borne by the Contractor. The insurer shall settle the claim after availing No Objection Certificate (NOC) i.r.o. 'Third Party Liability Insurance' from the employer.

57.8 Unless otherwise provided in the Contract, the Contractor shall prepare and conduct all and any claims made under the policies effected by it, and the monies payable by any insurers under all the insurance except Third Party Liability Insurance and Workmen Compensation Policy, shall be paid to the Employer's account and such amounts paid shall be apportion between the Employer and the Contractor in accordance with the respective responsibilities under the Contract. Any immediate settlement at the project site, that may arise, shall be taken care of by the contractor alone. Upon receiving the insurance amount for the said incident, the employer will refund the amount to contractor's account after observing required formalities.

57.9 To the extent specified below, the Contractor shall at its expense take out and maintain in effect, or cause to be taken out and maintained in effect, during the performance of the Contract, the insurances set forth below in the sums and with the deductibles and other conditions specified in the said Appendix.

57.9.1 TRANSIT INSURANCE POLICY FOR INDIGENOUS EQUIPMENT

Loss or damage occurring while in transit from the Contractor's or Subcontractor's or Supplier's end until arrival at the Site including loading and unloading, stacking at site i.r.o. the Plant and Equipment including spare parts and the Contractor's Equipment shall be insured. This policy shall cover 'ALL RISKS' including intermediate storage, if any. Inland Transit Clause (ITC) 'A' along with war and Strike Riots & Civil Commotion (SRCC) extension cover shall be taken.

If during the execution of Contract, the Employer requests the Contractor to take any other add-on cover(s)/ supplementary cover(s) in aforesaid insurance, in such a case, the Contractor shall promptly take such add-on cover(s)/ supplementary cover(s) and the charges towards such premium for such add-on cover(s)/ supplementary cover(s) shall be reimbursed to the Contractor on submission documentary evidence of payment to the Insurance company.

The Contractor shall take the policy in the joint names of Employer and the Contractor. The policy shall indicate the Employer as the beneficiary. However, if the Contractor is having an open policy for its line of business, it should obtain an endorsement of the open cover policy from the insurance company indicating that the dispatches against

this Contract are duly covered under its open policy and include the name of the Employer as jointly Insured in the endorsements to the open policy.

Amount	Deductible Limits	Parties Insured	From	To
110% of Ex-work Price of all the Plant and Equipment to be supplied from within India plus GST, if additionally payable.	As per IRDA Norms	Contractor & Employer	Contractor's or Subcontractor's or Supplier's end	Project's warehouse store at final destination

57.9.2 ERECTION ALL RISKS INSURANCE

a) The policy should cover all physical loss or damage to the facility at site during storage, erection and commissioning covering all the perils as provided in the policy as a basic cover and the add on covers as mentioned below.

- Earthquake
- Terrorism
- Extended Maintenance cover for Defect Liability Period
- Other add-on covers viz., 50-50 clause, 72 hours clause, loss minimization clause, waiver of subrogation clause (for projects of more than 100 crore), cover for offsite storage / fabrication (over 100 crore).

The policy shall be extendable following Extension of time clause. However, any additional premium required for such extended time that may be allowed by the employer due to contractor's fault (irrespective of imposition of Liquidated damage) shall not be reimbursed to the contractor by the employer.

Amount	Deductible Limits	Parties Insured	From	To
105% of Ex-work Price of all the Plant and Equipment to be supplied from within India plus GST, if additionally payable and 100% of erection price component	As per IRDA Norms	Contractor & Employer	Commence-ment of work at site	End of Defect Liability Period

b) THIRD PARTY LIABILITY INSURANCE

Third Party Liability cover with cross Liability within Geographical limits of India as an Add-on cover to the basic Erection All Risks (EAR) cover shall be provided.

The third party liability add-on cover shall cover bodily injury or death suffered by third parties (including the Employer's personnel) and loss of or damage to property (including the Employer's property and any parts of the Facilities which have been accepted by the Employer) occurring in connection with supply and installation of the Facilities.

Amount	Deductible Limits	Parties Insured	From	To
10% of the project value for single occurrence/ multiple occurrences in aggregate during the entire policy period.	As per IRDA Norms	Contractor/ Sub-contractor	Commencement of work at site	End of Defect Liability Period

c) All equipment and materials being supplied by Employer for the erection (as per Technical Specification) shall be kept insured by the Contractor against any loss, damage, pilferage, theft, fire, etc. from the point of unloading up to the time of taking over by Employer including handling, transportation, storage, erection, testing and commissioning etc. The premium paid to the Insurance Company by the Contractor for such insurance shall be reimbursed by Employer to the Contractor. The Contractor shall obtain competitive quotation for such insurance and shall take prior approval from Employer before taking the insurance. The insurable value of the equipment being supplied by Employer shall be intimated to the Contractor for arranging the insurance. The cost of such insurance premium shall be reimbursed to the Contractor for Employer Supplied Materials (ESM) for which the insurer shall be finalized by the Contractor.

57.9.3 AUTOMOBILE LIABILITY INSURANCE

The Contractor shall ensure that all the vehicles deployed by the Contractor or its Subcontractors (whether or not owned by them) in connection with the supply and installation of the Facilities in the project are duly insured as per RTA act. Further the Contractor or its Subcontractors may also take comprehensive policy (own damage plus third party liability) of each individual vehicles deployed in the project on their own discretion in their own name to protect their own interest.

57.9.4 WORKMEN COMPENSATION

a. Workmen compensation shall be governed in accordance with the statutory requirements applicable in India. The Contractor shall ensure that all the workmen employed by the Contractor or its Subcontractors for the project are adequately covered under the policy.

b. The policy may be project specific covering all men of the Contractor and its Subcontractors. The policy shall be kept valid till the date of Final Commissioning of the project.

   Alternatively, if the Contractor has an existing 'Workmen Compensation Policy' for all its employees including that of the Subcontractor(s), the Contractor must include the interest of the Employer for this specific Project in its existing 'Workmen Compensation Policy'.

c. Without relieving the Contractor of its obligations and responsibilities under this Contract, before commencing work, the Contractor shall insure against liability for death of or injury to persons employed by the Contractor including liability by statute and at common law. The insurance cover shall be maintained until all work including remedial work is completed including the Defect Liability Period. The insurance shall be extended to indemnify the Principal for the Principal's statutory liability to persons employed by the Contractor.

d. The Contractor shall also ensure that each of its Subcontractors shall effect and maintain insurance on the same basis as the 'Workmen Compensation Policy' effected by the Contractor.

57.9.5 CONTRACTOR'S PLANT AND MACHINERY (CPM) INSURANCE

The Employer (including without limitation any consultant, servant, agent or employee of the Employer) shall not in any circumstances be liable to the Contractor for any loss of or damage to any of the Contractor's Equipment or for any losses, liabilities, costs, claims, actions or demands which the Contractor may incur or which may be made against it as a result of or in connection with any such loss or damage.

57.9.6 The Employer shall be named as co-insured under all insurance policies taken out by the Contractor, except for the 'Third Party Liability', 'Workmen Compensation Policy' Insurances. The Contractor's Subcontractors shall be named as co-insured under all insurance policies taken out by the Contractor except for the 'Transit Insurance Policy For Indigenous Equipment', 'Workmen Compensation Policy' Insurances. All insurer's rights of subrogation against such co-insureds for losses or claims arising out of the performance of the Contract shall be waived under such policies.

57.9.7 The Contractor shall ensure that, where applicable, its Subcontractor(s) shall take out and maintain in effect adequate insurance policies for their personnel and vehicles and for work executed by them under the Contract, unless such Subcontractors are covered by the policies taken out by the Contractor.

58. EXPIRATION OF THE CONTRACT

Unless terminated earlier pursuant to Clause 55.3 hereof, this Contract shall be terminated when, pursuant to the provisions hereof, the Work have been completed and all the payments on account of the Work have been made.

59. EARNEST MONEY DEPOSIT

Mode of submission of EMD and the conditions for forfeiture of EMD are stated in clause no. 18 & 19 of ITB Respectively.

60. EQUIPMENT AND MACHINERIES

For timely completion of the work the contractor must have to deploy all necessary equipment, tools & tackles, machineries and adequate shuttering to execute the work at a time to perform all works simultaneously as per requirement of the employer.

61. PRICE ADJUSTMENT

For this Engineering, Procurement and Construction (EPC) Contract, the contract price shall be deemed to be fixed up to the end of schedule construction period as mentioned in this tender.

However, if any extension of time is allowed by the employer for delay not attributable on part of the contractor, price adjustment will be admissible only for the unexecuted portion of Civil work i.r.o. scope of work mentioned in Clause no. 5.2 of GCC following the prevailing price indices as published by the relevant Ministries of Government of India.

Unexecuted work to be identified from the Mile stones of the approved work schedule for delay analysis.

The formula for Price revision/adjustment is appended below.

i) Materials:

$V_M = (60/100) \times [0.88V – (C+S)] \times (WI-WI_O)/WI_O$

Where V_M= Variation in material cost, i.e. increase or decrease in the amount of rupees to be paid or recovered.

V = Value of work done during the period under reckoning.

C = Cost of the cement, if any issued by the owner, used in the work (cost shall be on the basis of recovery rates as applicable)

S = Cost of steel, if any issued by the owner, used in the work (cost shall be on the basis of recovery rates as applicable).

WI = Average all India wholesale price Index for all commodities for the period under reckoning as published in the R.B.I. Bulletin.

WI_O = All India wholesale price Index for all commodities as Published in the R.B.I. Bulletin for the month preceding the month of the bid submission beginning date.

ii) Labour:

$V_L = (30/100)\times[0.88V-(C+S)]\times (L-L_O)/L_O$

Where V_L= Variation in labour cost, i.e. increase or decrease in the amount of rupees to be paid or recovered.

C = Cost of the cement, if any issued by the owner, used in the work (cost shall be on the basis of recovery rates as applicable)

S = Cost of steel, if any issued by the owner, used in the work (cost shall be on the basis of recovery rates as applicable).

L = Average all India consumers price Index for industrial Labour (CPI-IW) declared by Labour Bureau, Govt. Of India as published in the R.B.I. Bulletin during the period under reckoning.

L_O = All India consumers price Index No. for industrial workers declared by Labour Bureau, Govt. Of India as published in the R.B.I. Bulletin for the month preceding the month of the bid submission beginning date.

iii) POL:

$V_{POL} = (10/100)\times[0.88V-(C+S)]\times (D-D_O)/D_O$

Where V_{POL} = Variation of POL cost, i.e. increase or decrease in the amount of rupees to be paid or recovered.

C = Cost of the cement, if any issued by the owner, used in the work (cost shall be on the basis of recovery rates as applicable)

. S = Cost of steel, if any issued by the owner, used in the work (cost shall be on the basis of recovery rates as applicable).

D = Average Diesel price of I.O.C's authorised outlet at Siliguri during the period under reckoning.

D_O = Diesel price of I.O.C's authorised outlet at Siliguri as on date of the submission of Bid for the month preceding the month of the bid submission beginning date

The following prices shall be subject to adjustment during the performance of the contract to reflect changes in the cost of material components in accordance with the price adjustment formulae stated hereunder:

i) Contract price of supply of goods as per price schedule (except marine/ air freight & marine/ air insurance).

All other components of Contract price shall be 'firm' and not subject to any price adjustment.

The price adjustment formulae referred to above shall be invoked by either party subject to the following further conditions:

a) As a rule no upward price adjustment shall be allowed for the periods of delay for which Contractor is responsible. Owner shall, however, be entitled to any reduction in the prices during the delayed period.

b) In case of delay in deliveries and completion periods for onsite erection, testing and commissioning of goods due to force majeure conditions price adjustment in Contract price of supply of goods, on site erection cost would be granted and specific mention in this regard will be made in time extension letter.

c) The total adjustment of Contract price component for which price adjustment is allowed under this clause shall be subject to a ceiling of plus or minus 10% (Ten percent).

d) Price adjustment will be admissible only if the resulting increase or decrease of each component is more/ less than two percent (02 %) of the Contract price only for that particular component.

e) Price adjustment shall apply only for work carried out within the stipulated time or extension granted by the owner. Price escalation shall not apply to the work carried out beyond the stipulated time for reasons attributable to the contractor.

f) The bidder shall indicate in his bid the value of different indices with suffix "0" as per RBI Bulletin included in price adjustment formulae, the month/ date to which the said value is applicable.

Bidder must support its bids with proof of published price indices as per RBI Bulletin for the month proceeding the month of the bid submission beginning date. In case publication is in language other than English, the publication must be supported by an English translation thereof certified by an official translator.

g) To the extent that full compensation for any rise or fall in prices to the contractor is not covered by provisions of this or other clauses in the contract, the unit rates and prices included in the contract shall be deemed to include such difference.

FORMULA FOR ADJUSTMENT PRICE FOR SUPPLY OF GOODS

a) For supply of Mechanical Equipment and associated mandatory spares.

$$\Delta P = P_0 \left[0.15 + 0.55 \frac{S_1}{S_0} + 0.3 \frac{L_1}{L_0}\right] - P_0$$

b) For supply of Electrical Equipment and associated mandatory spares.

$$\Delta P = P_0 \left[0.15 + 0.45 \frac{S_1}{S_0} + 0.1 \frac{C_1}{C_0} + 0.3 \frac{L1}{L_0}\right] - P_0$$

Where:

P_0 – Contract price for each relevant item as per the price schedule.

ΔP - Adjustment amount payable to the contractor.

S_0 –The Wholesale Price Index (WPI) for 'Ferrous Metals' published by Office of Economic Adviser, Ministry of Commerce and Industries, Govt. of India, for the month preceding the month of the bid submission beginning date.

S_1- The Wholesale Price Index (WPI) for 'Ferrous Metals' published by Office of Economic Adviser, Ministry of Commerce and Industries, Govt. of India, for the month in which the 2/3 rd of the period from the effective date to the date of dispatch falls.

C_0 - The Wholesale Price Index (WPI) for 'Copper Products (other than wire)' published by Office of Economic Adviser, Ministry of Commerce and Industries, Govt. of India, for the month preceding the month of the bid submission beginning date.

C_1 –The Wholesale Price Index (WPI) for 'Copper Products (other than wire)' published by Office of Economic Adviser, Ministry of Commerce and Industries, Govt. of India, for the month in which the 2/3rd of the period from the effective date to the date of dispatch falls.

L_0 – All India average Consumer Price Index number published by Labour Bureau, Govt. of India for Industrial Workers, for the month preceding the month of the bid submission beginning date.

L_1- All India average Consumer Price Index number published by Labour Bureau, Govt. of India for Industrial Workers, 3 months prior to date of shipment.

c) For Generator Transformers and other transformers

For supply, IEEMA formula as per IEEMA / PVC / POWER / 2003 effective from 1st June 2003 for Generator Transformers or any amendment thereof shall be applicable for Price Adjustment.

The claim shall be supported by the copy of the official document to establish the correctness of the same.

$$\Delta P = P_0 \left[0.15 + 0.30\frac{S_1}{S_0} + 0.55\frac{L1}{L_0}\right] - P_0$$

Where

ΔP = Adjustment amount payable to the Contractor.

P_0 = Contract price for each relevant item as per the price schedule.

S_0 –The Wholesale Price Index (WPI) for 'Ferrous Metals' published by Office of Economic Adviser, Ministry of Commerce and Industries, Govt. of India, for the month preceding the month of the bid submission beginning date.

S_1- The Wholesale Price Index (WPI) for 'Ferrous Metals' published by Office of Economic Adviser, Ministry of Commerce and Industries, Govt. of India, for the month in which the 2/3rd of the period from the effective date to the date of dispatch falls.

L_0 – All India average Consumer Price Index number published by Labour Bureau, Govt. of India for Industrial Workers, for the month preceding the month of the bid submission beginning date.

L_1- All India average Consumer Price Index number published by Labour Bureau, Govt. of India for Industrial Workers, 3 months prior to date of shipment.

d) Escalation formula for adjustment of prices for Hydro-Mechanical works such as Gate, Penstock, etc.

This formula for Price Adjustment shall be as follows:

$$CC_1 = CC_0 \left(m \frac{M_I}{M_0} + s \frac{S_I}{S_0} + l \frac{L_I}{L_0} + d \frac{D_I}{D_0}\right)$$

Where,

CC_1 = Gross value of RA Bills due to Price Escalation

CC_0 = Gross value of R/A Bills passed for payment by WBSEDCL

$CC_1 - CC_0$ = Price escalation payable

"m" = Co-efficient of materials electrode cost of work = 0.10

"s" = Co efficient of steel content in the cost of work = 0.40

"l" = Co efficient of Labour (for Industrial workers) content in the cost of work = 0.40

"d" = Co efficient of High Speed Diesel Oil content in the cost of work = 0.10

M = Pricelist as applicable of bid for Electrodes.

S = Price list as applicable of bid for plates

L = Minimum wages payable to workers as applicable at the project site as notified by Government of West Bengal.

D = High Speed Diesel Oil Price

Sub-Script

"0" = Index/ Base Price as applicable for the month preceding the month of the bid submission beginning date.

"I" = Index/Base Price as applicable for the Invoice Month.

The certified price list in support of the prices, prevailing for petrol, HSD and lubricants and also the monthly RBI Bulletin in support of price indices may be furnished to the EIC.

Note:

I. The claim shall be supported by the copy of the official document to establish the correctness of the same.

II. For the purpose of this date of shipment shall mean scheduled date of despatch or actual date of despatch whichever is earlier. The scheduled date of despatch shall be governed by the accepted PERT Net work for supplies wherein supply schedule for main equipment will be indicated.

Price adjustment will be admissible only if the resulting increase or decrease of each civil component is more/ less than two percent (02 %) of the Contract price only for that particular component.

No price increase will be allowed during the scheduled completion period (i.e. First 30 months) and for any delay for which extension of time is awarded by the Employer under the terms of the Contract with the imposition of L.D. as well as delay due to Force Majeure. The Employer will, however, be entitled to any price decrease occurring during such periods of delay.

The total adjustment (plus or minus) shall be subjected to a ceiling amount of Ten Percent(10 %) of the unexecuted value of total Civil work for delay not attributable on part of the contractor.

62. CONSTRUCTION POWER

The facility for required construction power at 11 kV voltage level for Lodhama II Small Hydro-electric Power Plant shall be arranged by the contractor at his own cost as per prevailing rate of WBSEDCL. The employer may, upon receiving contractor's request in writing, assist the contractor for getting such connection. The charges of installation as well as energy consumed by the contractor for the work shall be paid by the contractor to WBSEDCL on actual basis.

63. PROVISIONAL SUM

A provisional sum of **Rs. 2.00 Cr. (Rupees Two crore only)** has been kept in the schedule of Civil Item in BOQ sheet over the estimated Project Cost as non-competitive item to cover unforeseen matters excluding Force Majeure Issue as decided by E.I.C. The aforesaid sum will also cover Price Adjustment under Clause No.61 of GCC for execution of Civil work (for unfinished portion, delay not attributable to the contractor) of the Contract. Work Schedule and Price Estimates for assessing the work related to unforeseen matter (excluding Force

Majeure Issue) will be done as per prevailing WBPWD Schedule of Rates for Civil and Road Work, as the case may be, for taking up of the said work subject to approval of the E.I.C.

64. WORK UNDER PANDEMIC SITUATION

The contractor shall have to follow different Guidelines/ Safety Measures as issued time to time by the Concerned Authority in Government at different work sites and work related front under present Scenario or any adverse situations as prevail during Construction of the Project in the context of outbreak of COVID-19.

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1 INTRODUCTION

1.1 GENERAL

The Lodhama II Small Hydro-Electric Project (LSHP-II) is envisaged as a run-of-the river scheme, for utilization of flowing water in Lodhama Tunnel during residual period (monsoon period) for development of power potential in the head reaches of Lodhama River which is a tributary of River Rammam. The diversion site is located in Adit-II of Lodhama Tunnel of existing Rammam Hydel Project, Stage-II. The powerhouse is located left bank of Lodhama River near Lodhama Township having the latitude of 27^0 06' 19" N and longitude of 88^0 07' 23" E. The project with an installed capacity of 10 MW (2 x 5 MW) is expected to generate 29.066 GWh in a 90% dependable flow data which would help in adding to the Hydro Power which is the need of the North Bengal system of Eastern Regional Grid.

1.2 BACKGROUND

The Rammam Hydel Project Stage-II has been commissioned in the year 1995 with an installed capacity of 4 x 12.75 MW, harnessing total 51 MW. The hydro project has been conceived utilizing the discharge of Rammam River and Lodhama Khola.

At present the project have been commissioned by diverting the Rammam water and Lodhama water through drop type weirs and then through 'D' shaped tunnels to a common Fore-bay which was designed to cater the discharge of river Rammam and Lodhama. Two nos. of Penstock have been constructed connecting fore-bay and power house to feed four generating machines with a capacity of 12.75 MW each. The design discharge of each machine is about 3.114 cumec. The entire system from Fore-bay, Penstock, and Power House to Tail Race is designed to cater combined flow of Rammam and Lodhama.

Earlier during conceiving of Rammam Hydel Project Stage-II, diversion of Lodhama water towards the common Fore-bay could not be taken up due to some unavoidable circumstances. Thus the project was commissioned with the discharge of Rammam River only. After carrying out geological studies, a tunnel of about 4.523 km long was designed and constructed to divert the water of Lodhama River from its originally conceived location and connected with Rammam Tunnelby punching it, at the upstream of common Fore-bay. This project has been named as Lodhama Interconnection scheme (LICS) which augmented the generation of Rammam Hydel Project Stage-II considerably during non-monsoon period (November-June).

The new proposed Lodhama-II SHP of 10MW(2 x 5 MW) Installed Capacity, will use the frontal network (upto junction point of Adit-2 with LICS Tunnel) of Lodhama Interconnection scheme (LICS) by harnessing the discharge of Lodhama Khola during monsoon period (04 months) (July – October).

1.3 LOCATION AND ACCESS

The entire project area is well connected by a network of PUCCA ROADS. The headworks can be approached by access roads Siliguri-Rammam via Mirick-Sukhiapokhri- Manebhanjan or Siliguri- Kerseong-Ghoom- Sukhiapokhri- Manebhanjan. The nearest broad gauge railway station is New Jalpaiguri (NJP). Approximate Road distance from NJP Railway Station to Ghoom via NH-55 is 78 km and that from Ghoom to Lodhama by all weather road is 60 km. The nearest airport for the project is Bagdogra.

2 PROJECT COMPONENTS

Following are the major components needed to complete the network:

a. Civil works

- Transfer structure with suitable hydro-mechanical system
- Water Conductor system from junction point of Adit-2 with LICS Tunnel
- Water Conductor system from Adit-2 outlet to fore-bay
- Fore-bay
- Spillway and escape channel
- Surface Penstock
- Surface Power House
- Tail race Channel

b. Hydro-Mechanical items

- Transfer Structure Gate
- Penstock Gate
- Silt flushing Valve
- Trash rack
- Penstock pipe
- Tail Race channel gate

c. Electro-mechanical Items

- Pelton Turbine (Horizontal Shaft)
- Synchronous Generator
- 11 kV Indoor Switchgear
- Station Auxiliary Transformer
- 11 / 33 kV Step-up Transformer
- EOT Crane
- Electrical Auxiliaries
- Mechanical Auxiliaries

- 33 kV Outdoor Switch Yard
- Tail Race Channel

3 GEOLOGY

The Lodhama II project lies in lower Himalayas, consisting of Pre-Tertiary varied rock types belonging to different tectono-stratigraphic units. The areas fall within the Darjeeling group of Darjeeling-Sikkim Himalaya. Darjeeling gneiss are exposed in the basin including the entire stretch of Project Component. The rocks exposed in the project area are predominantly granite gneiss/ Biotite Gneiss. Most of the area is covered with slope wash material, comprising of boulders of Granite gneiss mixed with sandy /loamy soil. The bidder shall follow the Geological and Geotechnical report enclosed herewith this bid for assessment of extent of the work during bid preparation and at the time of execution of this project. However the contractor shall have to take up construction stage Geological and Geotechnical investigation to ascertain actual ground condition for Design Engineering and Construction Purposes.

4 HYDROLOGY

The Lodhama Khola has its origin in Tonglu Phatkedonda range having an altitude of about 3050 M. The Catchment area is rugged in nature with rocky slopes and at places covered with dense mixed forest. The river flows through dense forest range in the catchment area up-stream of intake area. The top range of the catchment area also remains covered with snow for a portion of the year which melts during summer. Lodhama Khola is a perennial source of water and ultimately join with Rammam River at the downstream of existing power house of the Rammam HEP (Stage-II) at an RL of nearly 870 M. This river passes through a steep gradient and also receives a good quantum of annual rainfall within its catchment area.

The total catchment area of Lodhama Khola at its intake point is about 60 Sq. Km. The average rainfall is calculated out considering the rainfall data from 1963 to 1976 and found to be in the order of around 2500 mm.

5 ENVIRONMENTAL IMPACT

Based on the preliminary assessment of environmental issues, it is envisaged that the project is likely to entail minor environmental impacts. However, these can be ameliorated to a large extent by implementing appropriate mitigative measures. There is no submergence of forest and cultivated lands due to construction of any components of the scheme. The infrastructural facilities for the scheme and its construction and maintenance staff will not cause any adverse effect on the environment.

VOL – 5- SPECIAL CONDITIONS OF CONTRACT

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1 SUB-CONTRACTING

Subject to **Cl. No. 8 of GCC**, the contractor shall propose sub-contractor / vendor / manufacturer for individual item / equipment / system for electro-mechanical works during detailed engineering stage.

Final make shall be approved by the employer during detailed engineering stage based on the performance certificates submitted by the contractor. For approved makers list of WBSEDCL for various components, the bidders are requested to go through **Chapter – 21** of **Volume – 6: Part – III**: Technical Specifications.

The contractor shall submit Performance Certificates issued to the proposed manufacturers by the respective employer for similar kind of job. The contractor shall also furnish documents in support of supply, delivery of similar equipment / system indicating thereon names of the organization, quantity ordered and quantity supplied along with their submission after placement of LOA. Non-submission of the same will be liable for rejection of the proposed manufacturers.

The Sub-contractor / Vendor:

i) Should be an ISO certified company.

ii) Should have manufactured similar equipment during the last Twenty (20) years reckoned from the date of this NIeT publication.

iii) The item / equipment / system so manufactured by the Sub-contractor / Vendor should have been in successful operation at-least at two (02) nos. of hydro power stations and/or should have successfully executed at-least two (02) comparable orders.

Note:

- Similar equipment / Comparable order is defined as 80% or higher of the size, capacity and operating condition of respective item / component to be used for this plant.
- Documentary evidence i.r.o. eligibility of the Sub-contractor / Vendor duly certified by respective ordering agency along with the duly certified complete details of the company profile shall be furnished by the Contractor.
- Sub-Contractor / Vendor needs to invariably comply with detailed technical specification covered in **Volume – 6: Part – III:** Technical Specification.

2 TEST SERVICE PERIOD

After Completion of the Facilities and Pre-commissioning, Test Service Period / Commissioning Period shall commence. During this period, Guarantee Tests (and repeats thereof) shall be conducted by the Contractor on the Facilities or the relevant part thereof to ascertain whether the Facilities or the relevant part can attain the Functional Guarantees specified in the Contract documents.

3 FUNCTIONAL GUARANTEES

a. The contractor shall declare that the facilities and all parts thereof have been installed in such a manner that the functional guarantees as specified in **Annexure – A to the SCC** for the Facilities and all parts thereof have been achieved, subject to and upon the conditions therein specified.

b. If, for reasons attributable to the contractor, the functional guarantees specified in **Annexure– A to the SCC** are not attained either in whole or in part, but the minimum level of the functional guarantees specified in **Annexure – A to the SCC** is met, the contractor shall, at the employer's option, either

i. Make such changes, modifications and/or additions to the facilities or any part thereof that are necessary to attain the functional guarantees at his cost and expense within a mutually agreed time, and shall request the employer to repeat the operational / guarantee test or,

ii. Pay penalty to the employer in respect of the failure to meet the functional guarantees in accordance with the provisions depicted in **Annexure– A to the SCC**.

c. Upon the payment of such penalty by the contractor pursuant to **Cl. No. 3.b.ii of SCC** above, the controlling officer shall issue the operational acceptance certificate for the facilities or any part thereof in respect of which the penalty have been so paid.

d. If, for reasons attributable to the contractor, the minimum level of the functional guarantees specified in **Annexure – A to the SCC** are not attained either in whole or in part, the contractor shall at his own cost and expense make such changes, modifications and/or additions to the plant or any part thereof as may be necessary to meet at least the minimum level of such guarantees. The contractor shall notify the employer upon completion of the necessary changes, modifications and/or additions, and shall request the employer to repeat the operational / guarantee test until the minimum level of the guarantees has been met. If the contractor eventually fails to meet the minimum level of functional guarantees, the employer may consider termination of the contract pursuant to **Cl. No. 56 of GCC** and recover the payments already made to the contractor.

4 TRIAL RUN

- As soon as the Facilities or part thereof has passed the Commissioning Tests and operated successfully during the Test Service Period, Trial Run Period shall commence.
- The Trial Run Period shall commence immediately after completion of Test Service Period. Field Acceptance Tests thereafter shall be carried out in accordance with the specifications and as requested by the Employer under the sole responsibility of the Contractor.
- The duration of the Trial Run Period shall be Thirty (30) days for Individual units.
- After successful completion of the Operational Acceptance Tests and Trial Run Period, the Controlling Officer shall issue a Taking Over Certificate to the Contractor.
- The Controlling Officer reserve the right to delay the issuance of Taking Over Certificate until such time he is fully satisfied with the works and the defects enlisted in the Test Certificate / Completion Certificate and other defects, if any, are rectified during the Trial Run Period.

5 SPARES PARTS AND TOOLS

5.1 SPECIAL TOOLS, PLANTS AND EQUIPMENT

All special tools, plants & equipment required for assembly, erection, dismantling of various item(s) / equipment / system(s) under the scope of the supply shall be deemed to be included in the scope of supply under this contract. The contractor shall submit a list of the above special tools, plants & equipment during detailed engineering stage. No extra cost shall be paid by the employer to the contractor in this regard.

5.2 SPARE PARTS

a. A list of MANDATORY SPARE PARTS for the item(s) / equipment / system(s) is provided in **Chapter 19 of Volume 6: Part – III:** – Technical Specifications for trouble-free Operation & Maintenance of the above equipment / system for five (05) years.

Supply of mandatory spare parts along with safe storage and other related works shall be within the scope of this contract.

b. List of any additional spare parts, specifically not mentioned in the list but recommended by the manufacturer(s) of the respective item(s) / equipment / system(s) for five (05) years of trouble-free operation & maintenance, shall be submitted by the contractor during detailed engineering stage. The Contractor shall supply the same under this scope of the contract.

c. The bidders shall quote their price in the respective cell provided for mandatory spare parts in the BOQ_XXXX.xls (Financial Bid). If the bidder does not provide any price in the respective cells, it will be assumed that the cost of all mandatory spare parts to be delivered within this scope of contract has been considered by the bidder with his total quoted price. No extra cost shall be provided to the Contractor in later stage in this respect.

d. If the contractor uses any listed mandatory spare part during installation of any item / equipment / system, the same shall be supplied to the employer at his own cost prior to the final commissioning of the plant.

e. The spares shall be delivered along with the first unit of the corresponding item / equipment / system.

f. All the Spare Parts for the equipment under the contract shall strictly conform to the specification and other relevant documents.Corresponding components of all the equipment and the spares shall be of the same material, dimensions and finish i.e identical to the corresponding main equipment / component supplied under the Contract and shall be fullyinterchangeable.

g. The Quality Assurance Plan and the inspection requirement for the spare parts shall be the same as the requirements depicted for the corresponding main equipment in the technical specifications.

h. The contractor shall provide all non-proprietary manufacture's drawings, catalogues, assembly drawings and any other documents to the Employer so as to enable the Employer to identify the recommended spares. Such details shall be furnished to the Employer as soon as they are prepared but in any case not later than one (01) month prior to commencement of manufacture of the corresponding main equipment.

i. The contractor shall provide all addresses and particulars of his sub-suppliers / vendors while placing the order on sub-suppliers / vendors for any items / components / equipment covered under this Contract to the Employer and shall further ensure his vendors that the employer, if so desires, will have the right to place order for spares directly on them on mutually agreed terms based on offers of such vendors.

5.3 AVAILABILITY AND DELIVERY OF THE SPARE PARTS

5.3.1 The contractor shall confirm the long-term availability of spare parts to the employer for the full life of the equipment covered under the contract. The contractor shall confirm that before going out of production of spare parts of the equipment covered under the Contract, he shall give the Employer at least one (01) year advance notice so as to enable the employer to order his bulk requirement of spares, if he so desires. The same provision shall also be applicable to sub-contractors.

Further, in case of discontinuance of manufacturing of any spares by the contractor

and/or his sub-contractors / manufacturers, the contractor shall provide the employer, at least one (01) year in advance, full non-proprietary manufacturing drawings, material specifications and technical information including information on alternative equivalent makes required by the Employer for the purpose of manufacture / procurement of such items.

5.3.2 The contractor shall indicate in advance the delivery period of the items of spare parts, which the employer may procure. In case of emergency requirements of spares, the contractor would make every effort to expedite the manufacture and delivery of such spares on the basis of mutually agreed time schedule.

5.3.3 It is expressly understood that the final settlement between the parties in terms of relevant clauses of the contract document shall not relieve the contractor from any of his obligations under the provision of long term availability of spares and such provisions shall continue to be enforced till the expiry of twenty five (25) years period reckoned from the date of issuance of Taking Over Certificate for the whole plant / complete job by the Controlling Officer unless otherwise specified by the Employer.

5.4 WARRANTY OF SPARE PARTS

The Contractor shall warrant that all spares supplied will be new and in accordance with the Contract Documents and will be free from defects in design, material and workmanship and shall further guarantee as under:

5.4.1 For any item of spare parts specified under the scope of this contract and/or to be ordered by the employer separately based on the offer submitted by the contractor / supplier after the completion of respective works for five (05) years operational requirement of the plant which are manufactured as a continuous operation together with the corresponding main equipment / component, the warranty period shall be considered upto Defect Liability Period.

5.4.2 In case of any failure in the original component / equipment due to faulty design, material and workmanship, the corresponding spare parts that was supplied, if any, shall be replaced by the contractor without any extra cost to the Employer unless a joint examination and analysis by the Employer and the Contractor of such spare parts prove that the defect found in the original part that failed, can safely be assumed not to be present in the spare parts.

5.4.3 Such replaced spare parts shall have the same period of warranty as mentioned above provided that such replacement for the original equipment and the spare replaced are again manufactured together.

5.4.4 The discarded spare parts will become the property of the contractor as soon as they have been replaced by the contractor.

5.4.5 For the item of spare parts specified under the scope of this contract and/or the offer submitted by the contractor after completion of the respective works, as the case may be, for five (05) years operational requirement of the plant, which with the written approval of the employer, are not manufactured as a continuous operation together with the manufacture of the corresponding main equipment / component, shall be warranted for trouble free operation for a period of minimum twenty four (24) months from the date of issuance of Taking Over Certificate for the whole Plant / complete job or twenty four (24) months from the date of delivery of the material to the site, whichever happens later.

5.4.6 For any item of spares specified under the scope of this contract and/or to be ordered by the Employer separately based on the offer submitted by the contractor after the completion of respective works, as the case may be, for five (05) years

operational requirement of the plant, if used within a period of twelve (12) months from the date of issuance of Taking Over Certificate for the whole plant / complete job by the Controlling Officer or twelve (12) months from the date of delivery of the material to the site, whichever occurs later, the warranty period shall be modified as twenty four (24) months from the date they are put to use.

5.4.7 The warranty period of spare parts that are not used within twenty four (24) months from the respective dates of the delivery at site as mentioned above will, however, be subject to condition that all such spare parts being stored/ maintained/ preserved in accordance with manufacturer's standard recommended practice, if any, and the same has been furnished to the employer by the contractor.

6 WARRANTY & LIABILITY OF SOFTWARE

The Contractor's warrantee and liability for own software included in the facilities shall be limited solely to the elimination of reproducible errors and malfunction thereof, provided the software is installed on hardware supplied or authorised by the Contractor, the Contractor is granted sufficient access by the Employer and is provided with all documentation and information to trace the error. Instead of eliminating errors in the supplied version of software, the contractor shall have the right to establish an error free latest version and supply the same at no additional cost to the Employer. The newer version, so implemented, shall be compatible with the existing hardware supplied or authorised by the Contractor. With respect to standard software (e.g. UNIX, DOS, MS Words, MS Excel etc.) licensed from others, the Contractor's warranty and liability shall be limited solely to the warranties and liabilities by the licenses of such software.

7 OPERATION AND MAINTENANCE MANUALS

The Contractor shall supply six (06) copies Operation and Maintenance manuals together with as built drawings of the facilities and other required documents to the Controlling Officer. The documents shall be prepared in such a manner to enable the Controlling Officer to operate, maintain, adjust and repair all parts of the Facilities. Unless otherwise stated in the Technical Specifications, the manuals and drawings shall be in English language, and in such form and number as stated in the Contract.

8 TRAINING FOR EMPLOYER'S PERSONNEL

The Contractor shall arrange training program at site for the Employer's designated personnel after completion of the facilities, preferably during trial run period. The duration of the training program shall be minimum Twenty One (21) days. The contractor shall provide training materials at least Seven (07) days before commencement of training program. The training shall be the part of contract and no extra amount shall be paid to the Contractor for organizing the training program.

9 PROCUREMENT OF MATERIAL

The items / equipment to be used for this project including E&M equipment shall be indigenous and the respective manufacturers of various items / equipment to be used for this project shall have their own manufacturing and testing facility in India. Furthermore, the E&M contractor or sub-contractor shall be the manufacturer of major electro-mechanical equipment viz. Hydro-turbine, generator etc. The EPC contractor shall submit necessary supporting documents along with their bid for fulfilling these eligibility criteria.

ANNEXURE – A: FUNCTIONAL GUARANTEES

1. GENERAL

This Annexure provides information on

a. the Functional Guarantees referred to in **Cl. No. 3 of SCC**

b. the preconditions to the validity of the functional guarantees, either in production and/or consumption, set forth below

c. the minimum level of the functional guarantees / rejection limits

d. the penalties for failure to attain the functional guarantees

2. PRECONDITIONS

The contractor shall mention Functional Guarantees for required items (specified herein) along with the Guaranteed Technical Particulars (GTP) to be submitted by him during detailed engineering stage.

3. FUNCTIONAL GUARANTEES

Subject to compliance with the foregoing preconditions, the contractor shall guarantee the following:

a. Guarantee on Turbo-Generator Set

i. Output and Combined Weightage Average Efficiency guarantees

Within the limits of temperature rise specified in **Cl. No. 3.10 of Volume – 6: Part – III:** Technical Specifications, the **rated output of the turbo-generator set at rated head** shall be stated and guaranteed**.** The Efficiencies of the turbine and generating unit shall be as high as possible. The **Combined Weighted Average Efficiency of the turbo-generator set at rated head calculated as per Cl. No. 2.7 below** shall also be guaranteed.

In addition, the maximum outputs of the turbine at full nozzle opening at rated net head shall be stated by the contractor during detailed engineering stage. The turbine shall also be suitable, safe and give efficient performance at part loads up to 40% of rated output.

The Contractor shall furnish Hill chart, details of test methods, provisions to be made for field testing, calibration of instruments for test purpose and all other relevant details within 01 (one) month after the Award of the Contract.

ii. Combined Weighted Average Efficiency

The Guaranteed Weighted Average Efficiency (combined) of the Turbo-generator set shall not be less than 86% and shall be determined from the field efficiency test and/or factory test values of efficiency at the rated head in accordance with the following formula for the purpose of penalty and rejection limit. The field tests and/or factory tests on the turbo-generator set shall be carried out by the contractor as specified in IEC or equivalent International Code.

$$\eta_{TG_{avg}} = K_1\eta_{TG_{110}} + K_2\eta_{TG_{100}} + K_3\eta_{TG_{80}} + K_4\eta_{TG_{60}}$$

Where,

$\eta_{TG_{avg}}$ = Weighted average Efficiency of the Turbine

$\eta_{TG_{110}}$ = Efficiency of the Turbo – generator set at 110% rated output at rated Head of 354.24 m

$\eta_{TG_{100}}$ = Efficiency of the Turbo – generator set at 100% rated output at rated Head of 354.24 m

$\eta_{TG_{80}}$ = Efficiency of the Turbo – generator set at 80% rated output at rated Head of 354.24 m

$\eta_{TG_{60}}$ = Efficiency of the Turbo – generator set at 60% rated output at rated Head of 354.24 m

$K_1 = 0.1$

$K_2 = 0.6$

$K_3 = 0.2$

$K_4 = 0.1$

The outputs at various nozzle openings from full opening to lowest operational opening range shall be stated by the contractor during detailed engineering stage.

The manufacturer has to provide a calibration protocol giving the rated efficiency for a given percentage of rated electrical output. In addition to the above, the contractor shall also guarantee the maximum synchronization time with grid for evacuation under stable grid conditions.

iii. Operational Guarantee

The contractor shall provide the required operational guarantee of the complete unit as per **Cl. No. 2.13 of Volume – 6: Part – III:** Technical Specifications.

iv. Penalties

For any shortfall in weighted average efficiency (as determined on the basis described in **Cl. No. 2.7** and output in the tested values at rated head from the guaranteed values, **Penalty shall be applied at the rate of half percent (0.50 %) of total unit price of turbine and generator (including price of governing system) for each one tenth percent (0.10%) by which tested value is less than the corresponding guaranteed values**. For shortfall in weighted average efficiency & output figures by less than one-tenth percent (0.10 %), pro-rata rates will apply for computing penalty.

No tolerance shall be permissible over the test figures of rated output.

In case of efficiency, tolerance will be allowed as per relevant IEC test code.

The penalties on account of shortfall of output and Weighted Average Efficiency shall be computed separately for each unit and the total amount of penalty shall be the sum of these two. The ceiling of penalty on account of shortfall in the weighted average efficiency will be ten percent (10%) of total unit price of the turbine and generator (including price of Governing System) and the same percentage will be applicable for output also.

v. Rejection Limit

The Employer reserves the right to reject the Turbo-generator units if the test values of either weighted average efficiency as determined by **Cl. No. 2.7** or the rated output are less than the corresponding Guaranteed Values as furnished by the contractor by **Two Percent (2.00 %) or more for each case of output and combined Weighted Average Efficiency** after allowing tolerance (in computation of efficiency only).

vi. Rectification to meet Guarantees

In case the specified tests as per relevant IS / IEC are proved to be unsuccessful in meeting the guaranteed values, the Contractor will be given one (01) month or mutually agreed reasonable time to improve or modify the design of the turbo-generator set or to carry out rectifications etc. at his own cost and risk, so that the

guarantees are met. Extension of time with imposition of liquidated damage (LD) may be allowed for such case.

If such attempt(s) to improve / modify the design or rectify the defect / failure or any remedial action taken by the Contractor fails, the employer will have the right to impose penalty or reject the equipment, without prejudice to other terms and conditions of the contract. The Contractor shall be bound to Employer's decision in this respect.

b. Guarantee on Main Transformer

i. Guarantee on efficiency and losses

The efficiency of the main transformer, its iron loss at rated voltage and rated frequency; full load loss at 75^0C and at rated output, rated voltage and frequency shall be guaranteed as mentioned in **Cl. No. 5.8** and **Cl. No. 5.9 of Volume – 6: Part – III:** Technical Specifications.

Pursuant to **Cl. No. 5.8 of Volume – 6:** Technical Specifications, Max. no-load loss and total loss at 100% loading and at 75^0C shall be 7 kW and 70 kW respectively.

ii. Penalties

Pursuant to **Cl. No. 5.9 of Volume – 6: Part – III:** Technical Specifications, Penalties for each of Transformers shall be calculated @ Rs. 3,34,447.00 per kW for the excess of the no-load loss and @ Rs. 1,51,616.00 per kW for the load loss. For fraction of a kW, the penalties shall be applied pro-rata.

c. Guarantee on Other Item(s) / Equipment / System(s)

Various other item(s) / equipment / system(s) shall be guaranteed as mentioned in various chapters of **Volume – 6:** Technical Specifications

Vol – 6-Part-I : TECHNICAL SPECIFICATION OF CIVIL WORK

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1. PREAMBLE TO THE TECHNICAL SPECIFICATIONS

1.1 GENERAL

The following specifications are part of the requirements for the work related to the permanent and temporary civil construction work, which are to be provided by the contractor according to the stipulations of the contract. Hence, the instructions given herein form an integral part of, and are applicable to, all technical and contract documents issued for the work. Addenda to these specifications may be issued as required during bidding and construction phases.It is the intent of these specifications, together with other relevant documents issued as part of the tender and contract documents or to follow later on, to provide the contractor with complete and detailed information and subsequent instructions necessary to enable him to submit a well-planned tender, to carry out the design, and to execute properly the work prescribed. It is the intent of these specifications to establish acceptable standards of quality. Minor deviations in details due to manufacturer's standard shop process will be considered for acceptance provided that, in the opinion of the Engineer-in-Charge, the proposed substitutions are equal in quality to those specified. All deviations shall be called out in writing in the Tender, and shall be specifically indicated on the shop drawings.

All work shall be executed according to the approved construction drawings and requirements released for construction, in a professional and diligent manner, and all supplies and work shall comply with the quality requirements defined in the relevant sections of these specifications and other contract documents. The contractor shall endeavour to provide all such necessary efforts in order to comply with the intent of these specifications to the satisfaction of the Engineer-in-Charge.The contractor shall comply with all safety procedures and requirements as stipulated elsewhere in bid document.

Any activities which are not covered in this 'technical specification' but may be indicated in the design, engineering and drawings by the contractor for execution of Civil work, technical specification of them shall have to be submitted by the contractor with detail engineering and drawings to the E.I.C. for approval.

No payment shall be made by WBSEDCL to the contractor for following / maintaining 'technical specification' during execution of items of Civil work. All cost shall be considered as included in the quoted prices of the contractor.

1.2 SUBMITTALS

The contractor shall provide the Engineer-in-Charge (at least six (06) set copies and one editable soft copy or as otherwise specified along with the design report) with all submittals as requested for in these specifications and other contract documents. Although their extent shall be to the discretion of the contractor, they shall be competent enough to illustrate adequately the problem of the aspect concerned for the understanding of the Engineer-in-Charge. At any time, the WBSEDCL may call either for additional information, completion of the submittals or request the contractor not to submit some of them. The contractor shall submit these documents to the Engineer-in-Charge so that, even if not specifically expressed, reasonable time will be given to the WBSEDCL to comment or approve the submittals.

1.3 STANDARDS AND CODES

1.3.1 GENERAL

Indian standards as far as possible are referred to in these specifications. Pertinent provisions of these standards shall apply to the work, and are hereby incorporated in these specifications. If a manufacturer name strictly exists, other manufacturers' product will also be acceptable provided

the designated material or workmanship is of equivalent or better quality, as decided by the Controlling Officer and do satisfy the relevant Indian codes. All standards and codes employed or referred to, shall be the latest current issue in effect at the date 28 (twenty- eight) days prior to the tender submission date.

One complete set of standards and codes adopted for the work shall be submitted free of charge by the contractor to the WBSEDCL, 21 (twenty-one) days after the contract has come into force or upon the Engineer-in-Charge's request. Such copies shall also be available at the contractor's business domicile(s) and at site, for the use of the Engineer-in-Charge/Site Engineer.

1.3.2 INDIAN STANDARDS, CODES, LAWS AND REGULATIONS

Throughout the duration of the contract, the materials, equipment, services, design and workmanship shall conform to applicable Indian codes, standards, laws and regulations in force in India, if not otherwise specified. It is the contractor's duty to acquaint him with all available Indian codes, standards, laws and regulations related to the work in any way and he shall procure and keep at the site a copy of each of such applicable documents.

1.3.3 SYSTEM OF UNITS

The SI system of units has been used throughout these specifications and this system of units shall be used consequently throughout the duration of contract for all technical or contractual purposes.

1.3.4 DEFINITION OF TIME AND KEY DATES

The periods of time and key dates used throughout these specifications have the meanings as specified in the '*Clause No.-A.5* of Notice Inviting e-Tender (NIeT)' and '*Clause No.-1* of General Conditions of Contract (GCC)'.

2. SITE INSTALLATIONS, SERVICES AND ENVIRONMENTAL OBLIGATIONS

2.1 SCOPE OF WORK

The Design, Engineering, Drawing, Construction, testing commissioning & allied work are to be executed but not limited for the following project components:

i. ADIT-II Tunnel Repairing
ii. Water Conductor from Transfer Structure to Forebay
iii. Water Conductor from Transfer Structure to Forebay
iv. Forebay
v. Spillway Channel
vi. Penstock Support System
vii. Power House
viii. Approach Road to Power house building
ix. Tail Race Channel
x. Any other installation envisaged during construction

The detail scope of work is stipulated in clause no. 5 of GCC.

The contractor shall have to prepare design, drawings and the design reports for all the above components including necessary protection/ stability work in consideration of geological conditions and river course and submit the same (detailed design report and the drawings) six (06) sets for necessary approval of the WBSEDCL. The drawings/ reports submitted by the contractor

shall be approved by WBSEDCL tentatively within 21 days from the date of receiving of the same. The contractor after receiving approved drawings shall prepare and submit detailed construction drawings (06 sets) for all components of the work and submit the same to the WBSEDCL for approval towards construction. The WBSEDCL shall provide the tender drawings of all components of the work. No separate payment will be made for such Design & Engineering work and the contractor's quoted rates shall be inclusive of all expenditures in this regard.

The contractor shall be responsible for providing plant, equipment, materials and labour for the provision of all necessary temporary work, site installations and services required for the realization of the work under this contract without any additional cost. The contractor shall be responsible for guarding the temporary work as well as the permanent work developed through the contract until the same to be taken up by the WBSEDCL. The contractor shall be responsible for maintenance of all structure including temporary work throughout the contract period i.e. up to defect liability period without any additional cost. No payment shall be allowed to the contractor for developing and maintaining of temporary work.

The contractor shall design, furnish, set-up, maintain and operate at the Site all temporary work, site installations and contractor's equipment for his own use as specified in this section, or required by the contractor, including camps, workhops, warehouses, storage and assembly areas, all machinery, vehicles, scaffolding, equipment, water and power supply, etc.temporary work and services provided and operated by the contractor shall conform to the applicable Indian laws, regulations, standards, codes and sanitary requirements stipulated for such purpose. In addition, they shall comply fully with all Indian laws and regulations relating with environmental protection, mitigating measures for reducing environmental impacts and remedial work on completion of the work. The design, construction, operation and maintenance of the contractor's temporary work and services may be subject to inspection by the Engineer-in-Charge. The temporary site roads shall be constructed, and maintained for the various working areas, camps, facilities and other temporary work during project construction period. Obtaining necessary clearances/ permissions from various state/ central authorities for the equipment, water and power etc. shall lie with the contractor.

2.2 SUBMITTALS

Within 21 (twenty-one) days from the date of issue of the notification of award, the contractor shall submit to the Engineer-in-Charge updated layout plans showing, the locations and arrangement of all temporary work and facilities. These plans shall include but not limited to the following:

a) Camps for contractor's employees/ labourers

b) Offices, warehouses, storage areas, and medical care services

c) Water supply, sewerage, sewage treatment and disposal, power supply and illumination

d) Mechanical workshops

e) Spoil areas, borrow, quarry and stockpile areas

f) Concrete batching plants, including cement storage

g) Materials testing laboratory

h) Explosives magazines

i) Security and safety arrangements

j) Measures to comply with environmental norms and conditionality

2.3 CONCRETE AND MATERIALS PROCESSING PLANTS

The contractor shall install and erect all necessary concrete and materials processing plants of sufficient capacity to meet the planned peak requirements during construction. The plants shall be subject to approval by the Engineer-in-Charge and shall be well designed and fabricated and kept in good running order to ensure compliance with the materials quality specifications. All control and measuring equipment shall be regularly serviced and calibrated. Concrete and material processing plants shall meet all environment guidelines/conditions imposed for construction of such projects by MoEF/Govt. bodies at no extra cost to the Client.

2.4 MATERIALS TESTING LABORATORY

a) The contractor shall preferably build and equip an adequate field laboratory for the sampling and for testing of materials for concrete, steel reinforcement, earth, rock or any other materials as specified in the pertinent Sections of these specifications for smooth progress of work as per work program.

b) The laboratory shall be run by contractor's personnel experienced in sampling and testing of materials, and quality control. The laboratory facilities, sampling, testing shall be at contractor's own cost.

c) Testing which cannot be performed in the contractor's laboratory due to lack of time or equipment shall be assigned to an independent organization with prior approval of Engineer-in-charge.

2.5 CAMPS FOR CONTRACTOR'S EMPLOYEES/LABOURERS

The contractor shall be responsible for the expenses of the required land including expenses for construction of camp office(s).

2.6 POWER SUPPLY AND ILLUMINATION

Local standby generating units to prevent the interruption of work during the failure of the primary power source and capable of maintaining minimum services such as illumination, water supply, dewatering, etc., safety and security shall also be provided by the contractor.

2.7 WATER SUPPLY

The contractor shall develop and maintain two separate water supply systems at the site:

a) Service water: for general construction use, treated to the extent necessary to meet specified requirements (e.g. for concrete)

b) Potable water: for supply to all buildings and plants requiring high quality water meeting statutory requirements for drinking water

2.8 SANITATION AND SEWERAGE

All offices, workshops, laboratory and other occupied work buildings shall be provided with toilets connected to properly constructed and regularly maintained septic tank, approved by the Engineer-in-Charge. Number of users is to be assessed by the bidder. The camp sites shall be provided with a complete, properly maintained and operated sewerage system, including septic tanks, sewage treatment and disposal facilities.

2.9 FENCING AND SITE SECURITY

The contractor's offices, workshops and storage compounds, campsites and all construction areas where exclusion of unauthorized personnel is necessary for safety and security, shall be adequately fenced, gated and guarded.

2.10 INSPECTION BY THE ENGINEER-IN-CHARGE (E-in-C)

The Engineer-in-Charge or his representative(s) has/ have the right at any time to inspect any part of the contractor's temporary facilities, without any advance notification, and the contractor has to immediately rectify any contravention of the specified requirements, as opined by him/ them.

2.11 FINAL CLEAN UP

Upon the completion of work, or when the plant is completed for its function, the contractor shall dismantle and demobilize all temporary facilities erected by himself or his sub-contractor(s), and remove all debris, objectionable material, and all other refuse which may have been deposited on site during the construction period. Such materials may be deposited only in areas approved by the Engineer-in-Charge. All excavated areas shall be filled, graded and dressed in a clean and orderly condition acceptable to the Engineer-in-Charge. As far as possible, such areas should conform to the natural appearance of the landscape. No demobilization or removal of temporary facilities and equipment shall be made without prior approval of the Engineer-in-Charge.

2.12 ENVIRONMENTAL OBLIGATIONS

The contractor shall, during the whole period of the work comply fully with all Indian laws and regulations relating to environmental protection, mitigating measures for reducing environmental impacts and remedial work on completion of the work. This obligation shall extend to the construction sites themselves, all the contractor's site installations, and all quarries, borrow areas, if any and spoil tips.

Notwithstanding any specific obligations as these may be specified in prevailing Indian laws and regulations, the contractor shall at all times comply with the following particular requirements for the protection of the environment, the local population and the workers at the construction site:

a) Collect, treat, remove from site and dispose of in accordance with the regulations and to the satisfaction of the Engineer-in-charge all domestic and constructional waste and excess construction materials (both solid and liquid), fuel, chemicals and other matter

b) Not clear any areas of forest or woodland without the authority or prior written permission of the Engineer-in-charge and other statutory authorities

c) Implement specific measures as directed by state/ central environment/forest department

The contractor will send representatives to constituted project environmental monitoring committees, as instructed with the Engineer-in-charge, and will at all times comply with the requests of said committees with regard to the need for environmental or health protection measures. He will also maintain close contact with local representatives and government institutions in addressing issues arising from the construction activities.

2.13 PAYMENT FOR SITE INSTALLATION AND SERVICES

The initial mobilization costs such as purchase and transport of contractor's equipment and materials to the site, planning, designing, installing, operating, maintaining and removing of all temporary work, site installations, services and facilities specified in this section, making submittals to

the Engineer-in-Charge, recruiting and transferring staff, obtaining rights of way, statutory permits and clearances, clearing, grading and excavating in areas for temporary facilities, and any other costs involved in preparation for constructing permanent work will *not be paid separately* and the entire cost thereof shall be included in the contract price for other items of the work. No separate payment shall be made for complying with any environmental obligations required by Indian national and state laws and regulations, and/or as described in this section, and all such costs incurred by the contractor to this end shall be considered as being included in the contractor's unit prices.

3. SAFETY PRECAUTIONS

3.1 SAFETY PROGRAMME AND ITS IMPLEMENTATION

The contractor shall undertake a comprehensive safety program covering all aspects of the work.It shall comply with the standards and regulations in force in India applicable to construction safety.

The contractor shall be responsible for enforcement of the health and safety provisions for his sub-contractors to be employed at the site. All accidental occurrences with serious accident potential such as major equipment failures, contact with high-voltage lines, and exposure to hazardous materials, slides, cave-ins, etc., shall be immediately reported to the Engineer-in-Charge. The contractor shall comply fully with all applicable national and state governments' safety regulations and standards in force in India.

3.2 PERSONAL SAFETY EQUIPMENT

a) The contractor shall provide his and his subcontractor's personnel as well as the Engineer's-in-Charge representatives and visitors with appropriate personal safety equipment. The use of such equipment shall be compulsory

b) Every person entering the working area in open air or in underground shall wear a protective helmet. Every person entering into underground work shall have a battery lamp

c) The safety-toe footwear with steel caps shall be worn by all employees engaged in work having an inherent danger to the feet. Light footwear such as sandals, canvas or tennis shoes shall not be permitted for construction work

d) During the drilling work and in the areas where the employees are exposed to harmful noise levels, ear protectors shall be made available and required to wear

e) Employees engaged in work having an inherent danger of eye or face injury shall be furnished and required to wear protection glasses, goggles or masks. Where irritant or toxic substances may come in contact with the skin or clothing, employees shall be wearing the protective clothing or shall be required to apply a protective ointment by a competent physician

f) Employees working on steep slopes or otherwise subject to possible falls from levels not protected by fixed guardrails or safety nets, shall be secured by safety belts and lifelines

3.3 ILLUMINATION AND EARTHING

3.3.1 GENERAL

All working sites in the open, transit areas, excavation sites, access to tunnel etc., shall be adequately illuminated during working at night or during inadequacy of light in daytime by electrical lights as specified here in the Clause No.-2(Site Installations, Services and Environmental Obligations).

3.3.2 ILLUMINATION OF UNDERGROUND WORK

Each working face shall be brightly illuminated. The entire length of Adit tunnel shall be sufficiently illuminated with electrical light throughout the duration of construction work. The lamps shall be located @ every 50m. Each lamp shall be 40W as a minimum. The lamps shall be installed in a particular area immediately after the rock supporting measures have been completed. Electrical cables shall be well insulated, protected and firmly fixed to tunnel walls by means of adequate insulators. Lamps shall be well protected against damage. Lighting by flame is expressly forbidden in the underground.

3.3.3 EARTHING, WET WORK AREAS, CONTROL OF ELECTRIC DISCHARGES

All equipment and appliances, exposed to lightning, shall be earthed electrically, and the effectiveness of such earthing shall be periodically checked by the contractor's specialized personnel. No equipment electrically powered by more than 24 Volts shall be operated by personnel standing in water. Only air, battery-powered or hydraulic tools shall be permitted in the wet areas. Where electrical blasting will be used, equipment shall be installed to control possible electric discharges in the ground due to storms, electrical motors, etc. As soon as such discharges are noted, electrical blasting operations shall be suspended, or the detonator type changed.

3.4 MAINTENANCE OF TRAFFIC AND SAFETY ON PUBLIC ROADS

The contractor shall be responsible for the safety along the roads related to the site, and he shall take all necessary precautions for the protection of the work and the safety of the public on the roads affected by his activities. Where the work will be carried out at the site of, or close to an existing road, the contractor shall maintain the vehicular and pedestrian traffic safe at all times. If his operations can cause traffic hazards, he shall repair or fence or take such other measures for ensuring safety which are satisfactory to the Engineer-in-Charge.

Roads subject to interference by the work shall be kept open or suitable detours shall be provided and maintained by the contractor, who shall provide, erect, and maintain all necessary barricades, suitable and sufficient flashlights, flagmen, danger signals, and signs. Roads, which will be closed to traffic, shall be protected by effective barricades on which acceptable warning and detour signs shall be placed. All barricades shall be kept illuminated and all lights shall be kept on from sunset to sunrise. The contractor shall submit his weekly activities schedule and the locations of his work along the existing public roads to the authorities concerned, and obtain all necessary approvals prior to commencement of the respective work. At the road crossings or in heavy traffic locations, the contractor shall carry out the work during the working hours as directed by the Engineer-in-Charge, and after the completion of the work he shall immediately make the necessary backfill and pavement at the crossings.

3.5 SUPPLY, STORAGE AND TRANSPORT OF EXPLOSIVES

The contractor shall at an appropriate time apply to the national and state governments, police and military or other responsible authorities for all permits needed to allow him to supply, transport, and store and use the explosives required for the Work. The contractor must allow in his work program for the time needed to obtain said permits.

The contractor is responsible for proper care and handling of detonators and explosives and he shall strictly comply with the rules and regulations in force in India regarding transport, supply, storage, handling and use of explosives. The contractor shall maintain a record of supply, storage and withdrawal of all explosives. For storing the explosive, magazine house is to be built as per the rules of Explosive Dept. GOI at contractor's own cost and the same will be handed over to the WBSEDCL after completion of the defect liability period. Free passage of Engineer-in-Charge or his representative is to be allowed as when required. This record shall be made available to the

Engineer-in-Charge on request. The Engineer-in-Charge shall be promptly notified of any loss or theft of explosives. Between the magazines and the place of use, the explosives and detonators shall be transported separately in lockable metallic containers loaded on a special wagons destined for the purpose of explosives transport only. These wagons shall be painted with striking colours for easy recognition. The inside of the containers shall be lined with wood in order to prevent a direct contact of the explosive or detonators with the metal.

In exigent situation, the WBSEDCL may arrange to supply required explosive materials on the basis of availability and as per requisition of the contractor on cost recovery basis. Recovery of cost of explosive materials shall be as per prevailing rates at the time of execution of the work.

3.6 BLASTING

All blasting shall be carried out in a workmanlike and safe manner by a competent, licensed and experienced blasting engineer or foreman. No blasting shall be done without his approval. Blasting will be permitted only after adequate provisions have been made for the protection of persons, the work, and public or private property. The contractor shall be liable for all claims resulting from personal injury and damage to property and equipment that may result from its blasting operations. Any damage done to the Work or property by blasting shall be repaired by the contractor.

Blasting in the open air shall be carried out only at certain hours of the day in accordance with a schedule mutually agreed upon by the contractor and the Engineer-in-Charge. Barriers shall be erected and warning shall be given to the workers at the site and to the public immediately before blasting, so that no person will enter the danger zone until blasting is finished. Any restriction imposed on the blasting schedule to ensure safety of structures, properties and lives shall not be accepted as a basis for a claim by the contractor. Upon completion of blasting, an "all clear" signal shall be given by the responsible blasting engineer after he has satisfied himself that all charges loaded have detonated and that no delay-explosions or misfiring are to be expected. Such methods of blasting shall be employed that shock and vibration are minimized. No charging and firing will be permitted during thunderstorms and other electrical disturbances. Mats or rubber tires tied together with rope shall be used as protection from flying debris to cover the charges where blasting may expose persons or property to injury or damage.

3.7 FIRE PRECAUTION

The contractor shall provide fire fighting system for extinguishing of any fire, which could break out on the construction sites, in temporary structures, stores, residential quarters, etc. An adequate number of fire extinguishers shall at all times be available at each construction site and in each building in camps and in offices and they shall be kept in satisfactory working order. Firefighting equipment shall be of the gas, dry powder or other suitable chemical or pumped water type. Their number, type and location will be subject to the approval of the Engineer-in-Charge.

3.8 DUST ABATEMENT

During the performance of the work and any operations appurtenant thereto, the contractor shall carry out proper and efficient measures, such as sprinkling with water or other means, whenever necessary to reduce the dust nuisance, and to prevent dust which has originated from his operations from damaging crops, cultivated fields, and dwellings, or causing a nuisance to persons. The contractor will be held liable for any damage resulting from dust originating from his operations.

3.9 POLLUTION OF STREAMS AND RIVERS

The contractor shall take all possible steps to prevent pollution of streams, rivers, and other water supplies, at or in the vicinity of the site and shall comply with applicable laws, orders and regulations in force in India concerning the control and abatement of water pollution.Under no circumstances shall the sewage from the camps, or other contaminated water, be released directly into river or other natural streams or any open areas without prior treatment.

3.10 MEASUREMENT AND PAYMENT

No extra payment whatsoever will be made for the safety precautions required to be provided by the contractor and the entire cost thereof shall be included in the total contract price of the work.Any repair work or any indemnities required due to contractor's non-compliance with the safety requirements shall be at the contractor's expense. Nothing contained in these specifications shall prevent contractor from providing, at its own cost, such amount of rock reinforcement, steel ribs or other supports for ensuring safety of excavation performed under the contract, as it may consider necessary, in excess of that specified by Engineer-in-Charge.

4. SURVEYING AND SETTING-OUT WORK

4.1 EXISTING SURVEY CONTROL POINTS

Basic survey network consisting of reference points exists in the project area. The contractor shall have to complete pre-construction survey with 01 (one) meter contour interval alongwith installation of sufficient number of reference pillars as per the direction of the WBSEDCL for finalization of project alignment. Afterthe same the contractor is required to draw the relevant L-sections and cross-sections of each project component location and after getting approval on the design, engineering & drawing for the civil structures by the WBSEDCL, the contractor is required to prepare final construction drawings and submit the same to the WBSEDCL for final approval towards construction. Prior to commencing any construction work, the contractor shall undertake survey for the purpose of checking these reference data and in order to satisfy himself as to their accuracy. Should he have any objections to these data and the relevant drawings, he shall inform the Engineer-in-Charge inwriting within 15 (fifteen) days of receiving them from the Engineer-in-Charge. No extra payment will be made for the above mentioned exercise to the contractor.

4.2 OBLIGATIONS OF THE CONTRACTOR

4.2.1 GENERAL

The contractor shall perform all calculations, surveys and setting-out necessary to establish the accurate location of the structures in advance of any setting-out work associated with all principal project features, the Contractor shall submit to the Engineer-in-Charge for approval a description of the method and procedures he intends to use in establishing bench marks and base lines.

4.2.2 BENCH MARKS AND TRIANGULATION STATIONS

Permanent survey control points shall be established prior to starting the work and such permanent points shall be preserved during construction. Complete and adequate logs of all control and survey work shall be maintained as it progresses. Such logs shall be available for the Engineer-in-Charge's inspection at all times. The contractor shall protect, preserve and keep accessible the bench marks and triangulation stations of the basic survey and those provided by himself. Any damage or removal of benchmarks and stations, including such of other parties shall be prevented. Any accidental damage shall immediately be brought to the attention of the Engineer-in-Charge. It is expressly stated that the contractor will be made responsible for the damage and its

consequences.

Benchmarks shall be of stainless steel or cast iron. In softer soil, the steel bolt shall be embedded in a block of concrete of suitable size, and absolutely stable. Inscriptions shall be durable and clearly legible. Underground benchmarks shall be installed at suitable locations and adequately protected. Subordinate points may be marked by steel pipes or pegs, subject to the approval of the Engineer-in-Charge. Every newly fixed point shall be checked, as far as possible through other elements than those, which served to establish the point.

4.2.3 ACCURACY OF SURVEYING

a) Measurement of horizontal distances, elevations, angles etc. to be done with high precision Total Station instrument. Chaining with metallic tape shall be restricted to measuring of short distances and will be rejected for use in survey of traverse nets

b) Traverse nets shall be executed with the precision and as per Survey of India practice and as per IS codes

c) Levelling shall be checked by closing the loop to the initial benchmark

4.2.4 DAMAGE TO CROPS AND VEGETATION

No trees or crops of economic value existing at the site shall be damaged or removed by the contractor during survey and cross-sectioning work prior to their enumeration and evaluation.Throughout the surveying and setting-out the contractor shall work closely with the authorized local appraisers of crops and vegetation in question and shall provide them with facilities necessary for the expeditious performance of their duties.As soon as a section of work has been defined and valued, the contractor shall delineate the boundaries of the areas to be cleared by approved markings.

4.3 CHECKING OF CONTRACTOR'S WORK BY THE ENGINEER-IN-CHARGE

The survey work for fixing of levels and lines will be the responsibility of the contractor. All elements of the contractor's survey work associated with the setting-out of principal project features will be regularly checked by the Engineer-in-Charge during the course of the work, and the contractor shall provide assistance at any time as required in the performance of such control work.The contractor may be required to provide the Engineer-in-Charge with any information, readings or computations for checking.The regular checks will usually be made during work breaks, but in case of urgency, the contractor shall restrict or stop the affected work.Any checks by the Engineer-in-Charge shall not relieve the contractor of his full responsibility for the accuracy of structures and parts of them with regard to their position and dimensions.

4.4 MEASUREMENT AND PAYMENT

No extra measurement for payment or payment will be made for contractor's survey and setting-out work including the assistance in check/confirmation surveys, and the entire cost thereof shall be included in the total contract price of the work.

5. QUALITY ASSURANCE

5.1 QUALITYASSURANCE IN EXECUTION OF WORK

The contractor shall establish equip and operate a comprehensive quality assurance set-up at the site during the full period of the work. The principal responsibility and duty of this set-up shall be to ensure that all work carried out and materials produced or supplied by the contractor comply fully

with the specifications. Supervision and testing which may be carried out by the Engineer-in-Charge in no way relieves the contractor of his full responsibility for the quality of the work and for compliance with the requirements of these specifications.

5.2 CONTROL OF THE PROGRESS OF WORK

Close progress control, and the preparation of corresponding progress reports, shall be an important part of the contractor's quality control responsibilities. The contractor must at all times provide the Engineer-in-Charge with up to date information on the progress of work and must without delay bring to the attention of the Engineer-in-Charge all delays or occurrences which could lead to delay resulting in imposition of LD, if applicable. The contractor shall submit detailed monthly progress reports to the Engineer-in-Charge, in which the contractual programme for the work is updated and information is given on the quantitative completion of civil work (in the form of tables indicating the quantities of completed work).

The monthly progress reports shall give full details of any delays to work in progress or planned delays in transport to/from the site, together with detailed proposals for overcoming or preventing delays, and for regaining any lost time. The contractor shall at any time, at the request of the Engineer-in-Charge, submit detailed reports on particular matters relating to the execution and progress of the work, if such reports are required in order to assess the quality or progress of specific activities or work.

5.3 CONTRACTOR'S LABORATORIES

The contractor shall establish, equip and operate on site laboratories for the testing of the following principal construction materials:

a) Concrete, including also the testing of sand, aggregates, cement, water and admixtures

b) Steel reinforcement

c) Any site testing and/or calibration of monitoring instrument

The numbers of samples to be tested, and the timing of testing, shall be as may be given elsewhere in these specifications, or as may be instructed by the Engineer-in-Charge. The staff of the contractor's laboratory shall have proven experience in similar previous work and their qualifications shall be subject to approval by the Engineer-in-Charge. Complete records shall be kept of all laboratory tests carried out and shall be available at any time to the Engineer-in-Charge on request. The Engineer-in-Charge shall be permitted at any time and without notice to observe tests being carried out in any of the contractor's laboratories, to inspect equipment or to study results.

Testing which cannot be performed in the contractor's laboratory due to lack of time or equipment shall be assigned to an independent organization with prior approval of Engineer-in-charge.

Manufacturer's test certificates of structural & reinforcement steel and cement are to be submitted to the Engineer-in-charge.

5.4 MATERIAL DELIVERED TO SITE

The contractor's quality control staff shall keep full records of all materials delivered to site for use in the work, and of all tests made on such materials either prior to or following delivery to site.These records shall be available at all times to the Engineer-in-Charge, together with any factory testing certification.

5.5 ENVIRONMENTAL CONTROL

The contractor shall appoint an environmental control officer to be responsible for ensuring compliance with all specified obligations, laws and regulations with regard to environmental protection of the site of the project, access roads and all site installations.Details of all environmental protection activities, and of any cases of environmental damage, shall be included in the monthly progress reports.

5.6 MEASUREMENT FOR PAYMENT

No measurement for payment will be made for any of the contractor's quality control activities required in this section. All costs of these activities will be included in the unit prices for work listed in the schedule.

6. COMMISSIONING

6.1 GENERAL CIVIL WORKS

The Design, Engineering, Drawing, Construction, testing commissioning & allied work are to be executed but not limited for the following project component:

i. ADIT-II Tunnel Repairing
ii. Water Conductor from Transfer Structure to Forebay
iii. Water Conductor from Transfer Structure to Forebay
iv. Forebay
v. Spillway Channel
vi. Penstock Support System
vii. Power House
viii. Approach Road to Power house building
ix. Tail Race Channel
x. Any other installation envisaged during construction

6.2 HYDRO-MECHANICAL EQUIPMENT TO BE INSTALLED

The principal items of hydro-mechanical equipment which are to be installed in civil structures shall include but not limited to the following:

i. Penstock HM work including Air vent Pipe
ii. Stop log gates at Lodhama Inter-connection Tunnel and the proposed Water Conductor at ADIT-II Tunnel with hoisting arrangement:
iii. Vertical sliding Screw Hoist Gate at the proposed Water Conductor within ADIT-II Tunnel
iv. Trash Rack including Silt flushing valve at Forebay
v. Penstock Gate at Forebay with hoisting arrangement
vi. TRC Gate with hoisting arrangement
vii. Any other installation envisaged during construction

6.3 E&M WORK EQUIPMENT TO BE INSTALLED

The principal electro-mechanical items which will be installed under the E&M contract are listed below:

i. Hydro Turbines and associated auxiliary & ancillary equipments
ii. Generator and Auxiliaries
iii. 11 kV Indoor Switchgears and Station Auxiliary Transformer
iv. Main Transformer
v. 33 kV Power Evacuation System
vi. LT Switchgear
vii. DC System
viii. Diesel Generator Set
ix. Supervisory Control and Data Acquisition System (SCADA
x. Cables, Cable Racks & Trays
xi. Earthing system for power house and transformer yard
xii. Ventilation System for power house
xiii. 40/ 10T EOT Crane for power house with all accessories
xiv. Illumination System
xv. Communication, Supervision and Surveillance System
xvi. Fire Protection System
xvii. Mechanical and electrical workshop with required items/ equipments

6.4 TESTING OF EQUIPMENT

The contractor shall provide/arrange for the testing of all items of newly installed electro-mechanical equipment. Should this testing reveal any defects or inadequacies of the work carried out by the contractor, he will immediately act to remedy or make good these defects or inadequacies, to the satisfaction of the Engineer-in-Charge,

6.5 COMMISSIONING OF THE PROJECT AS A WHOLE

The contractor shall fully participate (and co-operate with the Engineer-in-Charge) at the time of final commissioning of the project which shall include reservoir filling, filling of the water conductor system and commissioning of individual units in the power house. The commissioning of the project shall be undertaken during the monsoon when adequate water will be available to run the installed machines at the full capacities.

6.6 MEASUREMENT FOR PAYMENT AND PAYMENT

There will be no measurement for payment for any of the activities related to equipment commissioning as well as commissioning of the project as a whole. All costs related thereto will be covered by the total contract price.

7. SURFACE EXCAVATION

7.1 SCOPE OF WORK

This section covers all surface excavation work to be performed under this contract, which shall consist of removing all existing material of whatever nature to the lines and grades shown on the construction drawings or as otherwise directed by the Engineer-in-Charge. This work shall include drilling and blasting, loading, hauling and disposal of materials in designated spoil, stockpile areas or directly as construction materials. The contractor shall also be responsible for excavation which is not specifically required for the construction of permanent work, but incidental to the installation of temporary facilities such as site roads, office buildings, campsite, construction plants, etc. Slope protection and stabilization measures, which may be needed in conjunction with surface excavation work, are covered in other sections of these specifications. The approval given by the Engineer-in-Charge to the contractor's methods and equipment shall not relieve the contractor of his full responsibility for the proper and safe execution of surface excavations, or of liability for injuries to, or death of persons, or any obligations under this contract.

7.2 LINES AND GRADES

The contractor shall be responsible for setting-out all the structures and slopes as shown on the construction drawings, in accordance with the Clause No.-4 (Surveying and Setting-out Work).All extra work and over excavation caused by improper setting-out by the contractor shall be corrected by himself immediately upon the request of the Engineer-in-Charge at contractor's cost. The final excavation grades shall be in general bed rock of required quality. However, where the final excavation grades are defined by line and grade, the contractor shall take every precaution, and use the most appropriate method of excavation, to avoid the loosening of material or the breaking of rock beyond the lines and grades shown on the construction drawings. The bottoms of all excavations shall be trimmed to line and grade. Upon request of the Engineer-in-Charge, the final 200 mm of any loose geological information in excavations where concrete is to be placed, shall be excavated by hand to avoid disturbance of the bottom.

If, for any reason, excavation is carried out beyond the lines and grades shown on the construction drawings, the contractor shall remove the excess material and take the necessary measures to restore the required lines and grades with approved backfill or concrete, as directed by the Engineer-in-Charge. Should the contractor wish to excavate beyond the limits given on the drawings for his own convenience, he may do so only with the prior approval of the Engineer-in-Charge.

7.3 SLOPES, SLIDES, GEOLOGICAL OVERBREAK AND UNSUITABLE FOUNDATIONS

If geological conditions during the performance of the work do not permit excavation of slopes as shown on the construction drawings, or where the material is unsuited to from a firm foundation for the structures, the WBSEDCL will modify the drawings accordingly or issue direct order to change the slopes and grades.If overbreaks, slides or rockfalls occur, which, in the opinion of the Engineer-in-Charge are due to improper working methods or negligence by the contractor, and the effective excavated surfaces are beyond the excavation lines shown on the construction drawings, the contractor shall remove all excessive material and, if required, place approved backfill in the excavated voids.

Excavation beyond the lines and grades shown in the construction drawings, or, as directed by the Engineer-in-Charge, is defined as overbreaks. Geologically accepted overbreak in surface excavation is defined as overbreaks which occurs while both of the following conditions are

simultaneously fulfilled:

a) The Engineer-in-Charge is informed and given an opportunity for inspection while both the cause and the extent of the overbreak are clearly visible.

b) The overbreak did not occur while, in the opinion of the Engineer-in-Charge, the contractor was using improper working methods or was otherwise negligent, and it could not have been prevented by prompt and appropriate installation of supports.

7.4 EXECUTION

The contractor shall conduct all excavation procedures and operations so as to produce the required lines and grades. The surface excavation shall be performed by any approved method using any excavating and hauling equipment suitable for the work in accordance with the submitted detailed plans and time schedule, or approved modifications thereof.

All excavated areas shall be drained to the satisfaction of Engineer-in-Charge. Any surface or subsurface water shall be satisfactorily controlled by methodsacceptable to Engineer-in-Charge. When underwater excavation is to be performed, suitable equipment shall be used.At all times during construction, contractor shall adopt excavation procedures such that at no time shall the stability of any slope be impaired. The acceptance by Engineer-in-Charge of excavation procedures or equipment shall in no way relieve contractor of his sole responsibility for safeguarding the stability of all the rock faces and slopes excavated under this contract.The contractor shall carry out periodic cleaning to ensure that no hazardous accumulation of loose material occurs on the slopes or on any berm or ledges forming part of the excavation profile. The removal of mud and slush resulting from rain or flooding of the sites shall be performed by the contractor when, in the opinion of Engineer-in-Charge, it is considered necessary to ensure the safe and effective performance of the work. Excavation for structure foundations shall be performed in the dry. Final surfaces shall be protected against damage by erosion and movement of construction equipment. Any damage caused shall be repaired by the contractor.

Rock faces and surfaces at sensitive excavations such as tunnel portals, shall be carefully excavated and preserved during construction. Appropriate smooth blasting techniques shall be generally used there. Line-drilling may be applied at certain locations. Rock supports shall be installed where indicated on the construction drawings, or directed by the Engineer-in-Charge, to suit the actual geologic conditions encountered. The contractor shall exercise particular care when excavating in the vicinity of existing structures or those under construction. He shall be liable for any damage to structures or equipment caused by his operations. Acceleration due to the blasting shall be monitored as specified hereinafter. The contractor shall protect the subsoil and particularly the ground water from contamination by fuel or oil from his equipment. Water shall be sprinkled on work sites by the contractor to ensure dust free atmosphere.

7.5 DISPOSAL OF EXCAVATED MATERIALS

Excavated materials shall be transported to the disposal areas (within a lead of 5km of the project area) in such a way that spillage onto roads etc. is avoided. Any material that, despite the contractor taking reasonable care, does fall onto roads etc. shall be promptly cleared and removed by the contractor. No rock material may be dumped into any rivers or creeks. Earth or soil material may only be dumped into natural watercourses with the consent of the Engineer-in-Charge, and if prior written confirmation of this is obtained.The surfaces of all disposed excavated materials which are to remain permanently exposed shall be finished to prescribed lines and to stable slopes approved by Engineer-in-Charge. Adequate diversion of water courses in such areas and drains shall be constructed to prevent the undesirable accumulation of water in or around the disposal or stockpile areas. The contractor shall be liable for any damage to temporary or permanent work or to third parties and their property caused by inadequate drainage of the spoil or stockpile areas.

7.6 PREPARATION AND PROTECTION OF EXCAVATION SURFACES

If, during excavation in rock for concrete structure or linings, the rock beyond the limits of excavation shown on the construction drawings becomes broken or shattered, the contractor shall remove all loose material and replace it with concrete or shotcrete as directed.Shotcrete shall be applied to finished excavation surfaces where, in the opinion of the Engineer-in-Charge, it is deemed necessary to prevent air slaking, erosion or other deterioration of the surface. The protective coating shall be applied to excavated surfaces either with or without steel wire mesh reinforcement in accordance with the provisions of the Clause No.-9 (Shotcrete).

7.7 MONITORING AND PROTECTION FROM BLASTING

The contractor shall adequately protect existing structures from the effects of blasting, both from impact with rock or debris and from excessive shock. Structures at risk shall be inspected both before and after blasting, and shall be monitored during the blasting operations by appropriate means, if so directed by the Engineer-in-Charge. Blasting within 30 m of concrete or grout area will be permitted only after concrete or grout is 07 (seven) days old and only after submission by contractor, and approval by Engineer-in-Charge, of a plan showing the relative positions of structures or grouted area and the area to be blasted, contractor's proposed drilling and blasting plan, together with outline of precautions to be taken. All concrete or grout and other completed work within 30 m of blasting shall be protected by limiting the size of blasts. Blasting will not be permitted within 10 m of structures or installations vulnerable to damage by blasting. Replacement or repair of work damaged by blasting shall be carried out by the contractor at his own cost, unless otherwise instructed by Engineer-in-Charge.

7.8 MEASUREMENT AND PAYMENT

The payment shall be made as covered under the clause no.11 Of GCC

7.9 ILLUMINATION

The contractor shall install an adequate illumination system as stipulated in the Clause No.-3(Safety Precautions).

7.10 VENTILATION AND CONTROL OF DUST, SILICA AND NOXIOUS GASES

The contractor shall install and operate equipment and carry out all work required for the ventilation and control of dust, silica and noxious gases as stipulated in the Clause No.-3 (Safety Precautions).

8. ROCK SUPPORTS

8.1 SCOPE OF WORK

Work under this section include all labour, materials, tests, equipment and services required to protect, stabilize or support rock faces, cuts, slopes and masses exposed in the course of surface and underground excavation work, as well as the anchoring of any concrete structures into surrounding or underlying rock and repairing work of Adit Tunnel to be used in this project as per

provisions of the relevant IS Codes. This section covers the following items:

a) Rock bolt, rock anchor, rock bolt (resin end anchored) and grouted anchor bar.

b) Post-tensioned rock bolts (tendons).

c) Mesh Reinforcement.

d) Steel support.

Shotcrete concrete, grouting and drainage work, which may also be required for rock support purposes, are specified in other sections.

8.2 GENERAL

The rock stabilizing and supporting measures to be undertaken during or after the excavation work during construction in a safe manner will be as determined observing geological features of the cutting surface generally in consultation with expert Geologists deputed at Site and based on the known or presumed behaviour of the rock or ground. In case of emergency or unforeseen exigency, the contractor is authorized and obliged to undertake independently such supporting measures, as he deems necessary without prior consent of the Engineer-in-Charge. In such cases the contractor shall inform the Engineer-in-Charge immediately. The Engineer-in-Charge retains the right to order the contractor to change the method or system of rock supports being used, if he considers that the contractor's method of work is unsafe.

Nothing contained in this section shall be construed to relieve the contractor from sole responsibility either for the safety of the work or for liability for injuries to, or death of persons or damage to property, or of any of his obligations under this contract. An adequate quantity of rock support materials, skilled personnel and equipment shall be made available by the contractor at the construction sites with all necessary arrangements and be kept ready for immediate use at any time during the whole construction period. Required quantities of all rock support items to be decided on the basis of surface and exploratory Geological features at Sites and in consultation with experts in relevant field.

The E.I.C or his authorized representative at site shall be informed in advance about the proposed activities with details of required materials, manufacturer's instructions and certificates, methods of installations, testing and drawings, if any, fabrication details of steel ribs, lagging and lattice girder for approval. Decision of WBSEDCL in this regard will be final.

8.3 ROCK BOLT, ROCK ANCHOR, ROCK BOLT (RESIN END ANCHORED), WATER EXPANDABLE FRICTION ANCHOR, GROUTED ANCHOR BAR

8.3.1 ROCK BOLT

ROCK BOLT is a stressed (i.e. post-tensioned) reinforcing element consisting of a rod, a plate and a nut for stressing by tightening the nut. Rock bolts shall be of 25 mm. or 32 mm or 36 mm dia. and shall be of various lengths as specified in the construction drawings (for longer lengths, couplers may be required).

The rock bolts shall be manufactured from reinforcing bar with yield strength not less than 415/500 N/mm² (The reinforcing bar shall comply with IS: 1786). When coupler is used, the threading in the bar shall not reduce the effective diameter of bar. Coupler itself should be able to transfer at least 125% of the yield load of the bar. Rock bolts shall be furnished complete with all accessories and other materials necessary for their installation, fixing, stressing and grouting. Bearing plates shall be flat steel plates of following minimum dimensions:

36mm dia. rock bolt : 1 no. plate of 200x200x16mm

32mm dia. rock bolt : 1 no. plate of 200x200x12mm

25mm dia. rock bolt : 1 no. plate of 150x150x10mm

The plate shall conform to IS:2062 for structural steel. The nuts shall be heavy hexagonal type. The threads on the projecting ends of bolts shall be protected and lubricated with rust preventive compound. Rock bolts shall generally be tensioned at the requisite value as mentioned in the construction drawings. Diameter of hole drilled for installation of rock bolt shall be as mentioned in the construction drawings. The length of drill hole shall be such as to receive the specified rock bolt and to provide for its satisfactory anchorage, and sufficient protrusion of the threaded portion out of hole to fix plate, nut, and coupling for any kind of extension piece. The holes shall extend 150 to 200 mm beyond the length of the rock bolt or anchor.

After drilling each hole in sound rock, the drill hole shall be washed with clean water and cleaned by blowing out all drill cuttings and debris with compressed air. The holes in rock, which tends to swell or is interspersed with clay filled fissures, shall be cleaned with compressed air only. The compressed air shall not contain oil or any other material which could prevent the bond between rock and grout. Prior to installing the rock bolt, which will be stressed, the rock surface around the hole shall be prepared by levelling the same using cement mortar for the bearing plate. When the surface is not perpendicular to the whole axis, bevelled washer shall be placed between the bearing plate and the nut, or dished bearing plate and hemispherical washer used, to ensure uniform bearing. The method and equipment used for installation, to effectively seat, and to stress rock bolts shall be in accordance with the manufacturer's instructions and subject to the approval of the Engineer-in-Charge.

The rock bolts shall be stressed, immediately after installation in the hole, by torque (or jacking), by means of an approved and regularly calibrated stressing device, to an extent specified by the manufacturer or directed by the Engineer-in-Charge on the basis of values established during pull-out tests. Torque wrench, if being used for inducing tension, should be capable of inducing a pre-determined torque to an accuracy of ±5%. After initial installation, the contractor shall ensure that the rock bolts continue to act as effective supports by periodically testing the rock bolts and, if necessary, re-tightening to the directed torque or tension, till grouted. Grouting of the expansion-shell rock bolts shall be performed without de- stressing the bolt. Grouting shall be performed as soon as practicable after, but in any case not later than 07 (seven) days, of rock bolt installation. The bearing plate shall be caulked around its perimeter and grout shall be introduced into the hole through a plastic tube fixed to the shaft and extended to outside through a hole provided in the bearing plate, at a pressure sufficient to fill completely the space around each bolt for the full length without any air-pockets remaining inside the hole. A grout return tube through another hole in the plate shall be provided to ensure full column grouting.

Grout mix used shall have a water cement ratio of not more than of 0.32. The grout mix shall contain an expanding plasticizer admixture (allowing upto 3.5% expansion in neat cement), from a reputed manufacturer which has a long past proven record of use for such applications. The dosage of admixture shall be as per the manufacturer's recommendation. For additional workability, a compatible super plasticizer may also be required.

The grout mix shall have strength of 35 N/mm² at 28 (twenty-eight) days. Cracks and fissures adjacent to the rock bolt which the grout is found to be flowing from, during the grouting operation, shall be plugged or caulked at the excavation surfaces.

Prior to the installation of rock bolts in the work, a series of pull-out tests shall be carried out in different rock types designated by the Engineer-in-Charge and which will be representative of the rock expected to be encountered during the excavation. During the pull-out test both, the load applied and movement undergone shall be measured. At least 5 tests shall be required for each combination of the type of the rock bolts/installation condition to be able to assess the suitability of expansion shells. The pull-out tests shall be carried out sufficiently in advance of the installation of the rock bolts in the work. The contractor shall maintain detailed records of the pull-out tests, the results of which will be used to establish relation between rock quality and type of expansion shell and tensioning.

During progress of the work the contractor shall, in general, perform pull-out tests, in the presence of the Engineer-in-Charge on at least 2 per 100 rock bolts installed. In case of failure, additional testing shall be performed on selected rock bolts installed in the vicinity of the failed one and the rock bolts shall be replaced free of cost as directed by Engineer-in-Charge. If large scale failure is reported, the effectiveness of whole lot of bolts installed shall be decided by Engineer-in-Charge in consultation with the designers.

As a part of monitoring program during the progress of the work, and when directed by the Engineer-in-Charge, rock bolts shall be fitted with load cells. Approved load cells which allow to measure the increase or decrease in load in the bolt to an accuracy of 2% shall be supplied by the contractor, who shall measure the deformation undergone and record the loads registered on each load cell installed twice a month and submit the results to the Engineer-in- Charge within 48 hours of taking such readings. Such load cells shall be installed on the un-grouted rock bolts only.

8.3.2 ROCK ANCHOR

Rock Anchor is an un-tensioned reinforcing element consisting of a rod embedded in a cement grout filled hole. The rock anchor shall have a plate and a nut. The rock anchors will not be stressed. The rods shall be fully grouted with cement grout. Rock anchors shall be of 25 mm, 32 mm or 36 mm dia. and shall be of various lengths as specified in Bill of quantities (for longer lengths, couplers may be required).

The Rock anchors shall be manufactured from reinforcing bar with Yield strength not less than 415/500 N/mm2. (The reinforcing bar shall comply with IS: 1786.)

When coupler is used, the threading in the bar shall not reduce the effective diameter of bar. Coupler itself should be able to transfer at least 125 % of the yield load of the bar. Rock anchors shall be furnished complete with all accessories and other materials necessary for their installation, fixing and grouting. Bearing plates shall be flat or dished steel plates of following minimum dimensions:

36mm dia. rock bolt : 1 no. plate of 200x200x16mm

32mm dia. rock anchor: 1 no. plate of 200x200x12mm

25mm dia. rock anchor : 1 no. plate of 150x150x10 mm

The plate shall conform to IS: 2062 for Structural Steel. The nuts shall be heavy hexagonal type. The threads on the projecting ends of anchors shall be protected and lubricated with rust preventive compound. The surface of the rock anchors shall be clean of rust, scale, dirt or other foreign matter.

Diameter of hole drilled for installation of rock anchor shall be as mentioned in the construction drawings. The length of drill hole shall be such as to receive the specified rock anchor and to provide for its satisfactory anchorage, and sufficient provision of the threaded portion out of hole to fix plate, nut, and coupling for any kind of extension piece. The holes shall extend 150 to 200 mm beyond the length of the rock anchor.

After drilling each hole in sound rock, the drill hole shall be washed with clean water and cleaned by blowing out all drill cuttings and debris with compressed air. The holes in rock, which tends to swell or is interspersed with clay filled fissures, shall be cleaned with compressed air only. The compressed air shall not contain oil or any other material which could prevent the bond between rock and grout.

Prior to installing the rock anchor, the rock surface around the hole shall be prepared by levelling the same using cement mortar for the bearing plate. When the surface is not perpendicular to the whole axis, bevelled washer shall be placed between the bearing plate and the nut, or dished bearing plate and hemispherical washer used, to ensure uniform bearing. Both for overhead application and horizontal (slightly downward) application, the grout shall be introduced into the end of the hole through a pipe. The pipe will be gradually withdrawn as the hole is filled. Grout shall have a water to cement ratio of 0.25-0.28. An admixture containing an efficient water reducing

agent, a shrinkage compensating component and thixotropizing agent shall be used. The grout mix shall have strength development of min 25 MPa at 24 hours. Doses of the admixture shall be as per the manufacturer's recommendation to achieve the required properties.

The anchor bar shall be forced into the grout-filled hole before the initial set of the grout and good contact between steel surface and grout ensured. Anchors bars shall be protected after installations in such a manner as to prevent any movement until the grout has hardened. The Contractor shall replace any bars found to be loose after the grout has set. During progress of the Work the Contractor shall, in general, perform pull-out tests, in the presence of the Engineer-in-Charge on at least 2 per 100 Rock anchors installed. In case of failure, additional testing shall be performed on selected rock anchors installed in the vicinity of the failed one and the rock anchors shall be replaced free of cost as directed by Engineer-in-Charge. If large scale failure is reported, the effectiveness of whole lot of bolts installed shall be decided by Engineer-in-Charge in consultation with the designers.

8.3.3 ROCK BOLT (RESIN END ANCHORED)

ROCK BOLT (RESIN END ANCHORED) is a stressed (i.e. post-tensioned) reinforcing element consisting of a rod, a grouted anchorage in the form of fixed length, a plate and a nut for stressing by tightening the nut.

Grouted anchorage rock bolts shall be of 25 mm or 32 mm or 36 mm dia. and shall be of various lengths. The rock bolts shall be manufactured from reinforcing bar with yield strength not less than 415/500 N/mm2. (The reinforcing bar shall comply with IS:1786).Couplers may be required for the bolts. When coupler is used, the threading in the bar shall not reduce the effective diameter of bar. Coupler itself should be able to transfer at least 125 % of the yield load of the bar.

Rock bolts shall be furnished complete with all accessories and other materials necessary for their installation, fixing, stressing and grouting. Bearing plates shall be flat steel plates of following minimum dimensions:

36mm dia. rock bolt	: 1 no. plate of 200x200x16mm
32mm dia. rock bolt	: 1 no. plate of 200x200x12mm
25mm dia. Rock bolt	: 1 no. plate of 150x150x10mm

The plate shall conform to IS: 2062 for structural steel. The nuts shall be heavy hexagonal type. The threads on the projecting ends of bolts shall be protected and lubricated with rust preventive compound. Rock bolts (rock anchorage) shall generally be tensioned at the requisite value as mentioned in the construction drawings. Diameter of hole drilled for installation of rock bolt shall be as mentioned in the construction drawings.PVC Spacers shall be required for equal grout annulus all around the bolt. The length of drill hole shall be such as to receive the specified rock bolt and to provide for its satisfactory anchorage, and sufficient provision of the threaded portion out of hole to fix plate, nut, and coupling for any kind of extension piece. The holes shall extend 150 to 200 mm beyond the length of the rock bolt or anchor.

After drilling each hole in sound rock, the drill hole shall be washed with clean water and cleaned by blowing out all drill cuttings and debris with compressed air. The holes in rock, which tends to swell or is interspersed with clay filled fissures, shall be cleaned with compressed air only. The compressed air shall not contain oil or any other material, which could prevent the bond between rock and grout. Rock surface around the holes shall be prepared by levelling the same using cement mortar, for the bearing plate. Grouting of the drilled hole is done to provide permanent bonding in the fixed length of the rock bolt. After the hole is drilled and cleaned, fast setting resin cartridges shall be placed and tamped to the bottom of the hole to provide immediate required end anchorage. The remaining hole shall then be filled with slow setting resin cartridges or with mortar as directed by Engineer-in-Charge.

Number of fast setting resin cartridges shall depend upon the diameter, type (Fe-415 or Fe-500 etc.) & the orientation of the bolt & shall be determined by carrying out trial testing (pull out test) in the sample (similar) rock type prior to starting of excavation. At least five number of pull out tests be

performed for each combination or rock type to finalized number of fast setting resin cartridges, with suitable factor of safety as per Clause 4.4 of IS:11309 (1985).Grout shall have a water to cement ratio of 0.25-0.28. An admixture containing an efficient water reducing agent, a shrinkage compensating component and thixotropizing agent shall be used. The grout mix shall have strength development of min 25 MPa at 24 hours. Doses of the admixture shall be as per the manufacturer's recommendation to achieve the required properties. The rock bolts shall be stressed immediately by jacking or torque wrench or by means of an approved and regularly calibrated stressing device, to the extent specified.

Prior to the installation of rock bolts in the work, a series of pull-out tests shall be carried out, to optimize the fixed length. During the pull-out test for 32 mm dia rock bolt, the load applied shall be 35 ton and for 36mm dia. rock bolt, the load applied shall be 42ton.During progress of the work the contractor shall, in general, perform pull-out tests, in the presence of the Engineer-in-Charge on at least 2 per 100 Rock bolts installed. In case of failure, additional testing shall be performed on selected rock bolts installed in the vicinity of the failed one as directed by Engineer-in-Charge. If large scale failure is reported, the effectiveness of whole lot of bolts installed shall be decided by Engineer-in-Charge in consultation with the designers.

As a part of monitoring program during the progress of the work, and when directed by the Engineer-in-Charge, rock bolts shall be fitted with load cells. Approved load cells which allow to measure the increase or decrease in load in the bolt to an accuracy of 2% (two percent) shall be supplied by the contractor, who shall measure the deformation undergone and record the loads registered on each load cell installed twice a week or as directed by Engineer-in-Charge and submit the results immediately.

8.3.4 GROUTED ANCHOR BAR

GROUTED ANCHOR BAR is a reinforcing element consisting of a reinforcing bar embedded in a cement grout filled hole. It shall extend into structural concrete to provide anchorage of concrete structures. The grouted anchor bars will not be stressed. The rods shall be fully grouted with cement grout.

Grouted anchor bars shall be of 25 mm, 32 mm or 36 mm dia. and shall be of various lengths as specified in bill of quantities (for longer lengths, couplers may be required).The grouted anchor bars shall be manufactured from reinforcing bar with Yield strength not less than 500 N/mm2. (the reinforcing bar shall comply with IS: 1786).

When coupler is used, the threading in the bar shall not reduce the effective diameter of bar. Coupler itself should be able to transfer at least 125 % of the yield load of the bar. Grouted anchor bars shall be furnished complete with all accessories and other materials necessary for their installation, fixing and grouting. The surface of the grouted anchor bars shall be clean of rust, scale, dirt or other foreign matter. Diameter of hole drilled for installation of grouted anchor bar as mentioned in the construction drawings.

After drilling each hole in sound rock, the drill hole shall be washed with clean water and cleaned by blowing out all drill cuttings and debris with compressed air. The holes in rock, which tends to swell or is interspersed with clay filled fissures, shall be cleaned with compressed air only. The compressed air shall not contain oil or any other material, which could prevent the bond between the rock and grout. The grout shall be introduced into the end of the hole through a pipe. The pipe will be gradually withdrawn as the hole is filled.

Grout mix used shall have a water cement ratio of not more than of 0.32. The grout mix shall contain an expanding plasticizer admixture (allowing upto 3.5% expansion in neat cement), from a reputed manufacturer which has a long past proven record of use for such applications. The dosage of admixture shall be as per the manufacturer's recommendation. For additional workability, a compatible super plasticizer may also be required. The grout mix shall have strength of 35 N/mm² at 28 days.

The anchor bar shall be forced into the grout-filled hole before the initial set of the grout and good contact between steel surface and grout ensured. Bar ends to be embedded in the concrete

structure shall be provided with hooks welded to the bar to provide a good anchorage. In order to facilitate the inserting of the bars into the holes, the hooks can be welded to the anchor bar after installing. The welding and the overlap of the bar end with the hook(s) shall be as approved by the Engineer-in-Charge.

Anchors bars shall be protected after installations in such a manner as to prevent any movement until the grout has hardened. The Contractor shall replace any bars found to be loose after the grout has set. The depth of holes indicated on the approved drawings or as directed by the Engineer-in-Charge shall be measured from the effective excavation surface. Should the anchor bars be connected to the reinforcement steel of the concrete structure to be anchored, longer bars shall be provided in case of over excavation, to maintain the required position in the structure.

8.3.5 ROCK BOLT/ ROCK ANCHOR EXTENSIONS INTO CONCRETE

Threaded portion of rock bolts and rock anchor, where required to be extended into structural concrete, shall be protected during excavation and shotcreting operations and shall protrude sufficiently beyond the Shotcrete. The extension shall consist of an L-shaped reinforcing bar of similar size (as that of the bolt/anchor) and shall be welded to the bolt. The welding and the overlap of the bolt with extension piece shall be in accordance with the provisions of IS: 2751 and IS: 9417.

Stressing of rock bolts and acceptance tests shall be done in accordance with relevant IS Codes/ Hand Book (e.g. IS: 11309-1985, re-confirmed in 2001 etc.) and the contractor shall have to make all necessary arrangements in this respect.

8.4 MESH REINFORCEMENT

8.4.1 CHAIN LINK FABRIC

Chain link fabric shall be installed on surface excavations generally without Shotcrete, to protect surfaces from which loose pieces of rock or cobbles may fall. Chain link fabric shall conform to the requirements of IS: 2721 for zinc-coated steel chain-link fence fabric. The fabric shall have a mesh size of approximately 50x50mm, and a wire diameter of 3.15 mm. The fabric shall be placed against excavated surfaces with required secure fastening arrangements. The installation of chain link fabric as reinforcement of Shotcrete shall generally not be permitted. When the excavated surface is so uneven and rough that placing of welded wire fabric is impractical, use of chain link fabric as reinforcement to Shotcrete may be permitted by Engineer-in-Charge.

8.4.2 WIRE MESH

Wire mesh shall consist of welded wires in a fabric. Wire mesh shall be installed in surface and underground excavation as reinforcement for Shotcrete usually in combination with rock reinforcement. It may also be used with steel ribs, when it shall be laid over the outer flange of the rib and pinned or fixed to the excavated surface between the ribs where necessary.

Wire mesh shall conform to the requirements of IS: 4948 (Welded Steel Wire Fabric for general use). The wire mesh shall have a square mesh of 100x100 mm spacing made of mild steel wires of diameter 3 and 5 mm having yield strength not less than 275 N/mm² with proper anchoring/ fixing arrangements.

8.5 STEEL SUPPORTS

8.5.1 GENERAL

The contractor shall install the steel supports consisting of steel ribs in Tunnels or any underground excavation to the shape. Steel supports shall be furnished complete with bracing, bolts, nuts, washers, plates, tie rods, and other accessories necessary for installation of the supports.

8.5.2 STEEL RIBS

All steel section and plates used for ribs and accessories shall conform to IS: 2062 (Structural Steel of Standard Quality). Steel for bolts, nuts and washers shall conform to IS: 8500 (Specification for High Tensile Strength Structural Steel). Material used in splices shall conform to the specification of the material being spliced. All steel and fabrication thereof shall conform to the requirements of IS: 800 (Code of Practice for use of structural steel in General Building Construction). All welding, welding electrodes and workmanship shall conform to IS: 814 and IS: 816. Latest revisions of the IS codes where referred shall be applicable for this Contract.

8.5.3 LAGGING

Lagging with backfilling are the longitudinal supporting members placed behind the steel ribs, where necessary, to support the walls and crown of the excavation. Two different types of steel lagging are envisioned:

2-3 mm thick to be used behind the steel ribs in profiles already excavated.

4-5 mm thick when they are to be pressed or hammered ahead of the heading face for protection

Precast reinforced concrete panels of 5 to 7.5 cm thickness may be used as lagging instead of the steel profiles. Type of lagging used must be approved by the Engineer-in-Charge before the Contractor starts with the manufacture thereof. Concrete grade used shall be M25/A40 and reinforcement at the rate of 60 Kg/m³ minimum shall be provided.

9. SHOTCRETE

9.1 SCOPE OF WORK

The work under this section includes all labour, materials, equipment and services required for the execution of Shotcrete work to be carried out by the contractor under this contract. Shotcrete shall be applied to the excavated surfaces both in underground and surface excavation, as required or as directed or approved by WBSEDCL. The contractor shall design the mix, furnish materials, place, do proper curing and test Shotcrete as necessary to provide temporary or permanent protection and/or support of excavated surfaces either in surface or underground excavations.

The contractor shall furnish all materials, expert labour and equipment for preparing test panels, both for trial mixes and during the course of the work and for testing cores from panels or from in-situ Shotcrete. When the Shotcrete is applied as a temporary rock supporting or protection measure, the number and thickness of layers to be applied shall be governed by the prevailing rock conditions and will be determined by the Engineer-in-Charge. When the Shotcrete is intended to remain as a permanent lining or protection of rock surfaces, the thickness of such lining shall be as shown on the construction drawings or as directed by the Engineer-in-Charge.

Shotcrete shall be placed with or without steel wire mesh reinforcement, as directed, and may be used in conjunction with rock bolts, steel ribs and other rock supporting measures. The contractor shall maintain adequate stockpiles of materials for Shotcrete for immediate use in cases of emergency. Any damage or delay resulting from shortage of such materials shall be the contractor's entire responsibility. Methods and workmanship in the application of Shotcrete shall be in accordance with IS: 9012 or BS: 882.

9.2 DEFINITIONS

Shotcrete is defined as a mixture of cement, aggregate, water and accelerators in correct proportions, with maximum size of aggregate less than 10 mm projected at high velocity from a spray nozzle on to a surface to form a layer of pneumatically applied concrete on that surface. Shotcrete can be either wet or dry mix. It will be used for protection and supporting rock surfaces

after excavation, to fill the cavities caused by over-break or weathering.

Dry-Mix Process: The cement, aggregates and accelerator batched by weight, are thoroughly mixed dry (with enough moisture to prevent dusting) and fed into a purpose-made machine wherein the mixture is pressurized, metered into a dry air stream and conveyed through hoses or pipes to a nozzle in which water as a spray is introduced to hydrate the mix which is projected without interruption into place.

Wet-Mix Process: All materials including cement, aggregates weigh batched and mixed together with water, but without accelerators, to produce mortar or concrete. The mixture is then conveyed by positive displacement or compressed air to a nozzle where air, and accelerator, is injected to increase velocity, and projected without interruption into place.

Layer is a term used for a discrete thickness of Shotcrete built up from a number of passes of the nozzle and allowed to set. Rebound is a term used for all material, which, having passed through the nozzle does not adhere to the target surface.

10. DRILLING AND GROUTING

10.1 SCOPE OF WORK

The work under this section includes all labour, materials, equipment, operations and services required for the execution of drill holes, water-pressure test, and performance of grouting in the holes from surface etc. at locations shown on the drawings or as directed by the Engineer-in-Charge. The final number, length, location and inclination of the drilled holes as well as the composition and consistency of the grout mixes, grouting pressure, pumping rates and sequence in which the holes are to be drilled and grouted shall be governed by actual conditions encountered at site and shall be at all times subject to the approval by Engineer-in-Charge. All temporary drainage holes in the underground shall be filled with the grout. The extent of crack grouting will be determined by Engineer-in-Charge. Drilling for installation of rock bolts, grouted anchor bars shall be performed in accordance with the provisions set forth in the section Rock supports. All grouting work is to be carried out as per relevant Indian Standard and Guidelines.

10.1.1 DRILLING

Prior to the start of drilling (and/or grouting work) in any one working area, the contractor shall provide notice of and make available to the Engineer-in-Charge a drilling and/or grouting plan, with 56 (fifty-six) days for review. Once work has commenced and as the local sub-surface conditions are disclosed, the drilling and/or grouting plan may have to be modified accordingly on the basis of consultation with and direction by the Engineer-in-Charge. The contractor shall be prepared and equipped for variations in the drilling and grouting work.

The contractor shall make drilling logs and other pertinent information available to the Engineer-in-Charge on completion of each work phase and as needed during the work. The contractor shall provide notice of, and make available to the Engineer-in-Charge reports giving the results of each water-pressure test performed within one working day of the end of the shift in which the tests were carried out. The reports shall contain complete records of the execution of the test as described in this section.

The contractor shall provide to the Engineer-in-Charge (prior to scheduled use in the field) documentation of the effects on the grouting mixture of any additive proposed for use in the drilling water, and no additives shall be used without prior approval by the Engineer-in-Charge. Within 24 (twenty-four) hours of completion of any drilling with core recovery, the contractor shall submit, in duplicate, a technical log of the drillhole in a form approved by the Engineer-in-Charge. The log shall be in accordance with IS:4464 and shall include the following data:

a) Date of beginning and end of drilling,

b) Drillhole number,

c) Location, ground surface elevation, coordinates, inclination, direction, and length of drillhole,

d) Type and diameter of drilling bit and core barrel used, make of drilling rig and length and diameter of casing, if used,

e) Elevation of ground water levels encountered, including date and time of measurement,

f) Results of leakage tests and other drillhole tests, if any,

g) A record of the driller's observations on progress of drilling, rate of penetration, speed and uniformity of rotation of bit, action of the drill rig such as jerky, smooth, rough, steady, etc.,

h) Length of each core run and the length, or percentage, or both of the core recovered and location and cause of core losses,

i) Any changes in the character of the drilling water or mud, and in case the drilling water was lost (partly or totally), the elevation or depth when this happened,

j) A simple driller's interpretation and description of the nature of the formation encountered as the drilling progress,

k) Location and nature of cavities, seams, cracks, soft or broken rock, whether filled or open, and any other observation which could give information in connection with the purpose of exploratory drilling,

l) Names of drillers and inspectors.

Geological logging shall be performed by the contractor in presence of Engineer-in-Charge. When required by the Engineer-in-Charge the contractor shall provide assistance during core logging, and in particular with handling of core boxes and cleaning of cores. Colour photographs of the core boxes from each drill holes shall be submitted to the Engineer-in-Charge in 03 (three) copies within 10 (ten) days from the completion of the drill holes. The contractor shall submit reports in duplicate giving the results of each water- pressure test performed, within 24 hours of the end of the shift in which the tests were carried out. The reports shall contain the following:

a) Location and number of drill holes.

b) Date and time of test performance.

c) Type of test.

d) Pressure readings and water levels before and after testing.

e) Packer rod characteristics and depth of packer(s).

f) Total injected water volume and rate per minute and per linear meter of hole for various pressures applied. A plot showing water take versus increasing and decreasing pressure shall be prepared and both data and plot shall be submitted.

g) Description of all surface water leaks indicating the distance and approximate quantity.

Should the Contractor intend to use a water-soluble additive to drilling water, he shall submit a notification and a sample of the additive to the Engineer-in- Charge for approval at least 15 (fifteen) days prior to being used.

10.1.2 GROUTING

At least 56 (fifty-six) days prior to the start of the grouting work, the Contractor shall submit for approval fully detailed proposals and a detailed layout of his proposed arrangements for grouting, including specifications of all equipment, tools and all grouting materials to be used, and qualification and experience of the proposed personnel, and extent of technical support from external agencies. An overall grouting program shall be drawn up jointly between the Contractor and the Engineer-in-Charge. Grouting mixes, pressures, pumping rates, and sequencing will be selected, subject to modifications, to meet local conditions encountered during the performance of the work. Grouting work shall be planned in such a manner that they can be carried out according to the approved plan concurrently with other activities. Modifications to the grouting

program shall be implemented as directed by the Engineer-in-Charge.

Prior to each phase of grouting, the Contractor shall submit for approval a detailed program for the particular grouting work along with information relating to the methods he proposes to use and details of grout mixes. Nogrouting work shall be executed without prior written approval by the Engineer- in-Charge.

During the performance of the grouting work, the Contractor shall keep complete daily records of all grouting operations. These grouting records shall be compiled on an approved form and shall be submitted weekly to the Engineer-in-Charge. Results of water pressure tests and grout takes shall be presented in tabular form as well as graphically. The records shall contain all the information as per guidelines of IS: 6066 (1994), and shall include the following:

- Number and location of the drillholes,
- Results of water-pressure tests,
- Grouting method,
- Date and time of commencement of grouting and of each change in grouting operations,
- Rate of pumping,
- Grouting pressures and gauge reference number,
- Water-cement ratio and its variations,
- Separate quantities of cement, sand, bentonite, fly ash, admixtures and chemicals used,
- Connections, if any, with other holes and cracks, as well as any surface leakage of water or grout; crack location, how it was caulked and the success of caulking shall be described and approximate station and offset of each surface leak shall be recorded where it occurs in the Dam foundation,
- Number of holes and depth of holes left for re-drilling,
- Time of completion,
- Name of the foreman in charge.

The Engineer-in-Charge reserves the right to advise the contractor for any additional information deemed necessary to be included in the documents to be submitted.

10.2 EQUIPMENT

10.2.1 DRILLING EQUIPMENT

All drilling equipment used shall be of a type, capacity and mechanical condition capable of performing the drilling required under this Contract, and shall be subject to the approval of Engineer-in-Charge.

The contractor shall have sufficient drilling rigs at the site for the timely completion of the work. The drilling rigs shall be in good operating condition and adequate for the satisfactory progress of the work. Combustion engines for operation of drilling equipment will not be permitted for underground work.Drilling equipment shall be capable of drilling at any angle, upward or downward, and shall have the following capacity:

- Exploratory holes up to 100 m,
- Consolidation and impermeabilization grouting up to 10 m,
- Contact grouting up to 5 m.

Standard drilling equipment of the rotary and percussion type shall be used to perform the drilling as specified herein or as required by the Engineer-in-Charge. Percussion drilling equipment shall be

equipped with a water swivel for continuous flushing of the holes during drilling.

The Engineer-in-Charge may require some of the grout holes and pressure relief holes to be drilled using rotary type drills with core recovery. The rotary type machines shall be capable of drilling NX, AQ, BQ, NQ, NQ2, HQ, PQ size holes utilizing double tube core barrels equivalent and capable of recovering soft or friable materials with maximum possible core recovery. The equipment and crew shall be made available at site when Engineer-in-Charge requires exploratory holes to be drilled. All such cores shall be properly stored in wooden boxes and logged for inspection as per the Indian standard.

The drilling units shall be mobile and of size suitable to the dimensions of the galleries. The contractor shall keep at the site an ample supply of different types and sizes of drilling bits to allow optimal drilling in the different materials to be encountered in the course of work, and sufficient rods and casings of various diameters to allow proper telescoping and to ensure the stability of drill holes. The contractor shall provide measuring equipment for checking the actual inclination and alignment of drill holes.

10.2.2 GROUTING EQUIPMENT

Only modern, properly operating grouting equipment approved by the Engineer-in-Charge and operated by trained and experienced crew shall be used for the performance of the work. This shall be specifically observed when dealing with chemical products.

The grouting equipment required to carry out the work shall include mixers, grout pumps, packers, pipes, grout lines, fittings, pressure gauges, telephones, lighting circuits, trolley grout platforms and miscellaneous supplies. Sufficient grouting equipment shall be provided to meet the construction schedule and each plant shall be capable of satisfactorily supplying, mixing, stirring, pumping and injecting grout mixes of various viscosities as specified herein. The equipment shall be maintained in good operating condition at all times and any grout hole that is lost or damaged due to mechanical failure of equipment or inadequate delivery of grout shall be replaced by another grout hole by contractor at no additional cost to client.

The grouting equipment for mixing and placing the grout shall be such as to provide a continuous circulation of grout throughout the system and to permit accurate volume and pressure control. It shall be capable of effectively mixing and stirring the grout and forcing it into the hole in a continuous uninterrupted flow at any desired pressure up to the maximum required grouting pressure for a flow rate of 150litre/min.

Grout pumps shall be of the progressive cavity type and shall be capable of pumping at least 150 litres/min of grout at a maximum discharge pressure of 3000 KPa (3 N/mm²). Grout mixers shall have a minimum capacity of 0.5 m³ and shall be mechanically operated horizontal paddle type or preferably colloidal high speed impeller type. Facilities shall be provided at the mixer for the accurate measurement of grout materials so that mix proportions can be carefully controlled.

Sump or holding tanks having a minimum capacity of 0.5 m³ shall be mechanically operated and designed to keep the mixed grout agitated and in suspension. All grout should be discharged from the mixer into the agitator and from the agitator into the pump panel through a 2.36 mm sieve to remove lumps and large particles. Water meters shall be calibrated in litres and tenths of litres without bypass so that water can be measured directly in the mixer. A strainer with cleaning valve shall be provided in the water supply line, upstream of the meter to prevent sand and abrasive particles from entering the meters.

Pressure gauges of the approved make shall be of such calibration to cover a range of pressures from 0 to 0.5 N/mm² (500 KPa) and from 0 to 3.0 N/mm² (3000 KPa). An adequate number of spare gauges shall be provided at each grout plant. Contractor shall provide a standard master gauge against which all other gauges shall be checked periodically for accuracy and satisfactory operation. All the pressure gauges shall be numbered for identification.

Packers shall be capable of effectively sealing the grout holes at the specified elevation and shall be capable of withstanding without leakage pressures up to the maximum grouting pressure. The

type of packer to be used shall be of the pneumatically expanded rubber sleeve type. Double packer assemblies separated by up to 3 m of perforated pipe shall also be provided. A double line circulating system shall be used and the inside diameter of all lines, walls and connections shall be not less than 25 mm. Hoses and supply lines shall be capable of withstanding pressure 50% greater than those specified for grouting.

Grouting headers shall be provided for feeding grout into the holes. The header shall include a supply connection, a connection with a valve to the hole, and a return line with valve. Two number of approved make pressure gauges for the appropriate pressure range shall be installed. One shall be installed to indicate the pressure of the supply at the pump and the other to measure the back pressure at the hole.

Contractor shall furnish, install, maintain and operate satisfactory communication system between grout plants and the holes being grouted regardless of grout area locations. Contractor shall supply sufficient operating personnel, supervisors, labour, spare tools, to carry out each phase of the work properly and expeditiously. The grouting units shall be mobile and of size suitable to the dimensions of the galleries/drifts.

10.2.3 WATER PRESSURE TESTING EQUIPMENT

The washing and water pressure testing equipment shall include pumps, piping, pressure gauges, valves, seal assemblies and all other accessories, necessary to perform the Work. The Contractor shall provide a sufficient number of complete sets of pressure testing equipment (with spares) to allow simultaneous testing at the various drilling and/or grouting locations.

The pumps furnished shall be of the gear, centrifugal, or other acceptable types, with a minimum output of not less than 0.28 m3/min at 3.0 N/mm² (3000 KPa) gauge pressure and shall be capable of maintaining constant pressure. The contractor shall supply water storage tanks sufficient for the pumps in addition to flow meters and pressure gauges for calibration and checking.

Water-meters and pressure gauges shall be calibrated and certified by an independent laboratory prior to installation at the site and shall be subject to periodic verification. One pressure gauge and one water-meter shall, after independent checking, remain at the disposal of the Engineer-in-Charge for further checking purposes. The contractor may be requested to establish, by way of tests, correction graphs for pressure losses occurring in the pipes. Pressure gauges shall be installed directly at the collar of the drill hole.

10.2.4 EMBEDDED PIPES AND FITTINGS FOR GROUTING

Standard mild steel pipes/ galvanized iron pipes and fittings for grouting shall be set in the rock and concrete as the Engineer-in-Charge may direct, or where shown in the approved drawings. The pipes and fittings embedded in concrete shall be cleaned thoroughly of all dirt, grease, grout and mortar immediately before embedding and shall be firmly held in position and protected from damage or displacement while the concrete is being placed.

A standard coupling and nipple wrapped to facilitate eventual removal shall be attached to the grout pipe where embedded in concrete. No portion of the pipe shall be allowed to remain within 50 mm of the concrete surface and the resulting recess, after removal of the pipe or fitting, shall be filled with dry-pack mortar. Care shall be taken to avoid premature blockage of pipes. Any pipe that becomes blocked before completion of operations shall be cleaned out in a satisfactory manner or replaced by the contractor.

10.2.5 SITE LABORATORY

The contractor shall have a laboratory specially equipped for studies and tests relative to drilling and grouting work available on the site. The laboratory shall be manned by experienced laboratory assistant(s) familiar with conventional grout tests. In addition to the usual general laboratory equipment such as scales, oven, permeability meter and the like, it shall be equipped with:

- A multi speed laboratory mixer,
- A Marsh test cone,
- A mould for pressure testing the above cubes, variable from 0 to 2 tons,
- A set of sieves for grain size analysis of fines,
- Conventional laboratory glassware, including 1 litre beakers and test tubes, thermometers and aerometer, and Atterberg's limit measuring cups,
- A Baroid scale type mud density meter.

The Engineer-in-Charge shall be given free access to the laboratory and shall be entitled to carry out any studies and measurements he deems necessary. The contractor shall prepare and test the trial mixes as directed by the Engineer-in-Charge at least 28 (twenty-eight) days before commencement of any grouting. Materials for use in grout mixes shall be tested for compliance with the applicable requirements stipulated in 'Grouting Materials' of this section. Tests shall be performed on the grout mixes proposed for use in the work, to establish the consistencies in mixes, practical mixing ratios, initial and final setting times, and such other properties as may affect the quality of the grout.

During the actual grouting operation, the contractor shall carry out tests on grout mixes at the same time as grouting, and shall plot values of viscosity, sedimentation limits, compressive strength, and maximum viscosity possible for the grouting on a diagram. The frequency of testing will be once for each grouting job site or until acceptance criteria have been met. However, if a significant change in the cement source occurs, sampling and testing must be repeated and the new mix approved by the Engineer-in-Charge.

10.3 GROUTING MATERIALS

Water used for all drilling, washing and water testing and as an ingredient of grout mixtures shall be fresh, clean and free from deleterious amounts of silt, organic matter, alkali, acids, salts, oil and other impurities. Cement used in the grout mixes shall be Portland cement, conforming to IS: 8112. The fineness shall be such that 99% passes the 74 micron IS sieve, and that the Blaine fineness is not less than 3500 cm^2/gm. The cement shall be free from lumps. Whenever sand is added to the grout mix, it shall consist of clean, hard and durable particles free from lumps or clay and objectionable foreign matter. A supply of 5 m^3 of sand shall be kept in proximity of the work at all times. Sand shall conform to the following grading requirement:

Sieve size (mm) Percentage passing by weight (%)

2.360	100
1.180	95-100
0.600	60-85
0.300	30-50
0.150	10-30
0.075	0-5

Bentonite may be required in grout mixes. The bentonite used shall be conforming to IS: 12584. Approved admixtures shall be used by contractor in the grout mix to optimize the strength, viscosity, density, decantation, setting time and shrinkage. Only admixtures proved by testing prior to the start of grouting may be used, after approval by the Engineer-in-Charge. Manufacturer's

certificates or guarantees will not be accepted as relieving the contractor of his responsibility for the suitability of any admixture. The contractor shall handle, store and protect all cement and additives in such a manner that these materials will not be subject to deterioration or contamination. Deteriorated or contaminated materials shall not be used in the work.

10.4 GROUT MIXES

10.4.1 SELECTION OF GROUT TYPE

Following table shall be used as a general guidance only for selection of grout type for a particular application which may or may not occur at this project and may require other additives to be determined during grout optimization process:

Type of grouting	Objective	Ground Characteristics	Grouting Compounds
Contact grouting in tunnels	Void filling	-	Pure cement slurries (w/c ratio <0.8)
Consolidation grouting in tunnels/shaft/dam foundation and to assist excavation	Strength	Narrow or wide joints and fissures filled with sand or clay	Pure cement slurry
		Wide empty joints or fissures high permeability	Thick stabilized cement suspensions
		Injected grout leaks into adjoining open holes. Inflowing water in fissures	Thick Thixotropic suspensions (bentonite added for Thixotropy)
		Crushed rock/ injected grout leaks to the surface	Thick thixotropic suspension with fine sand added, additives for quick setting (if required)

10.4.2 PURE CEMENT SLURRIES

Water/cement slurry mixes are defined in terms of the W/C (water/cement) ratio by weight, and may vary from 0.5, for the thinnest mixes, to 0.67 or even 0.4 thick mixes.

10.4.3 USE OF BENTONITE IN CEMENT SUSPENSION GROUT

Preferred rate of sedimentation of a grout suspension is below 10%. Normal grout mixes don't meet this requirement when the water cement ratio is more than 0.8.To meet the requirement of sedimentation rate below 10%, the grout suspension must be stabilized. As a rule, stabilization is effected by bentonite addition in the range of 1% to 4% of the weight of cement. The relative loss of strength of hardened grout is negligible for upto 6% bentonite addition.

10.4.4 STABLE BENTONITE-CEMENT GROUTS

Stable bentonite/cement grouts shall be laboratory tested prior to use. The following graphs, in particular, shall be drawn:

- Equiviscosity curves,
- Bleed limit curves,
- Curves of equal mechanical strength,

- Curve of maximum possible viscosity for grouting.

These figures shall be obtained with a mixer which reproducesthe high turbulence of the site mixers and with the same materials (cement, bentonite, water) as will be used on the site. Bentonite/cement mixes for grouting shall not bleed more than 5%, expressed in terms of the volume of water visible above the grout after setting and the total volume prior to setting, as measured in a 1 litre, 6 cm diameter test tube.Viscosity shall be measured with a Marsh cone or equivalent method. Unconfined compressive strength after 07 (seven) and 28 (twenty-eight) days shall be measured on 5 cm³ stored in water. 28 (twenty-eight) days compressive strength shall be no less than 1 MPa. The time to initial set shall not be longer than 24 hours.

PREPARATION

The bentonite/ cement grout shall be made by first mixing a bentonite/water parent slurry in a high turbulence mixer and storing it, once adjusted to the defined W/B ratio, for approximately 24 hours in a large tank where it shall be kept in gentle movement, after which a quantity of parent slurry shall be taken and mixed with additional water and cement in a high-turbulence mixer.

The final mixing of the parent slurry with cement shall last at least two minutes after addition of all ingredients. The same mixing drum shall under no circumstances be used for mixing both bentonite/cement grouts and bentonite/ water slurries. Bentonite shall not be suspended in water which contains even the slightest amount of cement. The contractor shall provide detailed information regarding the material and batching, mixing and grouting plant he proposes using in his submission for the Engineer-In-Charge's approval.

GROUT TYPES

Three stable grouts with different batching proportions shall be developed. They shall be the thinnest possible mix (grout A), a mix of average viscosity (grout B), and the thickest possible pump able mix (grout C). The composition of these mixes for one cubic meter of grout should be approximately as given in the table below:

Ingredients	Grout A	Grout B	Grout C
Water	850 L	848 L	846 L
Bentonite	30 kg	40 kg	50 kg
Cement	425 kg	424 kg	422 kg
Total volume	1,000 L	1,000 L	1,000 L
Density	1.30	1.31	1.32
Viscosity (Marsh)	35 s	40 s	50 s
Bleed	4 %	2.5 %	1 %
28 day strength	1.2 MPa	1.2 MPa	MPa

These compositions are given as a guideline only and shall be adjusted to suit the materials used. A greater variety of mixes may be required.

10.4.5 POLYURETHANE

Polyurethane shall be used for consolidation of the sheared or disturbed rock, loose material and for impermeabilization against water inflow even under high pressure. Polyurethane is synthetic materials which penetrate even the thinnest fissures and are able to expand up to 30-40 times of

the original volume even in the presence of water. Polyurethane shall be of acceptable quality as approved by the Engineer-in-Charge.

10.4.6 OTHER CHEMICALS

When other chemicals are required or proposed, they shall be accompanied by the manufacturer's certificates that they have been commercially used with satisfactory service in the similar type of Work. The storage, handling and usage shall be strictly with the manufacturer's printed instructions. The use of toxic chemicals such as acryl amide shall not be permitted for use in the Work.

10.5 EXECUTION

10.5.1 GENERAL

The extent of proposed drilling and grouting programme is tentative. Engineer-in-Charge reserves the right to increase or decrease any part of the drilling and grouting programme should conditions indicate that this is required.

The contractor shall provide sufficient pump capacity and storage to ensure a continuous supply of water to all grouting operation at all times at each grouting location. Minimum water pressure in the supply lines shall be 0.35 N/mm². Sufficient compressed air shall be supplied by the contractor to perform the work with all equipment using compressed air operating at full capacity, the minimum delivery pressure in the air supply lines shall be 0.70 N/mm² at all times.In order to ensure efficient and satisfactory performance, Contractor shall employ competent and experienced drilling and grouting supervisors who shall execute directions of Engineer-in-Charge and supervise the work to be done.

During drilling, grouting, washing and pressure testing operations, the Contractor shall keep concrete and rock surfaces free and clean of oil, grease, drill cuttings, grout, cement, excess of water or any kind of waste. At all times during the progress of the work covered by this section contractor shall protect all open drillholes from becoming plugged or filled with oil, grease, drill cuttings, grout or waste. Contractor shall clean up; and remove all waste upon completion of the work in each area before he vacates that area.

Modifications to drilling and grouting techniques may be required as the knowledge and experience of rock and foundation conditions are gained. The contractor will be required to alter his operations properly to meet such modifications as per instructions of the Engineer-in-Charge. Necessity may alsoarise for drilling holes at certain places in a telescopic manner for which equipment and accessories are required to be available.All drill hole shall be thoroughly washed and cleaned by allowing drilling water to run until the return from the hole is reasonably clean as explained in IS:6066 (1984).

Drilling through overburden shall be done by ODEX or other suitable method approved by the Engineer-in-charge. Consequently, grouting shall be done by method "grouting through tubes with sleeves" as described in IS:4999 or any other equivalent method approved by Engineer-in-charge. Execution and controls shall be as per IS:4999 for overburden grouting.All drill hole shall be protected from being clogged. Clogged holes shall be re-drilled and cleaned at contractor's cost.Unless indicated otherwise, the drill hole shall not deviate from their designed alignment by more than 3% of their designed length.

10.5.2 DRILLING

PERCUSSION DRILLING

The holes shall be drilled at locations, in the sequence, orientation, inclination and to the depths shown on the approved drawings or as required by Engineer-in-Charge.Most of the holes for consolidation curtain or contact grouting and pressure relief will be drilled with drill of the percussion type which shall be equipped for constant water flushing at the far end of the drilling rod.Dia, length, location & orientation of holes drilled for contact/consolidation/ curtain

grouting/pressure relief in various structures shall be as shown in the relevant approved drawings.

The use of rod dope, grease or other lubricants on drill rods shall not be permitted. No drilling water additives of any kind shall be used without the written permission of Engineer-in-Charge.

All holes shall be established to within 250 mm of the specified location. All orientation shall be within 1° of the orientation specified. If for any reason the drillhole deviates in location or orientation in such a way that it does not satisfy the purpose for which it was intended, the contractor shall correct the deviation or shall drill another hole to the satisfaction of Engineer-in-Charge.

Whenever the drill water is lost or artesian flow is encountered, drilling operations may be stopped by Engineer-in-Charge who may require the hole to be grouted before drilling operations are resumed. The contractor is required to record the location, the flow and pressure of any artesian conditions encountered in any drillhole.On completion of drilling and washing of any grout or pressure relief holes drilled through the floor of the galleries, the contractor shall immediately cap the holeswith proper removable plugs (wooden or plastic) and shall protect them from entry of dirt or other foreign material. Any grout or pressure relief hole that gets obstructed prior to grouting or installation of elbow shall be cleaned out or another hole shall be drilled by the contractor.Grout or pressure relief holes shall not be drilled within 12 m of another hole which is being grouted or which has been grouted within the previous 24 hours.No hole shall be drilled through concrete before 05 (five) days after the placement of the concrete.

EXPLORATORY DRILLING/ HOLES FOR INSTRUMENTATION/ CHECK HOLES ETC.

The Contractor shall perform exploratory drilling holes through overburden or concrete, rock and hardened grout at any inclination as directed by Engineer-in- Charge. The quantity and the requirement for, exploratory drilling will be determined by Engineer-in-Charge. The use of mud or any other drilling fluids besides water is not permitted when coring.

Whenever the Engineer-in-Charge asks for the core recovery, the Contractor shall collect the cores and the cores shall be placed in wooden boxes in the correct sequence and designated accurately by permanently labelled wooden blocks recording the measured distances in the hole. No box shall contain cores from more than one hole. Designation marks, hole numbers and depth values shall be inscribed in the boxes, the cover securely fastened to the core boxes, and the boxes delivered at an area near the site as designated by the Engineer-in-Charge.Maximum core recovery will be required and if the blocking of the core is indicated by the drill behavior, the core shall be removed immediately from the hole, regardless of the length of run which has been made. Exploratory holes shall be water pressure tested and grouted under pressure if required by Engineer-in-Charge. Probe holes shall be of 38 mm minimum diameter. Exploratory holes shall be 76 mm minimum in diameter.

DRILLING FOR CRACK GROUTING IN CONCRETE LINED TUNNELS

The contractor shall drill holes for the crack grouting and sealing of open cold joints, construction joints and cracks in the concrete lining as directed by the Engineer-in-Charge and as stipulated in Clause No.-11 (Concrete).

The drilling shall consist of a series of 38mm dia drill holes executed within or along the cracks which have been determined by Engineer-in-Charge to receive such treatments. Rotary drilling shall be used unless otherwise approved by the Engineer-in-Charge.

DRILLING OF HOLES FOR DRAINING OF ROCK PORTAL FACE

The contractor shall drill holes around the periphery of the excavation for draining the surrounding rock. The minimum diameter of holes shall be 45 mm or as shown on the drawings or as directed by the Engineer-in-Charge. When so directed by the Engineer-in-charge, these holes shall be used for consolidation grouting of the surrounding rock to check the leakage of water.

The holes drilled in the roof of the tunnel arch shall be fitted with galvanized iron pipes extending

from the ceiling of the arch to the vertical walls of the tunnel as directed by the Engineer-in-Charge. These galvanized iron pipes with manifolds shall later be covered by shotcrete.

The holes drilled in the hill slope around the portal face shall be fitted with polyvinyl chloride (PVC) pipe with perforated holes encased in geo textile /fabric sheet. These PVC pipes shall be filled with gravel. Steel strainer shall be provided on the outlet end of the pipe.

DRILLING OF HOLES FOR ROCK BOLTS/ ANCHOR BARS/ ANCHOR BOLTS, GROUTING

Holes shall be drilled either directly into the rock or through the concrete/steel lining and then into rock as directed by the Engineer-in-Charge.

The holes shall be drilled in a direction normal to the surface of the underground excavation/concrete lining as the case may be. In cases where seams, if any, in the rock have to intersected, the holes shall be drilled at inclinations as directed by the Engineer-in-Charge. While drilling the holes, utmost care shall be taken to ensure that the reinforcement or structural ribs, if any, in the concrete lining shall not be cut through. The position of steel ribs shall be recorded and marked on the finished concrete lining. If the reinforcement or steel ribs are encountered during drilling of any hole in concrete, drilling shall be discontinued immediately and a new hole shall be drilled nearby. The holes so abandoned shall be backfilled with concrete as directed by the Engineer-in-charge and the surface of concrete shall be repaired.

Each hole shall be protected from becoming clogged or obstructed by a grout connection pipe fixed suitably into the holes and the holes shall be suitably capped or otherwise protected until these are grouted. Any hole that becomes obstructed before being grouted shall be cleaned out in a satisfactory manner.

Generally, the holes for consolidation curtain or contact grouting and pressure relief shall be drilled with the percussion type drill which shall be equipped for constant water flushing at the far end of the drill rod. The use of rod dope, grease or other lubricants on drill rods shall not be permitted and no drilling water additives of any kind shall be used without the approval of the engineer-in-Charge. Dia, length, location & orientation of holes drilled for contact/ consolidation/ curtain grouting/ pressure relief in various structures shall be as shown in the relevant drawings.

Whenever the drill water is lost or artesian flow is encountered, drilling operations shall be stopped and the hole shall be grouted before drilling operations are resumed. The Contractor shall record the location, flow and the pressure of any artesian conditions encountered in any drill hole.

On completion of drilling and washing of any grout or pressure relief holes, the Contractor shall immediately cap the holes with proper removable plugs (wooden or plastic) and shall protect them from entry of dirt or other foreign material. Any grout or pressure relief hole that gets obstructed prior to grouting or installation of elbow shall be cleaned out or another hole shall be drilled. Grout or pressure relief holes shall not be drilled within 12 m of another hole which is being grouted or which has been grouted within the previous 24 hours. No hole shall be drilled through concrete before 5 days after the placement of the concrete.

10.5.3 WASHING AND WATER PRESSURE TESTING

Immediately before grouting or pressure testing, the hole shall be thoroughly washed with water as explained in IS: 6066 or any other standard practice as approved by the Engineer in Charge. For routine grouting operations, simple water tests shall be conducted immediately prior a stage of any grout hole is grouted. A simple water pressure test involves isolating a segment of a hole generally 3 to 5 m in length by means of a single or double packers and pumping in water at constant pressure for a period of 15 minutes. The tests shall be carried out as per IS: 6066 or any other standard procedure or code of practice approved by the Engineer-in-Charge.

10.5.4 GROUTING

GENERAL GROUTING PROCEDURE

Grout holes shall not be grouted except with permission from the Engineer-in- Charge, until the

concrete/ shotcrete within a radius of 12 m from the grout hole has been completed and cured for 05 (five) days.

Full depth grouting shall be limited to 5 m depth of hole in rock, however considering rock geology, experience and pre-grouting results the Engineer-in-Charge may allow full depth grouting up to 10 m depth. For deeper grout holes, more than 5 m length the grouting shall be performed in stages of not more than 5 m length of grout holes as directed by the Engineer-in-Charge.

Once the grouting of a stage of a hole has been commenced it should be continued without interruption until completion. In general, a stage may be considered complete when absorption of grout at the desired limited pressure is less than 2litres/min averaged over a period of 10 minutes.

As far as practical, a continuous flow of grout should be maintained at the desired pressure and the grouting equipment shall be operated to ensure continuous and efficient performance throughout the grouting operation. The Contractor shall respond quickly and effectively to effect the desired changes in the grout mix consistency, rate and pressure of injection, etc., as directed by the Engineer-in- charge during the grouting operation. When grouting is interrupted due to plant break down, about 500-1,000 litres of clean water should be run into the hole and allowed to stand.

Should any hole connect to another during injection, the grout should be allowed to escape from the coupled hole until it is of the same consistency as that being injected; the coupled hole should then be capped and the combined holes brought up to pressure. After the first hole has been grouted, all the other holes are successively connected to the grouting header grouting shall be stopped whenever pressure gauges register a sudden drop of pressure or the rate of grout absorption increases abruptly or there is any indication of upheaval, disturbance or leakage. Additional holes may have to be drilled and grouted in the vicinity or sealing cracks which might have been left due to premature blocking of holes by interruption of grouting operation to subject them to the full pressure.

Grouting shall be stopped whenever pressure gauges register a sudden drop of pressure or the rate of grout absorption increases abruptly or there is any indication of upheaval, disturbance or leakage. Additional holes may have to be drilled and grouted in the vicinity or sealing cracks which might have been left due to premature blocking of holes by interruption of grouting operation.

It is advisable to begin with a low initial pressure of 0.1 – 0.25 kg/cm2/m of overburden and built up pressure gradually. The pressure shall be raised only when the intake rate falls below 5 lit/min. or as specified otherwise.

The true pressure at any depth should take into account the pressure head caused by weight of the grout in the hole as explained in IS: 6066 (1984).The control of pressure shall be exercised according to the guidelines of IS: 6066(1984).Compositions of all grout mixes shall be approved by the Engineer-in- Charge.

When pressure does not build up even after the grouting, a thick grout i.e. with water cement ratio less than 0.6:1 by weight or by grout with filler such as sand and bentonite, it is desirable to stop grouting after predetermined limit of consumption is reached. Additional holes shall have to be drilled and grouted in the vicinity of such holes. All grout holes shall be backfilled with grout mix 0.7 water: 1 cement with 3% bentonite or by mix as approved by Engineer-in-Charge after the grouting. A minimum 25 mm diameter delivery pipe is lowered to the bottom of the hole. Grout is pumped in the delivery pipe until it flows from the hole, then the delivery pipe is slowly withdrawn while pumping continues. If settlement of grout occurs after initial set, the holes shall be again backfilled by grout.

The contractor shall caulk, dry pack or seal any surface leaks in rock or concrete before continuing grouting operation. In areas of higher grout consumption sand may be required to be incorporated in the mix, the proportions of the sand permitted shall normally not exceed 2 parts of sand for 1 part of cement with approved plasticizer. The grout mixes which cannot be injected within 1 hour of mixing shall be discarded.

CONTACT GROUTING

Contact Grouting in Tunnels & shaft

Low pressure contact grouting shall be carried out between concrete lining and rock, over the entire length of concrete lined tunnels and draft tube concrete lining to fill voids between the rock surface and the following:

- Structural concrete in the crown of tunnel and in the concrete plug in the tunnel
- Concrete in any other zone within the underground work where conditions so required and as directed by Engineer-in-Charge

Contact grouting shall be performed from holes drilled in the overt of concrete lining of the tunnels, shaft (as shown in the construction drawings) in advance of consolidation grouting operation.

Washing and water pressure testing will not be required prior to contact grouting. In any section of the underground structure, the concrete lining within 100 m of that section shall have been in place for at least 21 (twenty one) days before grouting commences.

Contact grouting shall be carried out at low pressure (not exceeding 5 bars) and shall continue until all voids are filled, unless otherwise directed by the Engineer-in-Charge. Vent pipes for the release of air and water during grouting shall be provided in locations directed or approved by the Engineer-in-Charge. After the grouting of any hole is completed, the pressure shall be maintained by means of a stopcock or other suitable device until the grout has set. Check grouting shall be carried out where directed by the Engineer-in-Charge, to verify that voids have been completely filled with grout. Grouting will be regarded as being satisfactory if the pressure can be maintained for at least 5 minutes without further grout take. Contact grouting in the completed concrete plug in access ADITs shall be performed through the pipe system cast into the body of the plug as shown in the drawings.

FILL GROUTING

Fill grouting of exploratory and drain holes shall be carried out before placing of the concrete lining. The entire system of temporary invert drains and sump pits in the tunnel shall be filled by grouting with a cement sand grout. After completion of consolidation grouting (and installation of the permanent drainage system where required), the entire system of temporary invert drains in the tunnel shall be filled by grouting with a cement-sand grout at pressures directed by the Engineer-in-charge. During grouting operations, the permanent drainage system shall be protected. The contractor shall use a systematic procedure for fill grouting of the invert drains to ensure displacement of water and complete filling of the drains.

CONSOLIDATION GROUTING

Consolidation grouting shall be performed at ADIT-II and at other locations as advised by E.I.C.

Consolidation grouting shall normally be performed in a single stage through a nipple or packer installed at the collar of the hole within the concrete lining, but if geological conditions so dictate multiple-stage grouting either in ascending or descending arrangement shall be performed in the deeper holes as directed by Engineer-in-charge. Consolidation grouting at an open air structure shall first commence 07 (seven) days after concrete placement. Grouting for rock consolidation in any section of the completed underground structure shall not start earlier than 21 (twenty one) days after completion of contact grouting within 100 m of that section.

Immediately before grouting, the grout holes shall, rock characteristics permitting, be thoroughly washed out under pressure until the returning water is clear, and pressure tested.Grout holes adjacent to a grout hook-up shall be left open during grouting operations to facilitate the escape of air and water from pockets in surrounding rock. Where, during grouting of any hole, grout is found to be flowing from adjacent holes or cracks of any kind, such openings shall be capped temporarily by plugging or caulking.

When performing the multiple-stage grouting in descending arrangement, the grout that is within the hole shall be removed from each stage except the deepest one, by washing, or by the use of

a chopping or a "fishtail" bit before the grout sets. In the event of a sudden drop in pressure or a sudden increase in grout take, grouting operations shall be temporarily halted until the crack or opening causing the loss is located and caulked. During this time the drill hole shall be continuously washed to avoid a premature grout set which would inhibit grouting to resume. If such a pressure drop or increase in grout take can be related to hydro fracturing, grout pressure shall be reduced.

If surface grout leaks cannot be located and successfully caulked, or the cause for the pressure loss cannot be determined, within 1 hour, the washing of the drill hole will be stopped and the grout in the rock formation shall be allowed to set for 24 hours. After setting, the drillhole shall be hooked onto again and grouted. If the hole, or stage, does not accept grout the hole shall be re-drilled or a replacement hole shall be as directed by the Engineer-in-Charge.

If, during grouting, there is a communication between the holes, the Contractor shall either set packers in the communicating holes which shall be bled of accumulated air frequently and continue grouting one hole after another, or he may pressure grout the communicating holes simultaneously. Grouting injection will be deemed to be completed when the absorption of grout is less than 2 litres/ minutes or intake has become 0.03 m3 or less per stage of hole being grouted during 10 minutes at the specified grouting pressure and mixture.

After completion of grouting, the packers shall remain in the hole and the pressure shall be maintained until the grout has attained its initial set. The results of water-pressure testing and other information obtained during the performance of grouting will be used for the determination whether the grouting in each section of the work under consideration is completed in a satisfactory manner, or whether additional grouting in separate drill hole is required. The termination of grouting work in any sequence in any section of the Work will be as determined by the Engineer-in-Charge.

10.6 MEASUREMENT AND PAYMENT

The payment shall be made as covered under the clause no.11 Of GCC

11. CONCRETE (EXCLUDING REINFORCEMENT AND JOINTS)

11.1 SCOPE OF WORK

The work under this section includes all labour, materials, equipment and services related to the concrete work to be carried out by the contractor under this contract. The concrete work shall be performed to the dimensions as shown on the construction drawings or as otherwise directed by the Engineer-in-Charge. The contractor shall arrange concreting work in coordination with all other associate agencies related to the construction of permanent work where the material or equipment is to be fixed to, or embedded in the concrete structures. Formwork, reinforcement and Shotcrete are covered separately in other sections of these specifications. The approval given by the Engineer-in-Charge to the contractor's plants and equipment or their operation or of any construction methods shall not relieve the contractor of his full responsibility for the proper and safe execution of concrete work or any obligations under this contract.

11.2 STANDARDS

Unless otherwise specified, the standards and recommendations of Indian standards code of practices shall be followed in respect of all materials, equipment and performances.

The following Indian Standards are generally to be followed during design, preparation, execution and testing for acceptance of the work:

IS: 8112 – 43 Ordinary Portland Cement

IS: 456 – Code of practice for Plain and Reinforced Concrete

IS: 383 – Coarse and fine aggregates from natural sources for Concrete)

IS: 2386 (Part-IV) – Method of testing of aggregates for Concrete- Mechanical property

IS: 5878 (Part-V) Code of practice for Construction of tunnels conveying water: Concrete Lining

IS: 516 – Method of test for strength of Concrete

IS: 1199 – Method of sampling and analysis of Concrete IS: 457- 1957

IS: 9103 - Concrete Admixtures: Specifications

IS: 7861 (Part-I and Part-II) - Code of practice for Extreme weather concreting, Recommended Practice (Hot weather and Cold weather concreting)

IS: 2505 Concrete Vibrators – Immersion type general requirements

In absence of relevant Indian Standards and specifications the recommendations of "ACI Manual of Concrete Practice" and U.S.B.R. Concrete Manual shall be followed.

11.3 SUBMITTALS

11.3.1 SUBMITTALS BEFORE CONSTRUCTION

Submittals listed herein are related to items which require the consent of the Engineer-in-Charge and are to be submitted by the contractor before the appropriate work may proceed. Within 28 (twenty-eight) days from the date of issue of Notice to commence, but before procuring or mobilizing to the Site the equipment, the contractor shall submit to the Engineer-in-Charge updated and detailed plans and descriptions, consistent with those submitted with his Tender and any subsequent amendments and additions agreed to by the Engineer-in-Charge and the contractor, of the following:

- Aggregates Processing Plant:

The contractor may identify locally suitable query site(s) and arrange for Aggregate Processing Plant i.e. crusher obtaining necessary permission from the concerned authority. Materials to be extracted from the said query sites are to be tested from authorised test laboratory/ Govt. Technical Institutes to check quality of the materials, whether suitable for attaining requisite strength of concrete, with prior intimation to the E.I.C. Test results in original shall have to be submitted for acquiring approval towards use of the aggregate materials in construction work. Otherwise, the contractor shall have to arrange Aggregate materials for concreting and other work required for construction of the project as a whole from his own sources maintaining requisite quality as per relevant IS Code of practice.

- Batching and Mixing Plants:

Portable Batching and Mixing plant or any other means of batching and mixing of aggregates as per provision of relevant IS Codes shall have to be arranged by the contractor for obtaining uniform and workable concrete mixture. The contractor may also use Ready Mix Concrete of requisite strength following the codal provision to maintain specific quality of the Mix in course of time.

- Transport and Placing of Concrete:

Full details of the equipment and methods for transporting the concrete from the concrete plant to the final point of placing, including numbers, type and capacity of transport vehicles, concrete pumps, vibrators, and details of standby plants to be installed.

- Mode and methodology of concrete curing.

(a) Sampling and Testing of Materials:

The Contractor shall have to arrange for testing equipment for sampling and testing for quality control check of concrete work at site and technically qualified experienced personnel to look

after the work.

(b) Notification of any admixtures which the Contractor proposes to use for specific purposes, providing manufacturers specifications thereof and information about the chemical names of the principal ingredients and the effects of under or over dosage for approval of E.I.C. before use.

Should the Contractor intend to use an accelerator in any concrete work for his own convenience, he shall give full details of the type, dosage, influence on construction and the cost savings involved for according approval by the E.I.C. before use.

Details of the materials for formwork and surface finishes, treatment of construction joints, and construction techniques which the contractor proposes to use in order to achieve the required concrete surfaces and allowable tolerances,

At least 28 days prior to procuring or despatch to the Site of the particular item of work to which the submittal relates, the Contractor shall submit to the Engineer-in-Charge the following:

- Details of curing compounds, if any,
- Details of epoxy mortar for concrete repair.
- Drawings showing the location of construction joints proposed by the Contractor which differ from those shown on the Construction Drawings, including formwork and reinforcement details, for of work on that particular structure.

11.3.2 SUBMITTALS DURING CONSTRUCTION

(a) Contractor shall provide the Engineer-in-Charge with a weekly placing scheduling giving the detailed location of the pours, the approximate extent of pours, and the date on which the concrete will be placed. This weekly programme of concrete placement shall be submitted to the Engineer-in-Charge for his acceptance at least 02 (two) days prior to the commencement of the week.

(b) Before commencement of the concrete placement the contractor shall prepare a checklist regarding all preparations for the specified work such as rock surfaces and foundations, cleaning, formwork, reinforcement, embedding, and submit this list to the Engineer-in-Charge, who after his satisfaction about the work preparations will permit the contractor in writing to commence concrete placement.

(c) The contractor shall keep and make available to the Engineer-in-Charge records of the date, amount, and storage location of each delivery of cement and of the part of the work in which it was used and shall provide facilities for checking the stock of cement.

(d) During the performance of the concrete work, the contractor shall keep a diary where he shall record the construction procedures related to concreting. This diary shall be made available to the Engineer-in-Charge upon request. The records shall contain at least the following:

i. Commencement and termination of concreting of various parts of the structures,

ii. Quantities and quality of aggregates and cement provided, and the storage from which they were drawn,

iii. Sampling and testing performed and summary of results,

iv. Personnel employed during various stages of the concreting operation and name of the responsible inspector or foreman,

v. Equipment used,

vi. Directives received from the Engineer-in-Charge,

vii. Any special material or procedures employed.

The Engineer-in-Charge reserves the right to require any additional information deemed necessary

to be included in the submitted documents.

11.4 CONSTITUENTS OF CONCRETE

11.4.1 CEMENT

Each consignment of cement delivered to the Site shall be accompanied by a test certificate issued by the manufacturer in quadruplicate. If delivery is not directly from the manufacturer, the intermediate storage and delivery arrangements shall be subject to the approval of the Engineer.

Cement must comply with relevant IS Code otherwise shall be promptly removed from the Site.

All facilities for transport and storage of cement shall be subject to approval of the Engineer-in-Charge and shall be such that easy access for inspection is assured.

The Contractor is solely responsible for the timely supply of cement meeting the requirements of these Specifications and the Work. The delay due to the lack of suitable cement will not give the Contractor any right for the extension of time for the Completion of Work, or any claims resulting there from.

11.4.2 AGGREGATE

(a) GENERAL

Unless otherwise specified, concrete aggregates shall conform to the requirements of IS: 456 and IS: 383. They shall be tested in accordance with the provisions of IS: 2386.

Aggregates shall consist of clean, hard, dense, durable and uncoated materials, and shall have stable moisture content and grading when delivered to the batching plant.

Aggregates shall not contain substances which may impair the quality of the concrete, attack reinforcing steel or reduce bond. The following substances are regarded as being harmful: loam, clay, pieces with large cavities, foam-like or vitreous pieces, and organic materials such as topsoil, roots, wood, coal, lignite, etc. In doubtful cases the effects of harmful substances shall be established by tests.

(b) SOURCE

Coarse and fine aggregates shall be produced from suitable material obtained from the approved quarry and borrow areas or from river bed material or from other sources as may be designated or approved in the course of the work. The Contractor shall carefully clear the area from which aggregates are to be produced of unsuitable materials and other objectionable matter. The area shall be operated so as not to detract from the usefulness of the area. All materials removed from the area and not used in the work shall be disposed of as directed. Alternative sources developed by the Contractor shall be subjected to approval by the Engineer-in-Charge. The Contractor shall carry out tests to furnish satisfactory evidence that aggregates from such alternative sources comply with the requirements of this Section.

The aggregate source shall be subject to the approval of the Engineer-in-Charge. However, such approval of source shall not be construed as acceptance of all materials to be taken from that source. The Engineer-in-Charge reserves the right to reject certain localized areas, strata, or channels within the approved areas and zones, when the material is unsatisfactory for use.

(c) FINE AGGREGATES

The term "fine aggregate" is used to designate aggregate in which the maximum size of particles is 4.75mm. The gradation of fine aggregate shall be as given below:

Square Mesh Sieve Opening (mm)	Percentage passing (By weight)
4.75	95-100
2.36	80-100

1.18	50-85
0.6	25-60
0.3	10-30
0.15	2-10
0.075	0-3

The percentage of deleterious substance in the fine aggregate shall conform to IS: 383, except that the fine aggregate shall contain not more than 0.1% by weight of deleterious (reactive) ferrous sulphide. The total percentage of deleterious substance must not exceed 5% by weight.

Fine aggregate having specific gravity of less than 2.6 shall be rejected. Fine aggregates, when subjected to soundness test with a solution of sodium sulphate, after five cycles of tests, shall not suffer a loss of weight in excess of 10 per cent. Fineness modulus shall be 2.6 ± 0.4.

Fine aggregate, upon delivery to the batching plant, shall have uniform and stable moisture content. The amount of moisture shall be less than 6% by weight, and shall not vary by more than 0.5% per hour.

(d) COARSE AGGREGATES

The term "coarse aggregate" is used to designate aggregate which is retained on sieve opening 4.75mm. The coarse aggregate shall be well graded and its gradation will be decided based on the laboratory tests to obtain dense mass of concrete. The gradation will be approved by the Engineer-in-Charge before production of the concrete. Coarse aggregates shall be stored separately in stockpiles or bins in such a manner to avoid intermixing of different size of aggregates. The storing shall be done in following sizes: 4.75-10 mm, 10-20 mm and 20-40 mm. The percentage of deleterious substance in the coarse aggregate shall conform to IS: 383, except that the coarse aggregate shall contain no more than 0.3% by weight of deleterious (reactive) ferrous sulphide.

When subjected to following tests as specified in IS: 2386 (Part IV), the coarse aggregate shall comply with following requirements:

(a) Aggregate Crushing Value Less than 45%

(b) Aggregate Impact Value Less than 45%

(c) Los Angles abrasion value Less than 50%

When subjected to sodium sulphate soundness test, coarse aggregate shall not suffer a loss of weight in excess of 12% after five cycles.

Coarse aggregate shall be hard, dense, durable, uncoated rock fragments. Rock having absorption greater than 3% or specific gravity less than 2.5 shall not be used.

Aggregate delivered to the batching plant shall have uniform and stable moisture content.

The nominal maximum aggregate size in relation to the structure dimension shall not be larger than:

- 0.20 of the narrowest dimension between the side of forms,
- 0.75 of the minimum clear spacing between the reinforcing bars,
- 0.25 of the slab depth.

(e) WATER

A reliable and adequate water supply shall be installed and maintained by the Contractor for washing of aggregates, manufacturing and curing of concrete. The water shall be clean and free from harmful quantities of oil, acids, alkalis, sugar, salt, silt and other organic matters and shall conform to IS: 456. Water shall contain no more than 1,000 mg/l of sulphates (SO4), not more than 100 mg/l of chlorides (Cl), and shall have a turbidity limit of not more than 1,000 ppm.

Adequate water storage shall be provided at the batching plant to ensure smooth concrete production. Contractor shall familiarize himself with source and quality of water available. Attention is drawn to the possible requirement of settling pond and other facilities that he may be required to provide.

(f) ADMIXTURES

Admixtures shall be proposed by the Contractor and shall be used only upon written approval of the Engineer-in-Charge. Only admixtures that have been commercially used with satisfactory service in a similar type of concrete work shall be considered for approval. All admixtures shall be manufactured by a reputable company(ies), supported by a fully staffed technical service organization and research group.

The Contractor may use the following admixtures when required with the approval of the Engineer-in-Charge:

i. Superplasticizer meeting requirement of ASTM C-494, Type F.

ii. Air-entraining agent, (complying to IS 9103: 1999)

iii. Accelerating agent in the concrete, mortar or grout to increase the rate of hydration, shorten the setting time or increase the rate of hardening or strength development, (complying to IS 9103: 1999)

iv. Admixtures shall be stored and handled so as to avoid contamination to their properties by temperature or moisture changes or other influences.

v. The quantity of admixture used and the method of mixing shall be strictly in accordance with the manufacturer's printed instructions, or as required to produce specified results and approved by the Engineer-in-Charge.

vi. The Contractor shall be held liable for any contamination and difficulties resulting from the selection and use of admixtures such as delay in concrete placing or contamination to concrete during forms removal, and shall not be entitled to any time extension or claims resulting here from.

11.5 CONCRETE MIX DESIGN

11.5.1 GENERAL

i. Denomination of concrete classes is based on the characteristic compressive strength (in Newton per square mm) and maximum aggregate size.

ii. The characteristic compressive strength is defined as the compressive strength of 150 mm cube as measured at 28 (twenty-eight) days. The strength shall comply with the requirements of IS: 456.

iii. The following table shows, in general, the anticipated classes of concrete required in various sections of work. The specific class of concrete to be used in each area will be shown on the Construction Drawings or designated by Engineer-in-Charge:

Grade of concrete Type	Nominal Maximum size of aggregates (mm)	Nominal cement content (kg/m3)	Maximum slump
M-30 Reinforced	20	430	120

M-25 Reinforced	20	420	120
M-20 Reinforced	20	400	120
Plain	20	250	100
Plain	40	220	100

iv. Much before commencement of any concreting of Permanent Work, the Contractor shall start the testing of materials, propose the composition of concrete mixes and prepare trial mix of each of the proposed concrete class. The Contractor shall prepare the trial mixes using the cement, water, aggregates and admixtures intended for the work and which conform to the requirements specified in this Section.

v. The contractor shall determine, in accordance with IS standards and/or ACI Manual of Concrete Practice, the mix proportions for the designated classes of concrete. The contractor shall submit the test reports to the Engineer-in-Charge for approval. This preliminary test program shall include the determination of following parameters:

(a) Cement properties,

(b) Characteristics of aggregates,

(c) Mix water properties,

(d) Admixture properties,

(e) Proportion of aggregate ranges in the mix,

(f) Proportion of uncrushed to crushed aggregates,

(g) Cement content,

(h) Water-cement ratio (W/C),

(i) Workability of concrete mixes,

(j) Compressive and tensile strength,

(k) Entrained air,

(l) Density,

(m) Water-tightness.

vi. These tests shall be carried out until the concrete mixes show appropriate strength, workability, density, and water-tightness without the use of excessive cement and water. The actual cement content in the mix design shall be optimized and justified by using cement of various manufacturers during trial mix design.

vii. To carry out these preconstruction tests, full-scale machine-mixed test batches shall be made and test samples taken there from. Tests shall be made in ample time so that complete and acceptable results are available before concreting of structures.

viii. Test samples shall be made in accordance with IS: 1199 and tested in accordance with IS: 516. The test results shall be analysed in accordance with IS: 456.

ix. The mixes for different classes of concrete shall be approved by the Engineer-in-Charge in specific consultation with the designers

x. During the progress of the work, the mixes may be changed whenever, in the opinion of the Engineer-in-Charge, such change is necessary or desirable to secure the required strength, workability, water-tightness, density, economy, or to limit shrinkage. The Contractor shall not

change the approved mix proportions without the written permission of the Engineer-in-Charge.

xi. Water to be added to the mix shall be adjusted to compensate for any variation in the free moisture content of the aggregate as they enter the batch plant. Water beyond the specified water-cement ratio shall not be added without the written permission of the Engineer-in-Charge.

xii. The recommended air contents shall be as follows:

Nominal Maximum Aggregate Size in mm	Average Air Content in Percentage	Remarks
20	5	Tolerance for air content
40	4	in the field construction is ± 1.0 %t

11.6 QUALITY CONTROL

11.6.1 GENERAL

The Contractor shall be completely responsible for performing detailed quality control program during the execution of the work. This quality assurance program shall be subject to inspection and checking by the Engineer-In-Charge.

The Contractor shall keep records of test results, which shall be presented to the Engineer-in-Charge upon request. Should the Contractor wish to reduce his approved testing program he shall notify the Engineer-in-Charge of these changes 15 (fifteen) days in advance.Aside from Contractor's testing program the Engineer-in-Charge will make control test to the extent as he deems necessary. The Contractor shall give all required assistance in sampling and provide for the proper storage and transport of the specimens to be tested by the Engineer-in-Charge.The Contractor shall make such arrangements or purchase new equipment should the test results prove that changes in the aggregates or concrete plant are necessary to obtain required concrete quality.

11.6.2 SITE LABORATORY

The Contractor shall build, equip, and operate the site laboratory in which the tests included in the Quality Control Programme will be carried out. In some cases, where special tests are required, they will be made in other specialized laboratories after approval by the Engineer-in-Charge.

The laboratory shall be equipped with all the necessary equipment to carry out the tests indicated below. Else the contractor shall have to arrange the specified tests from recognized laboratory as per E.I.C.

(a) Tests on aggregates as per IS 2386 (Parts I, II, III, IV)

- Sieve analysis
- Compressive strength
- Specific gravity
- Water absorption
- Flakiness
- Sand equivalent
- Soundness and organic matter

- Los Angeles abrasion

(b) Tests on cement

- Equivalent alkaline content (IS 4032)
- Specific Blaine surface (IS 4031 (6))
- Standard Mortar Compressive Strength (IS 4031 (6))
- Shrinkage (IS 4031 (10))
- Heat of hydration (IS 4031 (9))
- Setting time IS 4031 (5))

(c) Tests on fresh concrete

- Consistency through slump test (IS 1199)
- Workability
- Heat of hydration using thermometers, cells and recording instruments

(d) Tests on hardened concrete

- Compressive strength on all classes of concrete (IS 516)
- Shrinkage IS 4031 (10))

11.6.3 CONCRETE SAMPLING AND TESTING

(a) AGGREGATES

Aggregate samples shall be taken from silos at the batching plant or from the conveyor belt. The sampling shall be done at the frequency of one every 1,000 m³ of produced concrete (cumulative of all concrete classes) and once a week at minimum. The following tests will be carried out:

- Sieve analysis
- Los Angeles abrasion
- Crushing Value
- Impact Value

(b) CEMENT

The following tests will be carried out at both laboratories and batching plant each week:

- Setting time
- Standard mortar compressive strength at 3, 7 and 28 days

(c) ADMIXTURES

Admixtures to be used for concrete production shall be tested for their suitability with the cement and other materials under actual working conditions.

(d) WATER

A sample of water will be taken from the concrete batch plant every 03 (three) months and submitted to chemical analysis as described in IS 3025.

(e) FRESH CONCRETE

The following tests shall be carried out by the Contractor on fresh concrete samples:

Consistency (slump tests) on all concrete classes (sieved at 40 mm for 80 mm and above size of aggregate concrete.

These tests shall be carried out at the beginning of manufacturing of the concrete for each work or

part of the work and for large quantities once every 100m^3.All consistency tests shall be determined on that portion of the total sample which passes a 40 mm size.

(f) HARDENED CONCRETE

Set of six samples for compressive strength tests at 7 and 28 days will be taken and tested for each part of the work, being defined as the volume poured in one concreting operation.For large concreting operations, this set of sample will be taken every 200 m3.Compressive strength specimens shall be prepared by the contractor and shall be performed in accordance with Indian Standards and code of Practice. All coarse aggregate larger than one quarter the minimum dimension of the mould will be removed by wet screening. Portions of samples of concrete used for slump, air content, unit weight, etc. will not be used to mould specimens for compressive strength testing.

In addition to the strength tests carried out as above, it is contemplated that tests on actual cores from the concrete laid in position will be made, and results thereof shall be in conformity with those obtained in case of cubes cast at the batching and mixing plant or at the placing point. For this purpose, it may be necessary to establish relationship between concrete strength versus age, as it may be possible to test control cubes and cores of the same age taken from the hardened concrete in the structure. Location and number of cores shall be decided by the Engineer-in-Charge. If the cores taken out show unreasonably low results, the work is liable to be rejected and may be required to be dismantled and re-done with all consequences to the Contractor. The Contractor shall afford all reasonable facilities for taking the test cores.

The Contractor shall fill the test holes left by the removal of the cores with concrete of the required strength to the satisfaction of the Engineer-in-Charge.

The Contractor shall at all times, have access to and association with sampling, design and test of trial mixes, tests of strength and similar other operations to obtain on the work, concrete of quality, density and strength corresponding to the laboratory tests. Failure on the part of the Contractor to associate with the operations aforesaid, shall not absolve him of the responsibility of producing on the Work, concrete of specified quality and strength.

(g) ANALYSIS OF RESULTS

The test results will include the different components analyses, the values obtained on fresh and hardened concrete and the characteristics of the corresponding batch given by the printer of the batching plant. The Contractor shall present regularly to the Engineer-in-Charge a synthesis of all the results in the form of tables, charts, statistical analyses (weekly and monthly reports).

11.7 ACCEPTANCE CRITERIA

11.7.1 CONCRETE COMPONENTS

The measured values shall be within the specified range of values indicated above. Any unsuitable material should be eliminated and the concrete manufacturing be suspended until the Contractor justifies that the replacing component is acceptable.

11.7.2 FRESH CONCRETE

Any controlled batch which will not satisfy the specified conditions in terms of consistency, air content and temperature, will be eliminated and concreting suspended until it is shown that corrections brought to the following batches are satisfactory.

11.7.3 HARDENED CONCRETE

The acceptance criteria for hardened concrete shall be as per the IS: 456. If analysis of test cube results indicate poorer concrete in the structure as per the acceptance criteria of IS: 456, the Engineer-in-Charge will order the contractor to provide core tests. Location and number of cores will be decided by the Engineer-in-Charge. The contractor shall take out the specified sizes of cores from the structure. In case the concrete cores fail to meet the specifications and the Engineer-in-

Charge is not satisfied with various tests results and quality, he will then instruct the contractor for removal or subsequent suitable strengthening measures for such work.

11.8 BATCHING AND MIXING

11.8.1 GENERAL

The contractor shall arrange to provide, operate, and maintain at the Site portable batching equipment to determine and control the amount of each individual material entering the concrete. Batching equipment shall be designed for such capacities which will permit performance of the concrete work in accordance with contractual construction program.

Water, cement, admixtures, fine aggregate and coarse aggregate shall be measured separately and not cumulatively. The accuracy of the measuring devices shall be maintained so that the indicated measure does not vary by more than 1 per cent from true measure throughout their range of use.

The devices shall be capable of being operated to control the delivery of materials so that the combined inaccuracies in feeding and measuring do not exceed the following limits:

Material	Percent (by weight)
Cement	1%
Water	1%
Aggregates	3%
Admixtures	1%

Batching of Aggregates shall be by weight only; Volume batching will not be permitted.

11.8.2 MIXING

Concrete shall be mixed in power-driven stationary batch mixers of approved type and size. They shall be kept clean and in proper working order. The mixing blades in the drum shall be replaced when worn by 10% of their design dimensions.

Movable truck mixers shall not be permitted for mixing concrete mixes.

The batching plant shall be provided with a bypass such that the mix materials can be discharged directly into a transit mixer drum. This bypass is to be used only in emergency and with permission of the Engineer-in-Charge.

The mixing equipment shall be capable of combining the aggregate, cementing materials, water and other ingredients, within the time hereinafter specified, into a thoroughly mixed and uniform mass, and of discharging the mixture without segregation.

The mixers shall be so charged that some water will enter in advance of cement and aggregate and all materials shall continue to flow in as rapidly as possible. The construction of the mixers should prevent loss of materials during charging.

The mixers shall not be charged beyond their rated capacities and the entire contents of the mixer shall be discharged before recharging. Unless otherwise authorized by the Engineer-in-Charge for mixers of 1m³ capacity or less, the mixing of each batch shall continue for not less than +1.5 minutes as specified in IS:456 (but not more than 5 minutes when mixing air-entrained concrete) after all materials, except the full amount of water, are in the mixer. For mixers of larger capacity, the minimum mixing time will be increased by 15 seconds for each additional 0.5m³.Mixers shall be rotated at the rate recommended by the manufacturer of the mixers.

The arrangement for controlling, measuring and mixing operations shall be such that the operator may observe the concrete discharging from the mixer.

Should a mixer at any time prove unsatisfactory, it shall be replaced or its use discontinued until it is made satisfactory. Each mixer shall be cleaned after each period of continuous operation and shall be maintained in such a condition that the mixing action will not be impaired. Where the distance between the batching plant and a concrete pour is such that it would in the opinion of the Engineer-in-Charge cause deterioration of mixed concrete in transit, dry batching may be permitted using transit mix trucks in accordance with IS: 456. Water shall be added not later than 30 minutes after batching.

On no account shall any addition be made to any component of a concrete batched once that batch has been mixed and discharged from the mixer, whether for the purpose of re tempering or for any other reason. Batching and mixing of concrete shall not commence unless due notice, at least 24 hours in advance, has been given to the Engineer-in-Charge and written approval has been obtained for the placing arrangements, and for the preparation and accuracy of the part of the Work in which concrete is to be placed.

11.8.3 CONVEYING

The method and facilities for concrete transport shall be selected by the contractor within the limitations of these specifications, and he shall be responsible for adequacy and suitability of the transporting system. The time elapse between mixing and the initial set of the concrete shall be taken into consideration. All methods used shall be reviewed by the Engineer-in-Charge.The concrete transporting methods and facilities shall be such that will prevent segregation of coarse aggregate, excessive loss of slump, and loss of ingredients. Equipment such as buckets, cars, conveyers and pumping equipment which may be used for conveying concrete, shall be of such size, design and condition as to ensure an even and adequate supply of concrete at the placement area. All equipment shall be kept clean and in good working condition.

The use of chutes to convey concrete will not be permitted, except that chutes less than 3m in total length may be used immediately adjacent to or in the forms with acceptance of the Engineer-in-Charge. Where chutes are used, they shall be so constructed and arranged as to permit continuous flow of the concrete without separation of the ingredients. There shall be no vertical drop greater than 1.5m, except where equipment satisfactory to the Engineer-in-Charge is used to confine and control the falling concrete. Concrete may be dropped through flexible elephant-trunk chutes, provided methods are used at the lower end to retard the speed of the falling concrete and prevent it from segregating. Where it is necessary to drop concrete from more than 1.5m it shall fall into a hopper with a capacity of 1m3 more than the total capacity of the full trunk. Buckets for transporting concrete shall be manufactured as low slump concrete buckets. All conveying plant shall be supported independently of the forms, except as specifically permitted by the Engineer-in-Charge. The conveying plant shall be kept free from hardened concrete and foreign materials, and shall be cleaned at frequent intervals.

11.9 PLACING

11.9.1 GENERAL

Contractor shall place concrete in a given location only after the Engineer-in- Charge has agreed with the placement of such concrete. All concrete shall be placed in presence of the Engineer-in-Charge. Concrete placed without prior knowledge and approval of the Engineer-in-Charge may be required to be removed and replaced at Contractor's debit. When placing the concrete by pumping, direct communication shall be maintained between the concrete placing crew and the pump operators. In order to reduce bleeding, slump shall not be higher than necessary to achieve proper placement and consolidation. Concrete shall be placed before initial set has occurred, i.e. 60 to 90 minutes after adding water to the mix. No concrete shall be placed when the atmospheric conditions are, in the opinion of the Engineer-in-Charge, such that proper placing and hardening of the concrete are not guaranteed. Specifically, the Contractor shall have the responsibility for

meeting the hot and cold weather concreting requirements and for postponing concreting whenever such requirements cannot be met or, based on weather forecast, probably cannot be met. Even if the above requirements are fulfilled, the contractor has the responsibility of delivering concrete product that meets specified requirements.

11.9.2 PREPARATION FOR CONCRETE PLACING

Concrete shall not be placed until all formwork, installation of embedded parts, reinforcing steel, and surfaces against which concrete is to be cast have been accepted by the Engineer-in-Charge.

All surfaces of forms and embedded items that have become encrusted with dried material from concrete previously placed shall be cleaned of all such material before the surrounding or adjacent concrete is placed.

Concrete shall not be placed in any structure until all water entering the space to be filled with concrete has been properly cut off or diverted by pipes, or by other means, and carried out of the forms clear of the work. Water shall not be allowed to stand on any concrete surface until it has attained its final set. Water flow over the concrete, which may injure the surface finish, will not be allowed.

Pipes, conduits, dowels and other items to be embedded in concrete shall be so positioned and supported prior to placement of concrete to be stable and provide sufficient clearance (50 mm min.) between said items and steel reinforcement to allow proper concreting. Securing such items in position by wiring or welding to reinforcement will not be permitted.

Where excavated surfaces which are to form the foundations for structural concrete, are absorptive or likely to become otherwise unsuitable, or where shown on the Construction Drawings, the Contractor shall place a 'blinding course' consisting of a layer of Class M10 or M15 concrete 50 to 100 mm thick, as directed by the Engineer-in-Charge, uniformly over the foundation such that the upper surface is at grade elevation. Blinding concrete shall be placed before installing reinforcement or formwork.

Immediately before concreting, the forms and all other surfaces which will be in contact with the fresh concrete shall be cleaned of all loose material and debris including shavings, wood chips, sawdust, pieces of wire, nails, fragments of hardened concrete and mortar. Clean-out holes which may be needed for this purpose shall subsequently be securely closed in order to obtain the required surface finish.

The use of compressed air for cleaning will be allowed only if adequate precautions are taken to avoid the deposition of suspended oil on construction joint surfaces, reinforcement or other items which are to be bonded to concrete.

The contractor shall provide such personnel and equipment so that the performance of the concrete work is in a satisfactory manner. The transporting and placing equipment shall be clean and in good condition, adequate, and properly arranged to proceed with the placing without undue delays. The number and condition of vibrators for use and standby shall be ample for the requirements during placement. The lighting system shall be sufficient to illuminate the inside of the forms when concrete is placed at night.

The contractor shall have protective coverings available for fresh concrete surfaces if there is a possibility of rain, hail, sleet, or snow. Rock surfaces against which concrete is to be placed shall be clean and free from oil, standing or running water, mud, loose rock, objectionable coating, debris, and loose or unsound fragment. Faults, fissures and seams shall be cleaned to sound rock, and if directed, backfilled with dental concrete, Shotcrete or dry- pack as appropriate. Immediately before concrete is placed, all surfaces shall be cleaned thoroughly by the use of high velocity air-water jets, sweeping with brooms, wet sandblasting, bush-hammering or other satisfactory means including combinations of the above.

Rock surface against which concrete is to be placed shall be kept wet for at least 12 hours during the 24-hour period prior to placing concrete and shall be in a barraged condition at the time of

placing, with all pools of water removed.

Before placing the concrete for tunnel lining the following requirements should be met:

(a) The excavated cross section profile shall be carefully checked to ensure the minimum lining thickness requirements and if necessary it should be corrected,

(b) All loose rock which has been trapped by the wire mesh covering over the excavated surface shall be cleared and the mesh be repaired and if necessary replaced,

(c) All timber supports, large wooden wedges used during the initial assembly and erection of steel supports shall be removed,

(d) Inverts of tunnel and shafts shall be totally cleaned of debris leaving sound rock wherever required the Contractor shall use mechanical tools to loosen and remove all loosened and blast barrage aged rock.

Before any concrete is cast against previously placed concrete, the surface of the old concrete shall be prepared as described in sub-section "Construction Joints".

11.9.3 PLACING AND COMPACTION

Concrete shall be carefully placed in designated position. In case, dense reinforcement or deep forms cause segregation of concrete while placing, suitable methods shall be used to prevent segregation. The free fall of concrete shall not exceed 1.5 m. Concrete shall be placed directly in its permanent position and shall not be worked along the forms to that position. Vibrators shall not be used to move concrete laterally.

The addition of water into concrete after batching to compensate for stiffening of the concrete before placing shall not be permitted. All concrete, with exception of concrete tunnel lining, shall be placed in continuous approximately horizontal layers. The thickness of the layers shall not exceed 400 mm for mass concrete, and 500 mm for structural and all other concrete. Each layer shall be soft when a new layer is placed upon it so that no seams or planes of weakness within the section can form, and the two layers shall be made monolithic by penetration of vibrators.

The Engineer-in-Charge reserves the right to order a reduced thickness of layers where the layers as stated above cannot be placed in accordance with the requirements of these Specifications. Time interval between successive lifts of mass concrete shall be determined by the Engineer-in-Charge. Nevertheless, a minimum of 72 hours shall elapse between successive lifts.

No concrete shall be placed under water except where shown on the construction drawings or specifically so required by the Engineer-in-Charge. No concrete shall be placed in running water. Water shall not be allowed to rise over freshly poured concrete until final set has been achieved.

Each layer of concrete shall be consolidated to the maximum practicable density, be free from pockets of coarse aggregate, completely fill all recesses in forms and around embedded parts, and be free of all voids. The concrete shall be compacted and worked into all corners and angles of the forms, around reinforcement and embedded items without permitting the component concrete materials to segregate.

No layer of concrete shall be placed until the previous layer in the same lift has been thoroughly consolidated. Each layer of concrete within a lift shall be covered with fresh concrete as soon as possible, but certainly within the period when the lower layer is still capable of being reverted so that successive layers can be thoroughly worked together. The maximum permissible time between the placing successive layers in a pour shall not exceed initial setting time of cement or 45 minutes, whichever is less, and shall be reduced to suit the temperature, humidity and job conditions. Concrete shall not be piled up in the forms in a manner that causes movement of the unconsolidated concrete, or permits mortar to escape from the coarse aggregate.

On proposal of the Contractor and with the Engineer-in-Charge's approval, the concrete lining in tunnel may be placed in one continuous pour from invert to crown with construction joints normal to the axis of the tunnel over the full cross section, or continuous placing may be adopted with a

sloping joint corresponding to natural angle of repose at end of each concreting cycle. Concreting of lining shall be carried out by concrete pump using methods which do not cause segregation or requiring remixing of the concrete. The point of discharge when concreting the crown above the springing line shall be kept buried sufficiently to allow enough pressure to be built up to completely fill the crown including areas of over-break in the crown if any.

Concrete shall be consolidated with the aid of approved immersion type mechanical vibrators complying with IS: 2505 or electric or air driven vibrators operating at a speed of at least 7,000 cycles/minute when immersed in the concrete. The vibrating equipment shall at all times be adequate in number of units and power to penetrate concrete as it is being placed, to the satisfaction of the Engineer-in-Charge. Vibrators with flexible operating shafts shall be used for reinforced concrete and for concrete in restricted forms. At least one extra vibrator in working condition shall be constantly on hand at each point of placement for emergency use.

Application of the vibrators shall be made systematically and at such intervals that the zones of influence overlap and the concrete is properly compacted. Every vibrator shall be operated in a near vertical position and the vibrating head shall be allowed to penetrate under the action of its own weight. In consolidating each layer of concrete, the vibrating head shall be allowed to penetrate and re-vibrate the concrete in the upper portion of the underlying layers. Extreme care shall be taken to ensure that the vibrators do not touch or disturb the reinforcing, embedded steel or forms.

To ensure even and dense surfaces which are free from aggregate pockets, honeycombing or air holes, it may be necessary to supplement internal vibration with hand-spading along the boundaries of the concrete and around embedded parts while the concrete is plastic under the vibratory action, should slip forms be used, the equipment and methods shall be such that the finished concrete will be well consolidated and homogeneous. Contractor shall use any or all of the above methods of consolidation, if required, to produce the necessary finish. Form vibrators shall not be used unless the forms are designed for form vibration and unless specifically authorized by the Engineer-in-Charge.

11.9.4 PUMPING CONCRETE

Positive displacement pumping or other approved methods may be used to place concrete in locations approved by the Engineer-in-Charge. The type and arrangement of equipment shall be subject to approval, and the equipment shall be operated only by experienced persons. Pneumatic placing will not be allowed. The equipment and its method of operation shall allow the concrete to enter the forms at a low velocity.

Concrete pumps and auxiliary equipment shall be in good condition and shall be maintained as such throughout the duration of the work. Thorough washing down of all parts that come in contact with concrete shall be performed after each concreting operation. Pump lines shall consist of rigid steel pipe or flexible pipe made of rubber, spiral-bound flexible metal or plastic, or combination of both. Use of aluminium pipe for pump lines shall not be permitted. Couplings shall be leak proof and strong enough to withstand handling during erection and poor support along the lines.

They shall provide a full internal cross section with no constrictions of the smooth flow of concrete. Immediately prior to the start of all concrete pumping, the pump and pump lines shall be primed by pumping an approved grout mixture through the equipment.

Concrete pumping operations shall be planned in such a way that concrete does not set before the succeeding layer is place thereon. An adequate supply of fresh concrete shall be provided at all times. When placing the concrete by pumping in tunnel lining, the sides of the lining shall be brought up evenly through windows prepared in the formwork and care shall be taken equal pressure is maintained on the formwork. The crown shall be filled through the slick line running along the top of the formwork. This line shall be deeply buried in the concrete at all times. Identifications marks to indicate the depth of burial shall be provided. The buried pumpline shall be withdrawn from the form gradually as the placement is completed. Air boosters shall not be permitted until

slick lines are buried at least 1.5 m into fresh concrete.

11.9.5 CONCRETE IN BLOCKOUTS, SECOND STAGE IN RESTRICTED LOCATIONS, ETC.

All concrete required to be placed in blockouts to permit the installation and adjustment of mechanical and other equipment, around formed holes and second stage concrete in other locations shall be included in respective concrete as described in these Specifications. The concrete surfaces of blockouts and first stage concrete at other locations shall be chipped and roughened as described herein before second stage concrete is placed at such locations. Exceptional care shall be taken to placing concrete in blockouts in order to ensure satisfactory bond with concrete previously placed and to secure complete contact with all metal work in the blockouts. The roughening of the first stage concrete surfaces shall be attained by chipping or sand blasting as approved by the Engineer-in-Charge and in such a manner as not to loosen, crack or shatter any part of concrete beyond the roughened surfaces. After being roughened, the surfaces of concrete shall be cleaned thoroughly of loose fragments, dirt and the objectionable substances and shall be sound and hard to ensure good mechanical bond between the existing and new concrete. Second stage concrete shall be placed in lifts of not more than 3.0 m and concrete placement rate shall not exceed 1.5 m per hour except as otherwise approved by the Engineer-in-Charge.

11.9.6 TOLERANCES FOR GENERAL CONCRETE STRUCTURES

General Areas of Application		Tolerances in mm
Variations of the constructed line or outlines from established position in plan	In 6 metres In 12 metres In24 metres or more	12 mm 20 mm 30 mm
Variations of dimensions to individual structural features from established position	In buried construction	Twice the above amount
Variations from the plumb, from the specified batter or from the curved surface of all structures, including the lines and the surfaces, walls and vertical joints	In 3 metres In 12 metres or more In buried construction	12 mm 30 mm Twice amount the above
Variations from the level or from the grades indicated on the drawing	In 3 metres In 12 metres or more In buried construction	6 mm 12 mm Twice the above amount
Variation in cross sectional dimensions of columns, beams, buttresses, piers and similar members and variation in the thickness of slabs, walls and similar members		-6 mm +12 mm
Variation from plumb and level for sills and side walls for radial gates and similar watertight joints	Not greater than:	3 mm/3 m

11.9.7 BUSH HAMMER FINISH

Bush hammer finish shall be applied on the surfaces when required by the Engineer-in-Charge. Bush hammering shall not commence until at least one month after placement of concrete. The tool used for bush hammering shall be electrically driven and have a head 3 cm² with 16 pyramid shaped teeth. The surfaces shall be finished at a rate of 250 to 400 cm² /minute indenting the concrete surface approximately 2 mm.

11.10 CONSTRUCTION JOINTS IN CONCRETE STRUCTURES

Construction joints are defined as concrete surfaces on or against which concrete is to be placed and to which new concrete is to adhere and which have become so rigid that the new concrete cannot be incorporated integrally with that previously placed.

Construction joints shall be located in the positions shown on the Construction Drawings or as required by the Engineer-in-Charge and the Contractor shall not be permitted to form any additional joints or deviate from the joints indicated on the drawings, without the written authorization of the Engineer-in-Charge. Necessary rearrangement of steel reinforcement arising from such modifications shall be to the contractor's debit.

Horizontal construction joints shall be arranged, wherever possible, to coincide with joints in the formwork.

Joints at exposed surfaces of concrete shall be straight and continuous. Feather- edged construction joints will not be permitted.

The faces of vertical joints shall be shuttered with expanded metal or other approved rough material. The expanded metal shall be removed as far as possible, before the adjacent lift is poured. If required, the surface shall be cleaned by wet sandblasting and roughened by light bush-hammering.

The surface of construction joints upon or against which new concrete is to be placed and to which new concrete is to adhere shall be clean, rough, and free of water when covered with fresh concrete. The laitance, loose or defective concrete and foreign material shall be removed from the surface of existing concrete. The previous concrete lift shall be saturated by water but surface dry when the successive lift is placed.

The surface of the hardened concrete shall be cleaned and roughened by wet- sandblasting and washing thoroughly with air-water jet. Care shall be taken to prevent undercutting of aggregate in the concrete during sandblasting.

Wet-sandblasting equipment shall be operated at an air pressure of approximately 7 bars. Sand to be used for blasting shall be dense, hard, not easily broken and sufficiently dry.

In lieu of wet-sandblasting the Contractor may propose high-pressure water blasting utilizing pressures not less than 400 bars, provided that such high- pressure water blasting produce equivalent results to those obtainable by wet- sandblasting.

The horizontal surfaces of construction joints may be treated by cutting with an air-water jet ("green-cutting"). This shall be performed after the initial set has taken place but before the concrete has become too hard for effective cutting. The fresh concrete surface shall be cut with air-water jets to remove all laitance and to expose clean, sound aggregate.

After cutting, the surface shall be washed with clean water. Care shall be taken that the treated surface does not become contaminated before new concrete is placed upon it. Should the surface become contaminated that a satisfactory joint with new concrete is not ensured the Contractor shall clean it by means of wet-sandblasting.

Water used in cutting, washing and rinsing of concrete surfaces shall be disposed of in such a way that it does not stain, discolour or affect exposed surfaces of the structures.

When necessary, as determined by the Engineer-in-Charge, structural concrete placement in forms shall be started with an over sanded mix with 19 mm maximum size aggregate, an extra 50 kg of cement per cubic meter and a 100 mm slump. This mix will be referred to as a starter mix and shall be placed approximately 50 mm deep.

Disturbance of the surface at a joint during the early stages of hardening shall be avoided, and traffic on the concrete will not be permitted until the concrete has hardened sufficiently to withstand such treatment without injury.

All construction joints shall be kept continuously moist until they are covered with concrete, provided that, if it becomes necessary to delay the placement of new concrete on or against a construction joint for an extended period, moist curing of the surface of the joint may be discontinued at the expiration of the regular prescribed curing period. If the moist curing is so discontinued, it shall be resumed not later than 24 hours prior to the placement of new concrete against the joints.

11.11 CURING AND PROTECTION OF CONCRETE

Plant for curing and protection of concrete shall be available at the location of each concrete placement before concrete placement is started. The water used for curing shall meet the requirements for water used for mixing concrete. The curing water temperature shall not exceed 25°C.

Exposed surface of concrete which have been finished as specified shall be protected from the direct rays of the sun for at least 2 days after placing. Freshly placed concrete shall be protected from barrage age by rainfall.

Exposed surfaces shall be kept moist or the moisture in the concrete shall be prevented from evaporating for at least 14 days after placing by means of continuous sprinkling or spraying with water, or by other methods approved by the Engineer-in-Charge.

Care shall be taken not to disturb the steel reinforcement projecting from any placement for at least 24 hours after the completion of such placement.

The Contractor shall not move any load on concrete surfaces which in the opinion of the Engineer-in-Charge have not attained sufficient strength. In case loads are required to be moved, the Engineer-in-Charge may permit Contractor to do so on condition that Contractor provides the means for protecting the concrete surface subject to approval of the Engineer-in-Charge.

The Engineer-in-Charge may permit the use of curing by means of membrane forming compounds. Sealing compounds proposed by the Contractor will be subject to sampling and testing and will have to be approved by the Engineer-in- Charge. Curing compounds shall be applied according to the manufacturer's recommendations to provide a continuous uniform membrane over all area. Curing compounds shall be applied only after moist curing has been carried out for at least 24 hours. Curing membranes shall be protected from barrageage at all times.

Curing compound shall not be used on any unformed surface where, in the opinion of the Engineer-in-Charge, the irregularities in that surface would prevent the membrane forming an effective seal, on any surface which has a temperature lower than manufacturer's recommended application temperature, on any surface where a bond is required for additional concrete, or where a bonded surface coating is to be applied. Where a curing compound is placed on a surface where a bond is required, it shall be removed by sand blasting or by other means satisfactory to the Engineer-in-Charge. Concrete poured in tunnels to form tunnel linings shall be cured by membrane curing, as described above. Curing compounds used in tunnels shall not contain solvents which may create hazardous conditions. Curing compounds used for surfaces exposed to view shall degrade completely when exposed to air for more than 3 months. They are to remain at least 80% impermeable for 1 month after application.

11.12 REPAIR OF CONCRETE

11.12.1 GENERAL

Repair of barrage aged or defective concrete shall be performed by skilled workmen only, and in the presence of the Engineer-in-Charge. No repair work shall be carried out until the Engineer-in-Charge has inspected the location of the proposed repair and accepted the method of repair proposed by the Contractor. The Contractor shall correct all imperfections on the concrete surface as necessary to produce surface that conforms to the requirements specified.

Where concrete is exposed to flowing water or to weather, porous and fractured concrete and surface concrete to which additions are required to bring it to prescribed lines shall be removed by chipping openings into the concrete a minimum of 75 mm below the reinforcing or to the depth required by the Engineer-in-Charge if sound concrete is not encountered at 75mm. Repair areas shall be formed and area filled with fresh concrete. If the concrete section to be repaired contains no reinforcement, concrete shall be chipped to a minimum depth of 100mm.

The chipped openings shall be sharp edged and keyed and shall be filled to the required lines with fresh concrete or patching mortar, as approved by the Engineer-in-Charge. Where concrete is used for filling, the chipped openings shall not be less than 75 mm in depth and the fresh concrete shall be reinforced and doweled to the surface of the openings, as directed by the Engineer-in-Charge. Dry pack mortar for patching shall consist of 1 part cementing material, 2 parts by volume of regular sand, and just enough water so that after thorough mixing of the ingredients the mortar will barely held together when compacted by squeezing with the hand. The mortar shall be fresh when placed, and any mortar that is not used within 1 hour after preparation shall be wasted. Just prior to mortar application, the surface to which the mortar is to bond shall be kept wet for at least 2 hours, then scrubbed with a small quantity of cement grout using a wire brush.

When repairs are more than 25 mm deep, the mortar shall be applied in layers not more than 20 mm thick to avoid sagging. After each layer, except the last is placed, it shall be thoroughly roughened by scratching with a trowel to provide an effective bond with the succeeding layers. The last or finishing layer shall be smoothened with a trowel to form a continuous surface with the surrounding concrete. All patches on exposed surface shall be neat and smooth and as nearly as possible of the same colour as the adjoining concrete. All patches shall be thoroughly bonded to the surfaces of the chipped openings, shall be cured to the satisfaction of the Engineer-in-Charge and shall be sound and free from shrinkage cracks and drummy areas.

For concrete surfaces where high velocity flows may occur, and as required by the Engineer-in-Charge, repairs to surfaces having F3 and U3 finishes shall be bonded with an epoxy adhesive approved by the Engineer-in-Charge and used in accordance with the manufacturer's instructions. All repairs to the surface of concrete required for flowing water shall be ground smooth to meet the tolerances specified for that surface. After removing the damaged concrete, the surface of concrete shall be cleaned off all debris, dust etc. using water air jets. Before placing fresh concrete, a 5 mm thick coat of neat cement slurry be applied over the cleared concrete surface.

11.13 PARTICULAR REQUIREMENTS FOR INDIVIDUAL CONCRETE STRUCTURES

Mass concrete shall not be placed during rains if sufficiently heavy or prolonged, as this may result in washing away of mortar from coarse aggregate on the forward slopes of placement. Once placement of mass concrete has commenced in a block, placement shall not be interrupted (by diverting, placing equipment to other places) till completion of such block.

Concrete shall be placed, as nearly as practicable, in its final position and shall not be piled up in large masses at any point and then pushed, shovelled, or vibrated into empty spaces for long distances. However, full capacity of concrete bucket may be deposited in one operation where this has not objectionable effects on placing of concrete, but near forms, in and around

embedded metal work and elsewhere, as directed, the contents of the buckets shall be discharged in such quantities that satisfactory placement shall be secured.

Concrete buckets shall be capable of promptly discharging low slump mass concrete mixes specified and dumping mechanism shall be so designed as to permit discharge of as little as ½ m3 portion of concrete in one place. Bucket shall be suitable for attachment to and use of drop chutes where required in confined locations. At such locations where freezing conditions are expected, richer concrete mix (higher in cement contents) shall be placed on the exposed surfaces of the mass concrete than in the interior with the approval of the Engineer-in-Charge.

The minimum allowable period between successive lifts of concrete in any one block shall generally be 72 hours, or as shown on the drawings or as directed by the Engineer-in-Charge. The height of a lift shall vary from 0.75 m to 2.25 m or as shown on the drawings or as directed by the Engineer-in-Charge while placement, the concrete shall fall vertically and shall be discharged fast enough to form a cohesive, bulging and growing mass without separation as the concrete is discharged by the concrete placing buckets. Since the mass concrete is placed with relatively dry consistency of low slump it shall be adequately and thoroughly vibrated into place. Areas adjoining embedded materials shall be consolidated with manual vibrators.

The maximum size of aggregate for mass concrete shall be 150 mm. Special measures, duly approved by the Engineer-in-Charge, shall be taken by the Contractor at the time of allowing river flows over the concrete which is still in the process of generating heat. Curtain grouting shall be carried out through the gallery when the concreting dam has reached up to a particular level as shown on the drawings.

11.13.1 CONCRETING IN NITCHES

When no longer required for turning/parking of the equipment, the nitches shall be filled with concrete of grade M 15.

11.13.2 CONCRETE LININGS OF TUNNELS

Concrete used for the construction of the linings of the tunnels and shafts shall be as specified on the Construction Drawings or as directed by the Engineer-in- charge.

The Contractor's proposed method of concrete placement is subject to the approval of the Engineer-in-Charge.

The vault and invert of the headrace and tailrace tunnels lining as well as in the construction and/or permanent access adits shall be cast in separate operations. The Contractor shall propose the sequence of the casting operations. The proposed method of concrete placement is subject to the approval of the Engineer-in-Charge.

The tunnel lining shall either be poured in sections or by "continuous pouring". If the Contractor wishes to use the latter method, then he shall first satisfy the Engineer-in-Charge that the concrete production, transport and placing equipment to be used has sufficient capacity to produce and handle the amount of concrete necessary for continuous pouring of the lining sections. In addition, the Contractor shall provide details of the steps to be taken in the event of an interruption in the concrete supply.

The number of vertical construction joints shall be reduced to minimum. Inclined construction joints will have the naturally running slope of placed concrete. In addition to treatment as specified in aforesaid "Joints in Concrete Structures", in case of inclined construction joints, the concrete in the crown and the invert shall be removed prior to placing of the next stage to avoid an acute angled construction joints relative to the inside surface of the tunnel lining concrete. No mortar layer will be required on the inclined construction joints in tunnel lining.

Prior to concreting, the rock surface shall be cleaned and shall be free from oil, mud, loose rock, objectionable coating, debris and loose or unsound fragments. All surfaces shall be cleaned with air-water jets or by other satisfactory means Particular attention shall be given to the drainage of flowing and the removal of standing water where concrete will be placed.

Reinforcement, wherever required shall be as per relevant drawings. The surge shaft shall be poured in lifts or by continuous pouring. If the Contractor wishes to adopt continuous pouring then he shall first satisfy EIC that the equipment to be used has sufficient capacity to produce and handle the quantity of concrete necessary for continuous pouring of lining height. In addition the Contractor shall submit details of the steps to be taken in the event of an interruption in the concrete supply. All embedments like grout pipes etc. be placed in position by the Contractor prior to starting concreting.

11.13.3 BACKFILL CONCRETE BEHIND TUNNELS

Backfill concrete in surface and underground work shall be placed for providing immediate support to the rock during excavation.

The concrete used for backfilling shall be of the class and grade as specified in relevant construction drawings or as directed by EIC

Prior to concreting, the rock surface shall be cleaned and shall be free from oil, standing or running water, sand, loose rock, objectionable coating, debris and loose or unsound fragments. All surfaces shall be cleaned with air-water jets or by other satisfactory means. Particular attention shall be given to the drainage of flowing and the removal of standing water where concrete will be placed.

The Contractor shall co-operate closely with the supplier of all the steel-linings during their erection prior to backfilling.

No windows for introduction of vibrators shall be provided in the steel liners. Working space shall be provided at the crown of the tunnel and the shaft to permit access for the necessary vibration of the back fill concrete. Special care shall be taken to ensure compaction of concrete and complete filling of the space beneath the steel lining and filling of the space beneath the steel lining and filling of the crown.

11.13.4 OTHER PARTS EMBEDDED IN CONCRETE

Anchors, anchor bolts, structural shapes, plates shapes, plates for gates, hoists, valves, machinery etc. and other miscellaneous parts shall be installed in the concrete by the Contractor, as shown on the Construction Drawings or as required by the Engineer-in-Charge. Wherever practicable, anchors shall be installed before the concrete is placed. Except as otherwise specified, drilling and installation of anchors in the concrete after concrete is placed, will not be permitted. Before being placed in position, all anchors and embedded parts shall be thoroughly cleaned of rust, grease, paint, splashed concrete, or other coatings that will reduce bond. Where the installation of the anchors is not practicable before the concrete is placed, formed openings shall be provided, and the anchors grouted into the openings at a later time in a manner acceptable to the Engineer-in-Charge.

Embedded anchors shall be supported during embedding and embedded so that the tolerances specified will not be exceeded. Care shall be taken not to disturb or displace embedded items during concrete placement.

Concrete may be placed to embed items erected by other agencies in the locations and to the dimensions shown on the Construction Drawings or as required by the Engineer-in-Charge. The methods of placement and rates of placing concrete shall be subject to the approval of the Engineer-in-Charge. Care shall be exercised that such parts shall not be barrageaged or disturbed by placing operations.

Unless otherwise specified the Contractor shall provide any foundation, wall or roof openings and coverings, concrete floor filling sleeves in foundations, inclusive of metal work supplied by other contractors. All adjustments to foundation levels, embedding, bedding and grouting work on foundations, and cementing work into walls and floors, shall be done by the Contractor but all levelling and adjustment of work in foundations shall be the responsibility of the contractor. Grouting shall be done by the Contractor under the supervision of the contractor, who will also approve the grout mixes and grouting pressures.

11.13.5 CONCRETE IN BLOCKOUTS FOR EQUIPMENT EMBEDDING

The Contractor shall form blockouts, place reinforcement and concrete as shown on the Construction Drawings or as directed by the Engineer-in-Charge, and in such manner as to ensure good bond with the existing concrete, to secure

complete contact with the metalwork to be embedded in the block out concrete and to avoid displacement of the metalwork. Blockout concrete shall include concrete around second stage gate parts, anchor bolts & anchor plates etc. Except as otherwise specified the hydro-mechanical, mechanical, and electrical equipment will be provided and installed by the suppliers in co-operation with the Contractor.

Before placing concrete, all parts to be embedded shall be checked to ensure that they are firmly fixed in their required position. The surfaces of blockouts or holes shall be thoroughly cleaned and wetted. Oil or grease shall be removed by brushing and chipping of affected surfaces to a sufficient depth, or by application of approved chemicals and flushed with clear water. The parts to be embedded shall be cleaned of rust, mill scale, paint, oil or grease before they are set into place. Where bond between metal parts and concrete or grout is not desired, approved material such as flake graphite or paraffin shall be applied to the metal parts. The metal surfaces shall be wetted before placing the concrete or grout. Only self-compacting concrete containing approved admixtures shall be used for the concrete in second stage in blockouts for equipment embedding as shown on the construction drawing.

11.13.6 GROUTING OF THE EQUIPMENT BEARING PLATES AND ANCHORS

Limited spaces and small blockouts where equipment bearing plates, anchors, rails, etc., are placed shall be grouted under pressure.

The grouting shall be performed using non-shrink cement-based grout or non- shrink epoxy grout as proposed by the contractor and approved. All mixing and grouting shall be performed in accordance with the manufacturer's recommendations and shall be tested prior to grouting. Technical service by manufacturer shall be organized by the Contractor upon request by the Engineer- in-Charge.

Before placing grout, the surfaces of the base concrete to which the grout will be bonded shall be roughened and cleaned of all laitance, loose or defective concrete, any coatings or other foreign material, followed by thorough washing with water.

Forms for grouting shall be installed where necessary and care shall be taken that the grout fills all spaces under the plates leaving no voids. The exposed surfaces of the grout shall be cured as recommended by the manufacturer and no loads shall be applied until the grout has reached the design strength.

11.13.7 PRECAST CONCRETE

Precast concrete shall be produced in an enclosed area separate from other construction work.

Precast units shall generally conform to the other parts of the same technical specifications where applicable and as required by the Engineer-in-Charge.

Precast units shall be protected at all times from barrageage at the place of fabrication and during handling, storage and erection.

Precast concrete units shall be placed in their correct relative location and temporarily braced and secured to prevent collapse or distortion of the structure until completion of the work to the satisfaction of the Engineer-in-Charge.

Following removal of formwork, any hole, voids or other blemishes in the surfaces of precast concrete units which are to be exposed shall be patched and a smooth rubbed finish provided. Rubbing shall be done with a carborundum stone and a mixture of Portland cement and water.

11.13.8 SLUSH GROUT

Slush grout may be used to fill cracks and fissures in zones as approved or directed by the Engineer. The slush grout shall be composed of cement, sand, and water in the proportion of one-part cement, two parts sand by weight, with sufficient water to produce a workable mixture, e.g. with water/cement ratio, by weight, ranging between 0.45 and 0.50. All materials shall conform to the specifications of this Section. The slush grout shall be mixed in a concrete mixer. Foundation surfaces shall be moist at the time of slush grouting. The grout shall be swept with brooms into foundation surfaces in such a manner as to fill thoroughly all cracks, crevices, and minor imperfections in the rock. The slush grout shall be cured after it has attained its initial set as specified elsewhere in this Section.

11.13.9 PLUM CONCRETE

Plums above 160mm and up to 300mm may be used in plain concrete work as shown in the drawings up to a maximum limit of 40% by volume of concrete when specifically permitted by engineer-in-charge. Plums should not be greater than one-third of the least dimension to be concreted. Plums shall be distributed evenly and shall not be closer than 150mm from the surface. The volume of plums should be well dispersed throughout the mass. This is achieved by placing a layer of normal concrete, then spreading the plums, followed by another layer of concrete and so on. Each layer should be of such thickness as to ensure at least 150mm of concrete around each plum. Care must be taken to ensure that no air is trapped underneath the stones and that the concrete does not work away from their underside. The plums must have no adhering coating.

12. FORMWORK

12.1 SCOPE OF WORK

The work under this section shall comprise supply of all labour, plant and material and the performance of all work necessary for the design, fabrication, supply, erection, maintenance and removal of formwork and false work to form concrete structures as shown on the construction drawings or as otherwise directed by the Engineer-in-Charge.

12.2 MATERIALS

Materials used for form sheathing and lining shall be of wood, steel, plywood, or fibre glass. All materials used in formwork construction shall be of adequate strength and quality for their intended purpose and shall be satisfactory to the Engineer-in-Charge.

Timber shall be sound, straight, free from warp, decay and loose knots and shall be dressed smooth. Except as expressly approved by the Engineer-in Charge, all timber brought to the Site for use as forms, shoring or bracing shall be new material.

Plywood for use as form shall be mill-oiled and edge-sealed. Plywood shall be non- warping, non-wrinkling and manufactured with special water proof glues. Plywood sheets shall be of uniform width and length.

The surface of steel of steel lined forms shall be smooth. Forms with dents, buckled areas or other surface irregularities shall not be used.

Forms for concrete surfaces exposed to flowing water (other than tunnel lining) shall be lined with sanded, uncoated, plywood veneer. Steel or impermeable plastic liners will not be permitted.

Rough sawn boards may be used only for the lowest grade of surface finish (F1).

Reuse of forms will be allowed only if they are thoroughly cleaned and repaired and capable of producing the finish required for the concrete. Timber or plywood forms repaired with metal patches shall not be used.

12.3 DESIGN

The contractor shall be solely responsible for the adequate design, construction and maintenance of any and all formwork and false work required in the work. Forms shall be designed to permit the concrete to be deposited as nearly as is practicable directly in its final position, and to allow inspection, checking the clean-up of the formwork and reinforcement to be completed without delay. Formwork and falsework shall be designed, fabricated, erected and removed in accordance with the applicable provisions of the recommended practice for concrete form of IS: 456.

12.4 ERECTION OF FORMWORK

Formwork shall be erected and maintained such as to confine the concrete without loss of mortar and produce required finished surfaces. Forms shall be set and maintained within the specified tolerance limit such that the complete concrete surfaces are within these limits.

Any forms which in the opinion of the Engineer are unsafe or inadequate in any respect may, at any time, be rejected and the Contractor shall promptly remove the rejected forms from the Work and replace them.

All form surfaces shall be thoroughly cleaned before erection and shall be lubricated with a non-staining mineral oil. All excess shall be wiped off the forms prior to placement of concrete. Oil shall not be allowed to come into contact with reinforcement steel or other embedded items.

12.5 FINISHED TOLERANCES

Forms shall be so constructed that the finished concrete surfaces shall be of uniform texture in accordance with the types of finish specified in Section "Concrete".

12.6 REMOVAL OF FORMWORK

Removal of forms shall be performed with care so as to avoid injury to the concrete and as soon as permissible in order to avoid delay in curing and repair of surface imperfections. Forms shall not be removed without the consent of the Engineer.

Forms shall not be removed until the concrete has attained sufficient strength to prevent damage to concrete. Damaged concrete shall be repaired or treated by the contractor as soon as possible, but not before the engineer has inspected such damage and agreed to the remedial work. The elapsed time between the completion of concrete placing and the removal of forms shall generally be in accordance with IS: 456.

13. REINFORCING STEEL

13.1 SCOPE OF WORK

The contractor shall furnish, fabricate, and install all reinforcement steel as shown on the approved detailed reinforcement drawings and bar lists prepared on the basis of Engineer-in-Charge's construction drawings. The work shall further include the furnishing and installation of all tie wires, clips, supports, chairs, spacers, couplers and other appurtenances necessary to produce finished concrete structures.

13.2 STANDARDS

Cutting, bending, cleaning, placing and fastening in position shall conform to the requirements of the following Indian Standards (latest edition):

IS: 432(Part 1)-: Specifications for mild steel and medium tensile steel bars and hard drawn steel bars for concrete reinforcement

IS: 456 - Code of practice for plain and reinforced concrete

IS: 1786 - Specifications for high strength deformed steel bars and wires for concrete reinforcement

IS: 2502 - Code of practice for bending and fixing of bars IS: 2571: Code of practice for welding of mild steel bars

IS: 13920: Code of practice for Ductile detailing of reinforced concrete structures subjected to seismic forces

Tolerance limit for reinforcement placing and fastening in position shall be in accordance with IS: 456.

In case of a conflict between the above Standards and the Specifications given herein, these Specifications shall take precedence.

13.3 SUBMITTALS

During the progress of the work, Engineer-in-Charge will prepare reinforcement drawings which will indicate the main structural reinforcement required in the particular structure. On the basis of these drawings the contractor shall prepare the detail bar bending schedules. All bars shown on the detail reinforcement drawings shall be identified on the bar lists and all bars shall be defined and dimensioned in clear and unambiguous way and be referenced to the relevant reinforcement drawings.

13.4 MATERIALS

Reinforcement steel shall be supplied by the contractor as outlined in the General Conditions of and Conditions of particular applications. All deformed reinforcing bars shall be high yield strength, deformed steel bars conforming to IS:1786 Grade Fe 415/ 500.All plain reinforcing bars shall be mild steel and medium tensile strength steel bars conforming to IS: 432 (Part 1).Wire for tying reinforcing steel shall be black annealed iron wire, or acceptable equivalent, with a diameter not less than 1.6 mm.

13.5 TESTING

Reinforcing steel shall be accompanied by a mill certificate and, when directed by the Engineer-in-Charge, tested in a recognized laboratory to demonstrate compliance with IS: 1786. In the course of concrete work, the Contractor shall conduct the following tests on the high yield strength deformed steel bars and plain mild steel bars:

One tensile strength for every 1,000 tons or as per standards; acceptance shall be as per IS: 1608-1972 and IS: 226-1975,

Welded joints or mechanical connections wherever used shall be tested to prove that the joints are of full strength of bars connected

13.6 STORAGE

Reinforcing steel shall be stored above the ground in separate groups according to size and length. Reinforcing steel which has been cut and bent according to the schedules approved by Engineer-in-Charge shall be marked with a bar number shown on the schedule, by using weatherproof tag or by placing in marked bins, and shall be stored in such a manner as to be readily accessible when required and to facilitate inspection. Reinforcement fabric supplied in rolls shall be straightened into flat sheets before being placed.

13.7 FABRICATION

Contractor shall cut and bend all reinforcing steel in accordance with bar schedules approved by Engineer-in-Charge.

Reinforcing steel bars shall be cut and bent at the site of the work or at a fabricator's plant in an acceptable workmanlike manner in accordance with Indian Standards. Notwithstanding the above, a bar-bending machine and a representative stock of reinforcing steel shall be maintained at the Site, sufficient to allow minor revisions and additions to be carried out as required by Engineer-in-Charge.

Reinforcing steel shall not be straightened or rebent in a manner that will damage the materials. Temporary bending and subsequent straightening of bars partially embedded in concrete shall not be permitted, except when shown on the construction drawings or with the written approval of the Engineer-in-Charge. Bars with kinks or bends other than those indicated on the drawings and schedules shall not be used.

The contractor shall not weld any item to reinforcing steel except as approved by Engineer-in-Charge and in conformance with accepted procedures.Reinforcing bars available from the rejected concrete structures shall not be used without prior approval by the Engineer-in-Charge.

13.8 PLACING

Before being placed in position, the reinforcing steel shall be thoroughly cleaned of loose mill scale and rust, grease, paint, or other coatings that would reduce bond. All splashed concrete that has dried on reinforcing steel shall be removed. Reinforcing steel to be incorporated in the work shall be placed accurately in the positions shown on the drawings and shall be held firmly in place during the placing and setting of the concrete.

Reinforcing steel shall be so placed that there will be a clear distance of at least 50 mm between the reinforcing steel and anchor bolts or embedded metal work, if not shown otherwise on the drawings or required otherwise by Engineer-in- Charge. Reinforcing steel shall be maintained in position by the use of small concrete blocks, steel chairs, steel spacers, steel hangers and other steel supports and ties, acceptable to Engineer-in-Charge. The cover of the reinforcement shall be as shown on the construction drawings. All reinforcement shall be inspected in place and approved by the Engineer-in-Charge before placing the concrete. Concrete placed in violation of this provision may be rejected and removal required.

14. WATERSTOPS AND JOINTS

14.1 SCOPE OF WORK

The work under this section include all labour, materials and equipment required for the supply, fabrication (if any), storage, handling, placing and splicing of metal sealing strips, PVC/Rubber Water stops and other components to be incorporated in the movement joints in concrete

structures as shown on the construction drawings, or as required by Engineer-in-Charge.The work shall include all the necessary supports and ties required for placing water stops and other materials.

14.2 STANDARDS

Material, testing, placing and sealing of joints shall conform to the requirements of the following Indian Standards (latest edition):

IS: 456	Code of practice for plain and reinforced concrete
IS: 290	Specifications for coal tar Black Paint Specifications for one part gun grade Polysulphide based joint
IS: 11433	Sealants
IS: 8543	Methods of Testing of Plastics Specifications for Hot applied sealing compounds for joints in concrete
IS: 1834	Specifications for Preformed fillers for Expansion joints in concrete
IS: 1838	Pavement structures
IS: 3400	Methods of tests for Vulcanized Rubbers IS: 13360 Plastics - Methods of Testing
IS: 1972	Copper plate, sheet and strip for Industrial purposes – Specification
IS: 3873	Laying Cement Concrete/ stone slab lining on slabs
IS: 4461	Code of practice for joints in surface hydroelectric power station Specification for bitumen primer for use in waterproofing and damp proofing
IS: 2508	Low Density polyethylene Film

In case of a conflict between the above Standards and the specifications given herein, these specifications shall take precedence.

14.3 SUBMITTALS

At least 04 weeks prior to procuring or dispatch to the Site of the particular item of work to which the submittal relates, the contractor shall submit to the Engineer-in-Charge the details covering the properties and performance, including the certified copies of reports of all tests made by the manufacturers, along with material samples of the products, of:

(a) PVC Water stops,

(b) Joint fillers,

(c) Joint sealing compounds

(d) Joint Sealant.

14.4 MOVEMENT JOINTS IN GENERAL CONCRETE STRUCTURES

The term movement joint comprises both, the expansion and the contraction joints in concrete structures. Movement joints shall be constructed at such locations and to such dimensions as shown on the construction drawings or as directed by the Engineer-in-Charge. The contractor shall supply and install the various joint components as specified herein, as shown on the Construction Drawings and in accordance with the manufacturer's recommendations.

No fixed metal embedded in the concrete shall be continuous through a movement joint except where expressly shown on the Construction Drawing.

Expansion joints may be comprised of the following elements:

- PVC water stop,
- Joint filler,
- Joint sealing compound (asphalt seal),
- Bituminous coating.
- Contraction joints may be comprised of the following elements:
- PVC water stop,
- Bituminous coating or other approved bond breaker.

14.5 MATERIALS

14.5.1 PVC WATER STOPS

Water stops shall be made of extruded polyvinyl chloride (PVC) conforming to IS: 15058.Material for water stops shall be clean, homogeneous and free from porosity and other imperfections.

Water stops will have minimum width of 230 mm for joints in general. Minimum wall thickness shall be 8 mm.

The wings of the PVC water stop shall be provided with corrugations or bulbs to achieve good bond. PVC water stops in expansion joints shall be provided with hollow centre bulb.

Storage of material prior to placement shall be made in such a way as not to alter the properties of the material during storage. Water stops shall be stored so as to permit free circulation of air around them. All materials shall be protectedfrom contact with oil and grease. Waterstops shall be stored in a place protected from the direct rays of Sun or to any other heat source.Waterstops shall be joined and fixed in place in accordance with manufacturer's recommendations to form a continuous watertight barrier. All cross-pieces, T- pieces and corner-pieces shall be factory produced.

All joints shall be welded with approved, thermostatically controlled electric heat equipment. The temperature at which the splices are made shall be sufficient to melt but not char the plastic material. All splices shall be neat with the ends of the joined waterstops in true alignment. A mitre-box guide and portable knife shall be provided for cutting the ends to be joined to ensure good contact between joined surfaces.

14.6 JOINT FILLER

Bituminous fibre sheet shall be 12 mm thick and shall conform to IS 1838 (Part-1) for preformed expansion joint filers for concrete paving and structural construction (non-extruding and resilient bituminous types).

14.7 JOINT SEALING COMPOUND (ASPHALT SEAL)

Joint sealing compounds shall be as per the specification for hot-applied sealing compounds for joints in concrete (IS: 1834).

14.8 BITUMINOUS COATING

Bituminous coating shall consist of 02 (two) layers of coating as per IS: 290.

14.9 JOINT SEALANT

Joint sealant shall be as per IS: 11433.

14.10 EXECUTION

14.11 MOVEMENT JOINTS IN GENERAL CONCRETE STRUCTURES

The Contractor shall supply all necessary supports and ties required for placing the Metal sealing strip water stop and shall position it so that its central axis coincides with the joint centre. Care shall be taken that Metal sealing strip and waterstop does not bend or deflect during concreting. Concrete adjacent to the Metal sealing strip and waterstop shall be thoroughly worked to ensure full contact with the Metal sealing strip and waterstop but without damaging it. PVC materials shall be protected from sunlight until installation is completed.

In the structures found on the rock, the Metal sealing strip and waterstops shall be sealed 500 mm minimum in the drilled or excavated slot below the effective foundation surface, and the space around the Metal sealing strip and waterstop in the slot shall be filled with non-shrink grout. Prior to commencement of concrete placing, the Metal sealing strip and waterstops placed shall be inspected by the Engineer-in-Charge. Before casting the second part of a movement joint, the whole surface shall be covered with bituminous coating, bituminous fibre sheet joint filler, or other approved bond breaker as shown on the Construction Drawings.

Before applying the joint sealant, the joint shall be raked out to a depth as specified. All laitance, dirt, oil and foreign matter shall be removed from the joint by sandblasting, compressed air, grinding discs, or other effective means, and the concrete surfaces coated with an approved suitable primer. Joint sealant shall be placed after the concrete curing period in accordance with manufacturer's instructions. The concrete surface temperature shall not be higher than 30°C at the time of placing, and the concrete shall be surface dry. After placing, the sealant shall be protected from the effects of water for a period of 10 hours. Sealant that becomes un-bonded from the concrete, or cracks, or shows any other defects before final acceptance of the work, shall be replaced by the Contractor.

15. METAL WORK

15.1 SCOPE OF WORK

The work under this Section includes all labour, materials and equipment required for the supply, fabrication, and installation of various metal work as shown on the Construction Drawings. The specifications contained in this Section are applicable for all metal work to be carried out by the contractor under this contract. Furthermore, the contractor shall install metal work supplied by others. This section covers the following items:

- Steel pipes
- Miscellaneous steel sections
- Watertight steel covers, frames, and gratings
- Handrails
- Railing
- Ladders, handles, and climbing irons
- Erection hooks
- Steel anchoring
- Metal work supplied by others

Unless otherwise stated or shown, all miscellaneous metalwork shall be fabricated from carbon steel sections, plates and bars complying with the requirements of IS:2062.Unless otherwise stated or shown, all miscellaneous metalwork shall be painted as specified hereinafter where specifically so stated, steelwork shall be hot-dip galvanized. The contractor shall be responsible for material quality control and shall ensure compliance of the metalwork to the pertinent standards and these specifications.

15.2 SUBMITTALS

The contractor shall supply certificates of compliance with specified Indian Standards or other relevant standards for all materials supplied to the Work. Manufacturer's catalogues and samples of materials proposed for incorporation in the Work shall be submitted for approval, if requested by the Engineer-in- Charge. From the information given in the Tender and on the Construction Drawings, the Contractor shall prepare, prior to the manufacture, his own shop drawings showing sections and plans of all parts, assemblies, connections and supports for all metalwork shown on the Construction Drawings. Two copies of each drawing, calculation sheet and schedule of materials shall be submitted to the Engineer-in- Charge for comments and approval. Within 14 days from the submission, the Engineer-in-Charge will return such drawings either as approved or with requests for modifications. Within 7 days the Contractor shall revise the drawings, calculations and schedules accordingly and return a new set (again in two copies) of these for the final approval.

After the final approval, the Contractor shall deliver one transparency and two copies of the documents to the Engineer-in-Charge for his files.

The approval of shop drawings and calculations shall not in any way relieve the contractor of his responsibility and obligations under this contract, particularly those relating to the adequacy and accuracy of the final product. Any materials ordered, or fabrication work performed, before the contractor's drawings are approved will be at his own risk.The contractor shall not be entitled to any time extension based upon the rejection of his designs or detail drawings if these fail to conform to sound engineering practices or to the stipulations contained in these specifications.

15.3 FABRICATION

The work shall be shop fitted and shop assembled where possible, and shall conform to the details on approved Contractor's shop drawings.

Workmanship shall conform to the best modern shop and field practice. All joints and intersecting members shall be accurately fitted and all work shall be fabricated in true planes (to tolerances as provided on drawings) with adequate fastenings.

Plates and steel sections shall be perfectly straight with smooth surfaces. Edges shall be sharp, clean and without burrs after the cutting. Thick plates may be flame cut, provided that the material is not damaged and that the edges of the cut are ground clean or machined. Plates shall be cold-

rolled. Correction of bent members by heavy blows shall be avoided. Special care shall be taken when hot- rolling becomes necessary.

All members shall be carefully and accurately assembled by welding, screws, bolts, or rivets as approved. The joints shall be filled, milled, or machined as necessary to provide closed and perfect connections. All frames shall be provided with suitable bracing to maintain alignment during transport. Units shall not be subject to overstressing during transport and erection. Hammering which would injure or distort the members will not be tolerated.

All fastenings, anchors and accessories required for fabrication and erection of the work shall be provided. Exposed fastenings shall be kept to an absolute minimum evenly spaced and neatly set out. Wood plugs shall not be permitted.

The Contractor shall check the actual dimensions and shapes of existing concrete openings before fabricating steel frames and metal supporting parts of steel covers and gratings.

15.4 WELDING

All welding shall be carried out by experienced welders using the shielded-arc method as described in the SP12 BIS Handbook for Gas Welders and BIS Handbook of Manual Metal Arc Welding for Welders. Welding rods shall be of the heavily coated type designed for all position welding, and the size, type and manufacture of the rods shall require the consent of the Engineer-in-Charge. All welding shall be continuous along the entire line of contact, except where tack welding is permitted. Bevelling of the materials shall be done as shown on the approved shop drawings and shall be finished to a smooth and true finish with an automatic gas cutter or grinder. The use of manual gas cutters shall require the consent of the Engineer-in-Charge.

The surface of the working materials shall be free from slag, moisture, rust, oil, paint or other impurities. Mill scale which cannot be removed with a stiff wire brush will be allowed to remain.

The face of welds shall be smooth and form a uniform bead. The size and thickness of weld neither shall not be less than specified, nor shall there be an excessive build-up or marked irregularities in the surface appearance.

Blow holes, slag, overlap, undercut and unsatisfactory melting of welded joints shall be removed with grinders or by other means and then re-welded. Due care shall be taken to protect the surrounding part from any injury or damage. Deformation of members resulting from welding shall be repaired by an approved mechanical method.

Steel which has been previously galvanized shall not be welded.

Welding of aluminium shall be done employing a "parent metal" or other approved filler rods. Surfaces which have been previously treated such as anodizing shall not be welded.

The Contractor shall propose the type and carry out the non-destructive testing of the welds as approved. All joints which are to be watertight shall be tested by dye penetrant.

15.5 SURFACE FINISH AND CORROSION PROTECTION

15.5.1 PAINTING

All metal components other than stainless steel, aluminium, embedded parts and those that are required to be galvanized, shall be prepared, primed and painted in the shop prior to erection.

Paints used for both prime and finish coats shall be two components epoxy based, shall be obtained from the same manufacturer and shall be the best quality of their kind. They shall be suitable for application in environments where the relative humidity may exceed 90%. The Contractor shall submit samples of all paints he proposes to use to the Engineer-in-Charge for approval, who will select the colour of the finish coats.

Prior to painting, steel surfaces shall be sandblasted down to rust degree SA 2- 1/2 according to SIS Standard 055900, to remove all mill scale, weld splatter, rust and any other deleterious material. Oil and grease shall be removed by an approved solvent. The surface shall be wiped clean of any dust prior to priming.

Immediately after cleaning, steelwork shall receive two coats of two component zinc epoxy primer, each of dry film thickness 0.05 mm. Any primer applied surface that shows signs of rusting, flaking, powdering or peeling of the prime coat, or any finish coat, shall be sandblasted to remove the paint bare to the metal as described above and repainted. After priming, steelwork shall receive a further two coats of two component epoxy based paint, each of dry film thickness 0.08 mm. The total theoretical thickness of paint applied, including prime coats, shall be 0.26 mm, but in no case less than 0.22 mm.

All painting work shall be carried out in accordance with the manufacturers recommendations in a clean dust-free environment with temperature and humidity controlled to comply with these specifications and the recommendations of the paint manufacturer. All the surrounding work shall be protected in a suitable manner from paint drops and overspray. All smeared and damaged surfaces shall be cleaned or repaired. After erection of painted miscellaneous metalwork the Contractor shall make good any damage to the paint coating in accordance with the manufacturers recommendations. The Engineer-in-Charge may require items which are badly damaged to be removed, returned to the shop and repainted.

15.5.2 GALVANIZED STEELWORK

All steel assemblies required to be galvanized shall, after the steel has been thoroughly cleaned of rust and scale, be galvanized in accordance with IS:4759 (Hot dip zinc coating on structural steel and other allied products). The zinc coating shall be 350 g/m² minimum. Any galvanized part that becomes warped during the galvanizing operation shall be straightened. Bolts, nuts and similar threaded fasteners, after being properly cleaned, shall be galvanized in accordance with ASTM Specification A 153 "Spec, for Zinc Coating (Hot-Dip) on Iron and Steel Hardware". Threads on galvanized bolts and nuts shall be formed with suitable taps and dies such that they retain their normal clearance after hot- dip galvanizing.

After installation on the final place all areas of damage to the galvanized coating shall be sandblasted and prepared and given 2 coats of approved zinc rich paint. The preparation of the steelwork surface and application of the paint shall be in accordance with the paint manufacturer's instructions.

The Contractor shall supply certificates of compliance with the above standards for all galvanized material delivered to the Site.

15.5.3 FASTENERS

Fasteners for miscellaneous metalwork including bolts, anchor bolts, cap screws and nuts shall be of stainless steel unless otherwise stated or shown.

Studs and anchors for fixing metalwork to concrete shall be of stainless steel and shall be of the expanding anchor type (e.g. Nelson or Hilti). Grouted or resin types shall require the consent of the Engineer-in-Charge.

15.5.4 ANODIZING

All aluminium parts exposed to view shall have an anodizing finish of uniform appearance and shall be free from marks and blemishes. Sulphuric acid shall be employed as electrolyte for anodizing unless otherwise directed. The coating thickness shall be 0.02 mm.

15.6 METALWORK SUPPLIED AND INSTALLED BY THE CONTRACTOR

15.6.1 STEEL PIPES

The Contractor shall supply and install steel pipes of various diameters and fittings in the positions shown on the Construction Drawings or as directed by the Engineer-in-Charge. Steel Pipes used shall be ERW (Electric Resistance Welded) of Steel of grade Fe410 as specified in IS 3589. The thickness of pipes shall be as shown on the drawings or as directed by the Engineer-in-charge. Weight of the pipe shall be calculated as per Table 5 of IS 3589. Pipes shall be carefully fastened and supported within the shuttering, in order to avoid any movement when pouring concrete. Pipes were not cast into concrete shall be adequately supported by galvanized mild steel holderbats or other approved means. The distance between pipe supports shall not exceed 2.0 meters.

The Contractor shall supply and install cast iron pipes and fittings as shown on the Construction Drawings or as directed by the Engineer-in-Charge.

Material shall be of first class quality grey cast iron subject to the approval of the Engineer-in-Charge.

Cast iron pipes and fittings shall be treated with bituminous paint at the manufacture's plant. Any damage to this coat shall be thoroughly cleaned and repainted to the satisfaction of the Engineer-in-Charge.

15.6.2 MISCELLANEOUS STEEL SECTIONS

The Contractor shall supply and install all small galvanized steel sections such as edge protection, angles, frames, bearing plates, brackets, beads at plastered corners, etc., of various dimensions. Bolts, screws, anchors and other accessories for interior or exterior purposes shall be included.

15.6.3 WATERTIGHT STEEL COVERS, FRAMES, AND GRATINGS

The Contractor shall supply and install all watertight steel hatch covers, frames, gratings for cable channels, drains etc., as required by the Engineer-in-Charge or as shown on the Tender Drawings and specified herein. All items shall be fabricated according to shop drawings prepared by the Contractor in the course of Work.

Covers shall be manufactured from 6 mm steel chequered plate with reinforcing steel sections where required, steel flats and lifting handles. Supporting frames shall consist of steel angles and welded steel flats provided with continuous watertight rubber seal. Frames shall be adjusted during installation to ensure a good fit and water tightness of the cover. The covers shall be placed flush with finished floors.

Steel gratings shall consist of welded steel flats. Mesh size shall be 30x30 mm. Frames and steel sections as supports for gratings shall consist of steel angle or channel sections fixed in the concrete. Frames shall be adjusted during installation to ensure a good fit and even bearing for the grating. Gratings shall be placed flush with finished floors.

Steel covers, frames and reinforcing members for supporting gratings shall be painted as specified above in this Section. Gratings shall be hot-dip galvanized and shall be fixed to support platforms using stainless steel screws and fittings.

15.6.4 HANDRAILS

The Contractor shall supply and install in the buildings handrails fabricated from galvanized steel pipes supported on welded steel flats and steel plates as shown on the Tender Drawings and as specified herein. Material for steel pipes shall be of standard weight and shall conform to IS: 4736. All items shall be fabricated according to shop drawings prepared by the Contractor in the course of Work.

Handrails shall be installed following the slopes and in the positions shown on the Construction Drawings and shall be supported to avoid movement when placing concrete in the blockouts. Handrails shall be painted as specified above in this Section.

15.6.5 RAILING

The Contractor shall supply and install steel pipe railings as shown on the Tender Drawings. Railings shall consist of welded galvanized steel pipes conforming to IS: 4736. All items shall be fabricated according to shop drawings prepared by the Contractor in the course of Work. Railings shall be installed indoor and outdoor, horizontal or inclined in the positions shown on the construction drawings and shall be supported to avoid movement when placing concrete in the blockouts. Steel pipe railings shall be painted as specified above in this section.

15.6.6 STAIRS, LADDERS, AND CLIMBING IRONS

The Contractor shall supply and install stairs, ladders, and climbing irons fabricated out of angles, channels, chequered plates, steel flats and plain round bars as shown on the Tender Drawings. Stairs, Ladders may have protection cages whenever required for safety of personnel. Fixings and fittings shall be of stainless steel. All items shall be fabricated according to the shop drawings prepared by the Contractor in the course of Work.

Stairs, Ladders, climbing irons and protection cages shall be painted as specified above in this Section.

15.6.7 ERECTION HOOKS

The contractor shall supply and install steel erection hooks as required by the Engineer-in-Charge. Erection hooks shall be formed out of structural steel conforming to IS: 2062 and IS:8500. Erection hooks shall be hot bent and shall be firmly held during placing of concrete.

Erection hooks shall be galvanized as specified above in this section.

15.6.8 STEEL ANCHORAGES

The contractor shall supply and cast into concrete steel anchoring as required by the Engineer-in-Charge or when shown on the construction drawings. Anchorages shall consist of 150 mm long, 16 mm diameter anchors made of mild steel conforming to IS: 432 (Part I).

Steel anchoring shall require no surface treatment. Where anchoring is to be done after concreting either for convenience or per specification or drawings, same shall be grouted by cement grout.

15.6.9 CABLE CHANNELS

Unless otherwise specifically indicated on the construction drawings, the cable channels shall be provided with steel covers and steel walls and floor plates. In general, the walls and floors shall have 2mm thick steel plates secured firmly into concrete of cable channels. The covers shall be of 6mm steel plates provided with frames. The covers shall be adjusted to have a good fit and shall flush with finished floors.

15.7 METAL WORK SUPPLIED BY OTHERS

Anchoring and conduits furnished by suppliers of electro-mechanical equipment shall be installed by the contractor at the locations shown on the construction drawings or on the installation drawings prepared by others and approved by the Engineer-in-Charge.Every piece handled over to the contractor shall have a handover card on which the following is stated:

(a) Installation site,

(b) Number of pieces,

(c) Number of reference drawings,

(d) Weight of the pieces, without packing,

(e) Special connections for fixing if necessary.

The Contractor shall transport the pieces from the warehouse to the installation site and fix it stiffly and with due precision behind the formwork before concreting. It is the responsibility of the supplier to check the correct fixing of these pieces behind the formwork before concreting takes place. The Contractor shall provide unless otherwise specified any foundations, wall and roof openings and coverings, concrete floor filling, sleeves in foundations etc. for metal work supplied by others. All adjustments to foundation levels, embedding, bedding and grouting work on foundations and cementing into walls and floors will be done by the civil contractor but all levelling and adjustment of work by the foundations will be done by the E&M and HM contractor. Grouting, when required, will be done by the Contractor under the supervision of the E&M and HM contractor who will also approve the mix and the grouting pressures.

16. STRUCTURAL STEELWORK

16.1 SCOPE OF WORK

The work under this section includes all labour, materials and equipment required for the design, supply, fabrication and installation of structural steelwork. Rock anchors/bolts and miscellaneous steel required for the work shall be dealt with as per relevant section of specifications.

16.2 MATERIALS

All steel rolled sections and steel plates shall comply with the requirements of IS: 2062 steel for general structural purpose.

All black bolts shall comply with IS: 1367 Technical supply conditions for threaded steel fasteners.

All high tensile steel bolts shall comply with IS: 3757. Specifications for high strength structural bolts, High tensile bolts, nuts and washers for use in galvanized structural steelwork shall be galvanized or cadmium plated.

All threaded fasteners shall comply with ISO metric standards, normal series, coarse pitch.

16.3 FABRICATION

Materials shall not be transported to the Site until all tests, analyses and final inspections have been made or certified copies of reports of tests and analyses or manufacturer's warranties have been approved. The tests specified in the standard specifications shall be carried out by the manufacturers of the materials or by an approved testing laboratory and certified copies of test reports shall be supplied to the Engineer-in-Charge. Materials for which test reports or certificates have not been approved shall not be used in the Work.

When doubts exist as to the soundness of any part, such part shall be subjected to a non-destructive testing, if requested by the Engineer-in-Charge, which may include X- rays or gamma rays.

16.4 BOLTED CONNECTIONS

Bolted connections shall be made using black bolts and/or high strength friction grip bolts. Black bolts shall be either cold forged or hot forged swaged head bolts.

16.5 WELDING

All welding shall conform to requirement stipulated in the Section "Metalwork". Shop welds shall be used wherever possible and the use of field welds shall be kept to a minimum. Unless otherwise approved field wells shall not be used where shop welds are shown on the drawings. The contractor shall be responsible for the control of distortion and limiting of shrinkage stresses.

16.6 ERECTION

The contractor shall furnish all necessary equipment and shall erect the structural steel in accordance with these specifications and approved shop drawings. Structural steel members to be stored shall be placed on blocks so that no part of the members will touch the ground or be over-stressed and shall be kept clean and properly drained.

Proper allowance shall be made to compensate for shrinkage of field welds so that the structure will not be unduly stressed or correct alignment affected. The contractor shall set out lines and levels, and fix and maintain work for the erection and checking or positions of steel work. Arrangements shall be such that no allowable stresses shall be exceeded doing erections. All temporary flooring, planking and scaffolding necessary for the erection work or the support of erection machinery shall be provided conforming to the applicable safety regulations.

The farming shall be carried out true and plumb and temporary bracing shall be provided wherever necessary to take care of all excessive loads. Such bracing shall be left in place as long as required for safety. The steelwork shall be progressively inter-connected to take all dead, wind and erection caused stresses in a secure manner. Anchor bolts shall be positioned with a template before the concrete is placed to ensure that the anchor bolts are maintained in the correct position during the placing of concrete.

Hammering that will injure or distort the members will not be approved. The members shall not be over-stressed during the process of erection. Any error in the work which prevents proper assembling and fitting of parts shall be reported immediately to the Engineer-in-Charge, and his approval of the proposed method of correction obtained.

Erection in the field will be by bolting, high-strength friction grip bolting, are welding or a combination of these methods, as shown on the drawings or directed. In bolted connections where black bolts are used, the bolts shall be drawn tight and, where directed, the threads shall be burred or spot welded so that the nuts cannot be loosened. Where high tensile bolts are required, the method of fabrication and assembly of the connections shall comply with the provisions of the Indian Standards for friction type joints.

After erection, all temporary bracing and its connections shall be removed, holes plugged and the steelwork, including the protective coating specified, made good. All fields bolting and welding shall be subject to inspection and any faulty work shall be removed and replaced by the contractor upon requested by the Engineer-in-Charge.

16.7 PROTECTIVE COATING

All structural steelwork members shall be sandblasted down to grade Sa 2-1/2 according to Sis Standard 055 900.The corrosion protection of structural steel members shall be as follows:

- 2 shop coats of 2-component zinc-rich primer, dry film thickness min. 0.04 mm, max. 0.06 mm per coat, total dry film thickness min. 0.80 mm, max 120 mm
- Intermediate coat of 2-component epoxy micaceous iron oxide paint, dry film thickness min. 0.06 mm
- 1 finish coat of 2-component epoxy paint or 2-component polyurethane paint, dry film thickness min. 0.06 mm

The finish coat shall be applied after the erection of the steel structure at its final location. The intermediate shop coat shall be cleaned and lightly roughened before application of the finish coat.

17. BUILDING AND ARCHITECTURAL WORK (Make list shall be finalized during design stage)

17.1 SCOPE OF WORK

The work under this section includes all labour, materials and equipment, and performance of all operations required for the execution of the finishing and architectural work inside or outside of buildings, rooms or chambers to be constructed under this contract.

17.2 NOMINAL SIZES

The contractor shall allow for variations between nominal sizes and actual sizes where such variation is within the required tolerances or is normal trade practice.

17.3 FINISHING WORK

Finishing work shall not commence until each or all of the following conditions have been met to the satisfaction of the Engineer-in-Charge:

The area concerned and such adjacent areas, which may affect the finishing work, have been weatherproofed

All construction including installation of permanent plant, fittings and equipment has been completed

The concrete or other materials have dried out sufficiently. The Engineer-in-Charge may request a test for dryness to be performed by the contractor

17.4 MASONRY WALLS

17.4.1 GENERAL

The contractor shall construct masonry walls where shown on the construction drawings or as directed by the Engineer-in-Charge. All masonry walls shall be constructed after the structural concrete work has been completed. The work shall include, but not limited to, the brickwork.

17.4.2 MATERIALS

Masonry units shall be bricks units. The Contractor shall submit samples of bricks to the Engineer-in-Charge for approval. Cement, sand and water shall be as specified in the relevant section of "Concrete".

Masonry units shall have a moisture content (expressed as a percentage of total absorption) of not more than 30% (thirty percent) at time of delivery. Units made from cinder aggregate shall not be used. All bricks shall be adapted to the wall thickness and approved by the Engineer-in-Charge. The mortar shall be thoroughly mixed until uniform in colour and shall be used before it has taken initial set. Mortar, which has partially set, shall not be used, nor shall more water be added to it.

17.4.3 EXECUTION

The masonry units shall be laid on horizontal courses, true to line and plumb, and vertical joints shall be staggered with respect to those in the courses next above and below. No broken bricks and

blocks, except as are required as closures for the proper sizing of courses, cracked or misshapen bricks will be used in the work. Corners, and at edges of framed openings, bricks shall have finished return ends. All exposed bricks, which are to be cut, shall be cut with a carborundum wheel.

17.5 WALL, FLOOR AND ROOF FINISHES

17.5.1 GENERAL

The Contractor shall install finishes on walls, floors and roofs according to the approved shop drawings as approved by the Engineer-in-Charge.

The work shall include, but not limited to, the following:

- Plastering
- Floor finish
- Roof finish (cement mortar)
- Special floor finish (Granolithic concrete)

17.5.2 MATERIALS

Cement, sand and water shall be as specified in the relevant section of "Concrete". Waterproofing and epoxy resin shall be approved by the Engineer-in-Charge and shall be used in perfect accordance with the manufacturer's instructions.

17.5.3 EXECUTION

Concrete surfaces, which are to receive a rendering coat, shall be roughened, scratched and free from all laitance, scum. Loose carbonate scale, loose aggregate, dirt and other foreign matter and shall be kept thoroughly wet for 24 hours prior to the application of mortar. All masonry and concrete surfaces to which cement mortar is to be applied without furring shall receive one coat of an epoxy resin type bonding agent or other agent approved by the Engineer-in-Charge.

17.6 TILE WORK – FLOORS AND WALLS

17.6.1 GENERAL

The contractor shall install tiles on walls and floors and according to his shop drawings as approved by the Engineer-in-Charge. The contractor shall submit samples of tiles for approval by the Engineer-in-Charge with respect to quality and colour. Tile samples shall include the manufacturer's full colour and texture range of the series specified by the Engineer-in-Charge.

17.7 BITUMINOUS WATERPROOFING MEMBRANES

17.7.1 GENERAL

The contractor shall supply and install bituminous waterproof membranes on roofs and floors with or without thermal insulation as directed by the Engineer- in-Charge. Membranes on roofs shall include protective mortar, roof drain and downspouts.

17.7.2 MATERIALS

Bituminous waterproof roofing shall consist of 3-ply built-up roofing layers applied as follows:

3-ply built-up roofing

Asphalt primer 0.4 l/m²

Asphalt compound 1.5 kg/m²

1st layer felt 39 kg / 42 m² roll

Asphalt compound 1.5 kg/m²

2nd layer felt square meshed 35 kg / 21 m²

or perforated fibre glass felt 28 kg / 10 m² roll Asphalt compound 2.0 kg/m²

3rd layer felt 35 kg / 21 m² roll

Asphalt compound 2.1 kg/m² Plastic sheet protection one layer

17.7.3 THERMAL INSULATION

Thermal insulation shall be provided in the form of thermal insulation panels laid directly on the bituminous roofing felt covering the cement mortar screed. The thermal insulation material shall in turn be covered with a second layer of bituminous roofing felt. Panels for thermal insulation shall be of synthetic insulating material having a density of approximately 30 kilograms per cubic meter. The panels shall have a thickness of 30 mm. organic material like cork shall not be permitted. Consideration shall be given to the chemical composition of panels, with regard to any possible chemical reaction with bitumen.

Insulating panels shall be laid with staggered joints and with their joints coated with bituminous paint. They shall then be covered by a layer of bituminous roofing felt. Joints in bituminous roofing felt shall consist of a minimum overlap of 100 mm sealed with a layer of hot bituminous paste. Roofing felt shall be laid such that it overlaps the insulation layer and joins with the roofing felt beneath the insulation layer. The 2 layers of felt shall be joined together to completely surround and seal the insulation layer on all sides and edges.

17.7.4 EXECUTION

Concrete roof slabs shall be prepared to receive bituminous 3-ply built up roofing by first laying a 1:3 cement mortar to form the slopes. The thickness of the screed shall vary between 20 mm (minimum) and 120 mm (maximum) thickness. The surface of the concrete slab prior to the laying of the screed shall be prepared in accordance with the requirements for concrete construction joints as specified in Clause No.-12 (Concrete).

The cement mortar screed shall be allowed to cure for a minimum period of 3 weeks before covering with the specified insulation and waterproofing layers. A layer of bituminous roofing felt, thermal insulation panels and a second layer of bituminous roofing felt shall be placed over the cement mortar screed as specified above.

3-ply built-up roofing shall then be applied follows:

(a) Asphalt primer shall be evenly applied in accordance with the manufactures recommendations over the surface of the bituminous roofing felt covering the thermal insulation panels. Asphalt compound shall then be evenly poured and sprayed over the asphalt primer. Compound heated to a temperature exceeding 140°C above the melting point shall not be used. Asphalt felt, roofing and special roofing shall be laid over each respective asphalt compound with care to avoid bulges. The sides and ends of these sheets shall be provided with an overlap of at least 90 mm. The joints shall be completely watertight.

(b) The whole surface shall be covered by plastic sheet protection in order to allow the movement of the top protective mortar screed without damaging the 3-ply built-up roofing. Care shall be exercised when carrying out roofing work surrounding anchor bolts, parapets and roof drains to prevent leakage.

The top protective screed shall be placed in two 25 mm thick layers with wire mesh laid in between. Wire mesh shall consist of 0.9 mm diameter galvanized steel wire with a mesh size of 25 mm or similar approved.

17.8 ALUMINIUM DOORS, WINDOWS AND ROLLING SHUTTERS

17.8.1 ALUMINIUM DOORS

(a) FABRICATION

The contractor shall supply and install aluminium doors as required. They shall be installed in accordance with approved shop drawings. All aluminium doors, frames and hardware shall be to the approval of the Engineer-in-Charge. Prior to fabricating or ordering the aluminium doors, the Contractor shall check the actual dimensions and shape of existing concrete openings.

(b) ROLLING SHUTTERS

The contractor shall supply and install steel rolling shutters as required. These shall be installed in accordance with approved shop drawings. Prior to fabrication or order of the rolling shutters, the contractor shall check the actual dimensions of existing openings. The rolling shutter shall be of approved make, made of required size of MS laths interlocked together through their entire length and jointed together at the end by end locks mounted on specifically designed pipe shaft with brackets, side guides and arrangement for inside and outside locking with push and pull operation complete including wire springs and MS top cover of required thickness. The rolling shutter may also be required to be fitted with motorized arrangement and related work.

17.9 GLASS AND GLAZING

17.9.1 MATERIALS

Each glass sheet shall bear the manufacturer's label showing its grade, thickness and type. Labels shall remain until the glass has been set and inspected. When glass is not cut to size by the manufacturer, the contractor shall furnish an affidavit certifying the grade, thickness, type and manufacturer of the glass supplied. Sealant and glazing compound shall be compatible with the frame as recommended by the manufacturer. Glazing beads and seals shall be black neoprene or vinyl chloride.

17.10 PAINTING WORK

17.10.1 GENERAL

The work includes preparing and painting various surfaces as directed by the Engineer-in-Charge, including protection and finish painting of metal surfaces, except those metal surfaces specified under the Technical Specifications for equipment supplied by others. The Contractor shall provide all labour, materials, supplies, equipment and scaffolding to perform all operations necessary to complete the work.

17.10.2 MATERIALS

Colour of paints shall be in accordance with the colour schemes selected by the Engineer-in-Charge. Exact tones of the colour selected shall be in accordance with the samples supplied and applied on test areas in the Work approved by the Engineer-in-Charge.

All paint materials shall be delivered to the Site in their original containers, with labels intact and seals unbroken. All paints shall be of well-known registered brands.

All tinting colours and thinning materials shall be of the same brand as the oil paint specified for the particular area. Tinting colours for oil paint shall be colours-in-oil, ground in pure linseed oil of the best grade.

With the exception of ready mixed materials in original containers, all mixing shall be done at the Site.

The Contractor shall provide for the purpose of maintenance one unopened 4 litre can of each type and each colour of paint used, on completion of the work.

17.10.3 PREPARATION OF SURFACES

Concrete and masonry work shall be left for one month and any surface defects repaired before painting.

Cracks, holes and other defects in plaster shall be filled or patched with an approved filling compound. The filling shall finish flush with and in the same plane as the adjoining surface. Where patches in cement plaster are required, the surfaces shall be coated with an approved bonding agent, the defects filled with an approved mortar mix for patching, and the patched areas finished to match the texture of the cement plaster. Plaster surfaces that will be painted for the first time shall be uniformly coated with a solution composed of 1 kg of zinc sulphate to 4 litres of water, to which shall be added 28 g of dry sienna to each 4 litres of zinc sulphate solution. 24 hours after application of the zinc sulphate solution, the surfaces shall be thoroughly washed with clear water and allowed to dry thoroughly.

Metal surfaces to be painted shall be clean and thoroughly dry before painting. Rust, loose scale, oil, grease and dirt shall be removed with approved solvents, wire brushing or sanding. Metal welds and blisters shall be ground and sanded smooth, pits and dents filled and imperfections corrected so as to leave a smooth surface.

Wood surfaces to receive paint shall be cleaned of all dirt, grease, dust or any other deleterious matter. All surfaces shall be thoroughly sanded and all nail holes, cracks and any other defects shall be coloured to match the colour of the finish paint. The finish surfaces shall be smooth, level and uniform, free from any stains and shall be uniform in colour and shade.

The contractor shall be responsible for and shall rectify any surface finish which in the opinion of the Engineer-in-Charge is unsatisfactory to receive paint.

18. SLOPE PROTECTION

18.1 SCOPE OF WORK

Work under this section include all labour, materials, equipment and services required to protect the slopes either excavated or those of embankments and backfills.The contractor shall place the various items specified herein as protection to slopes or lining to ditches to the lines and thicknesses and in the locations shown on the construction drawings, or as directed by the Engineer-in-Charge. Sprayed concrete, rock bolts, wire mesh, and drainage work, which may also be required for the slope protection, are specified in other sections of these specifications.

18.2 GABIONS (WIRE CRATES)

18.2.1 MATERIALS

Gabions (or wire crates) shall have a volume varying between 1 and 4 m3, depending on the local requirement. They shall be rectangular in shape and constructed of double twisted galvanized mild steel wire formed into a hexagonally shaped mesh, of area 5,000 mm2. Corners shall be reinforced with larger diameter galvanized wire and then filled with cobbles or rock fragments.

The iron wire for gabion construction shall be hard drawn conforming to IS: 432 (Part II). The galvanized coating on wire shall conform to IS: 4826. The wires shall have the following minimum diameters:

Net and tension rods	3 mm
Wires for corner reinforcement	5 mm

Seam wires 2 mm

Fill material shall comprise cobbles or rock fragments that are dense, sound and resistant to abrasion. Cobbles and rocks shall be free of cracks, seams and other defects that would increase their susceptibility to destruction by erosive action. Individual cobbles or rock fragments shall be rounded and well graded in size between 120 mm and 200 mm. Flat rock fragments shall not be used.

18.2.2 EXECUTION

Gabions shall be assembled, connected together and filled as shown on the Tender Drawings and described herein.

Foundation surfaces upon which gabions are to be placed shall be reasonably smooth and even, with excessive high spots removed and voids filled with small rock fragments. Gabions to be placed at the toe of slopes shall be laid in a trench at least 250 mm deep. Gabions shall be secured in position by tying to adjacent gabions, and where laid on slopes, shall be fixed to the slope surface by 2 m long hardwood stakes driven through the gabions into the ground at 2 m interval. Internal galvanized wire tension rods shall be provided to reduce distortion of the cages.

After several gabions have been placed in position adjacent to one another they shall be securely tied together continuously at their corners over their full height and filled by hand with cobbles and rock fragments as specified. Once full, the cage lid shall be placed in position and securely tied around its whole perimeter.

Further gabions to be added, either above or adjacent to those already placed, shall be securely and continuously tied to existing gabions along all edges of contact before filling.

18.3 RANDOM RUBBLE MASONRY

18.3.1 WET MASONRY WALL

The contractor shall construct wet masonry walls (or random rubble masonry) for slope protection to the lines and in locations shown on the construction drawings or as directed by the Engineer-in-Charge.

The stone for masonry walls shall be natural or crushed stone having sufficient strength and durability required for its use, not less than 150 mm thick. The rock shall be of suitable color and appearance as determined by the Engineer-in- Charge. The rocks in the exposed face shall be approximately flat.

Mortar for masonry walls shall comprise 6 parts of clean fine aggregate to one part of cement by volume. Fine aggregate and cement shall comply with the requirements specified in the Section "Concrete".

Stones shall be moistened and hand-placed with uncoursed close joints onto a bedding of 200 mm thick drainage and 150 mm thick filter layers. Spaces between stones shall be filled with mortar. Surface joints shall be finished struck.

Weep holes of 50 mm dia. PVC pipe shall be installed through the wall to the pattern shown on the approved Construction Drawings or as directed by the Engineer-in- Charge. The upper surface of the walls shall be finished smooth with trowelled layer of 10 cm capping concrete.

After completion of a section of masonry walls, it shall be cured with water for a minimum of 72 hours.

18.3.2 DRY MASONRY WALL

For certain sections of wall, only dry masonry may be required. In such case, stones shall not be filled with mortar.

18.4 GRASS TURF

The Contractor shall furnish and place the grass turf (field sod) as protection of excavated surfaces and embankment slopes where shown on the Construction Drawings or directed by the Engineer-in-Charge. Grass turf shall consist of a dense and well rooted growth of permanent and desirable grass indigenous to the area. When sod is lifted, it shall be covered with grass recently cut to a length of not more than 70 mm.

Areas to be turfed shall be fine graded to a uniform surface and loosened to a depth of 30 mm. Where directed, the topsoil shall be placed on the prepared surfaces. Field sod shall be placed over a whole area (not in strips) of the designated slope. Field sod, excluding grass depth, shall be at least 50 mm thick. When laid on the slopes steeper than three horizontals to one vertical, it shall be pegged with wooden stakes. Grass turf shall not be placed in the season of heavy rains.The contractor shall be responsible for all completed turfing and shall water the turf whenever necessary to ensure rooting. Any break which may occur through slippage of sod shall be repaired and any sod which is dead shall be removed and replaced by the contractor.

19. EXPANSION JOINT

19.1 Materials

Pre-moulded Joint Filler in Expansion Joint: It shall conform to IS 1838 (Pt. I). The thickness shall be25 mm with tolerance 1.5 mm. and shall be of the maximum available standard length not less than one lane width. The filler board shall be positioned vertically with the prefabricated joint assemblies along the line of the joint within tolerance of +10 mm from the intended line of the joint. The depth of board shall be 25 mm less than thickness of slab within a tolerance of ± 3mm so that the top of the board shall be below the surface or will not impend the passage of the finishing straight edge or oscillating beam of the paving machine.

Bitumen Hot Sealing Compound: The joint sealing compound shall be fuel and heat resistant type complying to grade B of IS 1834. It shall be capable of adhering to the concrete without cracking, spilling and disintegration.

19.2 CONSTRUCTION PROCEDURE

Expansion joints shall be provided as shown in the drawing and as per directions of Engineer-in-Charge. All joints shall be constructed true to line with their faces perpendicular to the surface of the pavement. The joint shall be 20 mm wide. The depth of the non-extruding filler pad shall be 25 mm less than the depth of the concrete slab.

Before the provision of expansion joint, the face of the already laid concrete slab shall be painted with primer at the rate of 2.6 litres per 10 square meter. The expansion pad shall be properly cut to shape and shall then be placed in position abutting the painted face of the already laid concrete slab. The adjacent slab shall then be concreted. The face of the pad against which the new concrete slab is to be laid shall also be painted with primer before laying the concrete, while concreting a neat groove of size 20 mm x 25 mm as per drawing shall be formed on top of the pad taking care that the edges are absolutely straight and that the groove so made does not get filled with any material like concrete, mortar and other rubbish.

Before the curing process is started, the top of expansion joint shall be filled with bitumen sand mixture in order to ensure that no foreign material used in curing enters into the joint. This filling shall be removed before filling the joints with sealing compound.

For sealing the joints, following operations shall be carried out:—

(a) The joints are cleared of any foreign matter to the full depth up to the top of expansion pad

with steel spatula.

(b) The joints are blown with compressed air.

(c) Cleaning is done with Kerosene oil.

(d) Priming is done with spray gun @ 2.6 litres per 10sqm of the surface to be primed.

(e) The primer is allowed to dry completely before pouring the sealing compound.

(f) The sealing compound grade 'A' is heated to the required temperature ranging between 155 °C to 165 °C or to the temperature range specified by the manufacturer. Over-heating shall be avoided. Pouring shall be done from vessel with spout in such a manner that the material will not get spilled on the exposed surface of the concrete, any excess filler on the surface of the pavement shall be removed immediately and the pavement surface cleaned.

(g) The filling shall be worked into the joints with hot flats to ensure escape of trapped air.

(h) The filling is then ironed with hot iron. It is recommended that while in summer the joints may be sealed flush with the adjacent pavement surface, in winter the sealing compound may be filled to a depth 3-4 mm below the surface.

(i) The edges of the joints are then cut and trimmed to ensure neat and straight line finish.

(j) To prevent tackiness or pick up under traffic, the exposed surfaces of the sealing compound shall be dusted with hydrated lime, if directed by Engineer-in-Charge (Nothing extra shall be paid for the same).

20. ROAD WORK

Concrete road shall be laid in accordance to the IS codes and approved drawings. The bituminous road, wherever required shall be laid in accordance with the relevant IS codes and PWDSOR.Any assessment of the dimension of the road to be done by the bidder.

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1. SCOPE OF WORK

The scope of work of the contractor shall include design, drawing, engineering, fabrication, supply, transportation, erection at site, testing and commissioning of all hydro-mechanical structures & equipment with manually/electrically operable hoisting arrangements, including labour, tools and tackles, including all auxiliary work etc. complete in all respect of Lodhama-II Small Hydroelectric Project of capacity 10 MW (2 X 5 MW).

The contractor shall have to prepare and submit to the owner the design details, material specifications, construction drawings, design reports for all hydro-mechanical structures & equipment including Penstock for approval.

The Hydro-mechanical items involve in the work are listed below:-

- Penstock HM work including Air vent Pipe
- Stop log gates at Lodhama Inter-connection Tunnel and the proposed Water Conductor at ADIT-II Tunnel with hoisting arrangement
- Vertical sliding Screw Hoist Gate at the proposed Water Conductor within ADIT-II Tunnel
- Trash Rack including Silt flushing valve at Forebay
- Penstock Gate at Forebay with hoisting arrangement
- TRC Gate with hoisting arrangement

Detailed scope under the abovementioned items are stated in Clause No. 05 (Scope of Work) of GCC.

The items stated above are exhaustive, however, the contractor need to carry out any work that is not mentioned above but required to carrying out for successful commissioning of the plant.

(a) <u>DETAILS OF DESIGN, DRAWINGS AND OTHER DATA/ DOCUMENTS TO BE SUBMITTED BY CONTRACTOR AFTER THE AWARD OF CONTRACT AT VARIOUS STAGES OF CONTRACT OPERATION</u>

i) Design calculations for all components and parts in accordance with design criteria & specifications to prove their adequacy supported by catalogues/ technical literature of all bought out components with selection criteria & characteristics.

ii) General assembly and sub-assembly arrangement and detailed dimensions of the parts of the equipment to be supplied under the contract.

iii) Block out drawing dimensions locations of anchors and first stage concrete outlines: Material list covering specifications, sizes, quantities, weight of each component from which the various parts will be made and their finishes of machine surfaces, weld details, welding rod specifications and inspection methods.

iv) All handling attachments for site assembly, painting system including cleaning & application procedures, priming and final coats.

v) The contractor shall be required to submit quality assurance documents, test certificates as required within 30 days prior from the date of dispatch of the equipment from factory/shop.

vi) For guidance during installation of the work and subsequently for guidance during plant operating and maintenance, contractor shall prepare and submit Installation, operation &

maintenance manuals as applicable and submit in 06 (Six) copies along with soft copy completion report and as build drawing.

vii) Any other documents specified elsewhere in the Technical Specifications or as desired otherwise by the WBSEDCL which are not mentioned /specified but otherwise are necessary for commissioning of the project.

(b) SUBMITTALS

i) The contractor shall provide to the WBSEDCL at least **6(Six) copies** or as otherwise specified, of all submittals as requested for in these specifications and other bidding documents. Although their extent shall be to the discretion of the contractor, they shall be complete enough to illustrate adequately the problem of the aspect concerned for the understanding of the WBSEDCL. The drawings shall be legible and at least in A-1 size.

ii) At any time, the WBSEDCL may call either for additional information, completion of the submittals or request the contractor not to submit some of them.

iii) The contractor shall submit these documents to WBSEDCL for comment and approval.

iv) All drawings shall be carefully checked by the contractor for accuracy, completeness and clarity before submission to WBSEDCL for approval. The contractor shall be responsible for correctness and adequacy of the design in relationship to the specifications.

v) Approval by the owner for the contractor's design and drawings shall not relieve the contractor for any part of the contractor's obligation to meet all the requirements of the equipment, specifications or of the responsibility for the correctness of the contractor's drawing and designs.

vi) The requirements of any alterations requested by WBSEDCL shall not be construed to mean that the drawings have been checked in detail, shall not be accepted as justification for an extension of time and shall not relieve responsibility for the adequacy of the designs and correctness of the drawings.

vii) The design of all equipment shall be such that installation, replacements and general maintenance may be undertaken with the minimum time and expense.

viii) It is not the intention in these specifications to specify complete details of various processes to be followed by the contractor/ agency during fabrication & erection work. This is left to the experience and practice of manufacturer, who shall perform these processes as per the prudent engineering practices in the field. However, certain features and processes specified herein are intended to establish minimum standards for the work. It is the intent of these specifications to establish acceptable standards of quality. The specification drawings & the location of trash rack, valve, gates and hoists in this document are indicative only. The contractor shall prepare detailed designs alongwith calculations and drawings and get same approved by WBSEDCL before fabrication is taken up. These specifications shall be read along with the said fabrication drawings for purposes of this contract.

ix) The contractor shall fabricate and supply the trash racks/gates/ valve/ embedded parts/ hoists and controls etc. as per his designs supported with detailed drawings and calculations

and as approved by WBSEDCL.

2. APPLICABLE INDIAN STANDARDS AND PUBLICATIONS

a) GENERAL

i) All work& supplies shall conform to the Indian standards. Authoritative standards and codes other than IS or those specified in the bidding documents, which ensure an equal or higher quality, may also be acceptable.

ii) All standards and codes referred to shall be the latest current issues.

iii) In case of discrepancies between these specifications and national or international standards and codes, these specifications being part of bidding documents shall govern, unless otherwise directed by the WBSEDCL in each particular case.

b) NATIONAL STANDARDS, CODES, LAWS AND REGULATIONS

i) Throughout the duration of the contract, the materials, equipment, services, design and workmanship shall conform to the applicable national codes, standards, laws and regulations in force in India, if not otherwise specified.

ii) It is the contractor's duty to acquaint him with all national codes, standards, laws and regulations related to the work in any way and he shall procure and keep at his work on the Site a copy of each of such applicable documents.

3. TRANSFER STRUCTURE GATE

Rammam Stage-II Hydel Project is operational by diverting the Rammam water and Lodhama water through separate drop type weirs and then through 'D'-shaped tunnels to a common fore-bay. Water from Lodhama Khola is generally utilized for generation of Rammam Stage-II Hydel project during non-monsoon period.

The proposed Lodhama-II Small Hydroelectric Project will utilize the frontal network (upto junction point of ADIT-II with LICS tunnel) of Lodhama interconnection scheme by harnessing the discharge of Lodhama Khola primarily in monsoon period. However, the plant may also operate during other time of the year based on availability of the water. The schematic detail is given in Drawing No. - LODHAMA-II/CIVIL/schematic/1/REV-0 of Volume-7 of this tender document for reference.
Suitable structural arrangement through 02 (two) Stop log Gates one each at Lodhama main tunnel and ADIT used in this scheme, and one screw hoist gate at ADIT is to be made for smooth diversion of 3.74 cumec of water (10% over load above 3.40 cumec) without turbulence from existing Lodhama main Tunnel of size 2400mm (width) x 2400mm (height) to the rectangular water channel of about 1700mm (width) x 1500mm (height) to be constructed within the existing ADIT-II of size 4000mm (width) x 4000mm (height). The Stoplog Gate at Adit-II shall be at the upstream side of the screw hoist gate (drawing enclosed). For all practical purpose the channel should be so aligned that one side of the channel may be the side of the ADIT-II

The Stoplog Gates may be in 03 (three)/ 04 (four) Horizontal segments or as suitable for lifting manually with mechanical arrangements shall have to be made to stack the segments in side walls or any proper place when not in use and capable of being put in place of operation as and when required. The gate shall be water tight and shall be designed as per latest editions of IS: 5620, IS: 6938 and any other relevant IS codes or standard practices in

vogue. Necessary design calculations in regard to the gates and smooth and non-turbulent diversion of water are to be submitted.

A suitable access pathway shall be considered up to proposed gate points for operation and maintenance purpose. For the said purpose, it may be considered to make provision of the pathway over channel top keeping operation maintenance provisions (such as manhole/detachable top cover etc on the channel) or at the tunnel floor by the side of the proposed channel.

4. TECHNICAL SPECIFICATION FOR TRASH RACKS

4.1. GENERAL

- One set of trash rack with manually Hoisting and lifting arrangement and consisting of interchangeable panels suitable for handling and fixing to the built-in steel support frames, shall be designed, supplied and installed by the contractor in Fore-bay.

- Trash Rack will be installed to prevent floating matters injurious to the water turbines from entering into power waterway and to adequately withstand the impact forces, static loads and vibrations which are likely to occur due to flow of water passing through the trash rack.

4.2. DESIGN DATA

The trash rack shall be designed for the following conditions:

a) Type : Removable trash rack as applicable as per IS: 11388

b) Quantity : 01 (one) set

c) Clear opening of vent : About 1600mm (width) x 1800mm (height)

d) Inclination to vertical : 10°

e) Full Supply Level : EL 1434.24m

f) Design discharge : 3.40m3/s (10% overload to be considered)

Other required design data will be supplied as and when required.
A water level gauge covering FRL & MDDL shall be provided in the Fore-bay. The Gauge shall have the provision to be connected with power house central control system (SCADA). Provision of accessibility of the gauge for maintenance/ trouble shooting shall be provided by the contractor.

4.3. STEEL GRADE

Structural Steel shall confirm to IS: 2062 (Steel for general structural purpose). The contractor shall conduct all tests according to relevant I.S. or according to relevant British/ American code of practice and submit the test certificates to WBSEDCL. Tolerance in dimensions shall be within the limits as prescribed in the relevant I.S. codes and standards. Surface defects shall be removed as required by the relevant standards. All local repairs, grinding or machining shall be smoothly blended into the surrounding surface. Steel shall be of Grade as per technical specification and of SAIL/RINL/TATA/Jindal/ ESSAR make.

4.4. FABRICATION AND ERECTION

The manufacturing of the trash rack panel's attachments shall be as per the design. Fabrication and supply of these parts shall be as per respective specifications of this document or as per WBSEDCL's instruction. The bidder has to quote his rates for manufacturing, transport, Erection at site including applying primer, painting with approved paint & providing arrangement for removal of panel & refixing etc. complete in all aspects. The activity of erection envisages erection of all Horizontal & Vertical structural sections as per design, previously fabricated trash rack Panels and the embedded parts including providing & fixing hoisting hooks.

4.5. DRAWING FOR FABRICATING TRASH RACK PANELS

The contractor shall prepare design & submit drawings for all items of trash rack panel attachments and trash rack embedded parts for approval of WBSEDCL and procedures/ schedules that shall be followed by the contractor for the fabrication and installation.

4.6. TOLERANCE

Various tolerances for this work are as per the latest Indian Standards. These will have to be adhered to at the time of fabrication and shop assembly as well as during fabrication, erection, commissioning and testing of the various structural parts.

4.7. ENGINEERING DATA

All engineering data submitted by the contractor after final process including review and approval by the WBSEDCL shall form part of the contract documents and entire work covered under these specifications shall be performed in strict conformity to the final data, unless otherwise expressly asked by the Engineer in writing. All manufacturing and fabrication work in connection with equipment prior to the approval of the drawing shall be at the contractor's own risk.

4.8. MANUFACTURING AND ERECTION SCHEDULE

The contractor shall manufacture, supply, deliver & erect the trash rack and its fixture as per approved schedule and drawings well in advance for smooth execution of work at site.

4.9. FOUNDATION AND FIXTURES

All fixtures necessary for proper erection of trash rack panels shall be supplied by the contractor. If desired by the WBSEDCL the contractor shall provide the Engineer any special design criteria for civil foundation work.

4.10. MATERIAL AND WORKMANSHIP

4.10.1. METAL WORK FABRICATION AND MACHINE WORK

All equipment, materials and supplies shall be of the most suitable quality for the work. The contractor shall without extra cost provide samples and co-operate in the testing of materials and inspection of the work. The WBSEDCL shall have access at all times to the places of storage and to the places where material will be fabricated or processed to determine whether their fabrication and process are proceeding in accordance with the specification and as per drawings or not.

The WBSEDCL may reject at any stage, any work which he considers to be defective in quality and he shall not be debarred from rejecting the brought materials by the reason of his having previously passed them. Any portion of the materials rejected shall be removed from the work site by the contractor at his expense, upon written instructions to that effect by the Engineer-in-Charge. Replacement of such materials shall be made by the contractor at his expense.

4.11. SCREW THREADS

The threads for bolts and nuts shall have metric threads of International standards organization and conforming to Indian standard ISO Metric Threads Diameter pitch combinations IS: 4218 (Part –II).

4.12. FITS AND TOLERANCES

Fittings used for different components shall be according to the best modern shop practice. Due considerations shall be given to the special nature of function of the parts and to the corresponding accuracy required to secure proper operation. The Fittings shall be in accordance with Indian standard. These shall be subjected to the approval of the Engineer. The tolerances for embedded parts and components of trash rack panels shall be considered as per relevant standards and specifications.

4.13. FABRICATION OF STRUCTURAL STEEL

The structural steel work for the equipment covered by the specification shall conform to the requirement of reamed work and shall conform to the following requirements unless otherwise called for in these specifications. All completed members shall be free from twist, bends and open joints. Attention is called to the special nature of the work involved in the manufacture of equipment, which required closed adherence to the dimensions, tolerances and finish called for.

4.14. STRAIGHTENING

Before being laid off or worked in any manner, structural material shall be straight without twist, bends or kinks and shall be cleared all rust and dirt. If straightening is necessary, it shall be done by method that will not injure or mar the materials.

4.15. SHEARING, CHIPPING AND GAS CUTTING

Shearing, chipping and gas cutting shall be done carefully by torch or by electric arc and all portions of the work, which shall be exposed to view shall present neat appearances. Gas cutting shall be mechanically controlled. Re-entrant cuts and copes in beams and channels shall be filled before cutting.

4.16. WELDED EDGES

The edges of plates or shapes to be joined by welding shall be formed properly to suit the selected type of welding. Sheared edges of plates and shapes to be joined by welding shall be machined or chipped to sound metal before welding.

4.16.1. WELDING STUDS

Welding stud wherever used shall be welded in place with automatic end-welding guns. Templates of sufficient thickness to afford good alignment shall be used to accurately locate the studs during the welding cycle and to locate matching holes in other material. Bushing shall be used for template holes, if necessary to ensure angular alignment of the studs and location accuracy required for proper fit of parts to be assembled.

4.16.2. PREPARATION FOR WELDING

Members to be joined by the welding shall be cut accurate to size, and where required shall be rolled or pressed to the proper curvature in accordance with the dimensions shown on the approved drawings. The edges of the members to be joined by welding shall be sheared, flame-cut or machined to suit the required type of welding and to allow through penetration. The cut shall expose sound metal free from lamination, surface defects caused by shearing or flame cutting operation and other injurious defects. The surface of plates to be welded shall be free from rust, grease and other foreign matter for a distance of at least 50 mm back from the edge of the weld.

4.16.3. WELDING TECHNIQUE

All welding shall be performed by electric arc process using coated electrodes or other means where applicable, automatic machines, with correct precision control shall be used. After being deposited, the weld shall be cleaned of slag or flux and shall show uniform section, smoothness of weld metal, feather edges without overlap and free from porosity and clinkers. Visual inspection at the edges and ends or welding shall indicate good fusion with the base metal. When weld metal is deposited is successive layers, each layer except the last shall be penned moderately with a tool before the next layer is applied.

Particular care shall be taken in aligning and separating the edges of members to be joined by butt-welding, so that complete penetration and fusion at the bottom of the joint shall be ensured. All pin holes, cracks and other defects shall be repaired by chipping or grading the defects to sound metal and re-welding where fillet weld are used, the member shall fit closely and shall be held together during welding the welding rods used for manual welding shall be of heavily coated type and shall be suitable for all position welding where required. In welding, precautions shall be taken to minimize stresses due to expansion and contraction and distortion due to heat by using the proper sequence in welding i.e. by penning the welds while hot or by other satisfactory methods.

Rectifications of distortions by blows after welding shall not be permitted. The welding shall conform to Indian standard "code of practice for Use of metal arc welding for General construction in Mild steel 'IS: 816. The electrodes shall conform to the Indian standard "Specifications for covered Electrodes for Metal Arc welding structural steel for welding products other than sheers and for welding sheets (Part-I and II) IS: 814.

The contractor shall prepare shop and field welding procedure including stress relieving and preheat requirements and shall submit this procedure to the WBSEDCL for approval. The procedure shall be in accordance with the best modern welding practice and shall be such as to minimize residual stress and distortion of the finished members of the structure. Approval of any procedure, however, shall not relieve the contractor of the sole responsibility for producing a finished product meeting all requirements of these specifications. Welds in contact with rubber seals shall be ground flush, all corners and corner weld in contact with rubber seals shall be rounded.

4.17. APPROVAL TEST OF WELDING PROCESS

Specifications of the welding procedure that are proposed to be used shall be established and recorded and a copy of such procedure specifications together with certified copies of report of results of tests made in accordance with the procedure specifications shall be furnished by the contractor. The procedure specifications shall conform to the Indian standard "Approval tests for welding procedures part I fusion welding of steel IS: 7307 (part-1)".

4.18. RADIOGRAPHIC EXAMINATION

Radiographic Examination of the weld to be carried out by the contractor as per the direction of EIC, if required.

4.19. STRESS RELIEVING

Stress relieving of parts, where required shall be carried out after all welding including their radiographic examination is complete but before they are machined or assembled into structure. The stress relieving of equipment's materials and supplies, constraining plates thicker than 28 mm, shall be as per I. S. procedure & relevant standards.

5. SILT FLUSHING VALVE

Two number silt flushing valve suitable for an opening of about 500mm (width) x 500mm (height) shall be provided on sunken floor of the Fore-bay tank. The valve shall have seals and shall be operated by screw hoist of adequate capacity.

6. PENSTOCK

6.1. SCOPE OF WORK

The specifications described herein under cover all labour, materials, plant, equipment and services related to the supply, handling, design, fabrication, transportation, erection, painting, testing and commissioning of Penstock steel liner, its stiffeners and accessories from high tensile steel plates including design, manufacture, transport and supply of erection trolleys for construction work to be carried out by the contractor under this contract.

The work shall be done strictly as per approved design, fabrication/ erection drawings approved by the WBSEDCL. These fabrication/ erection drawings shall be prepared by the contractor and shall be based on the approved design & construction drawings with addition/ alternations and modifications, if any from time to time. However, the approval issued by the WBSEDCL of the contractor's Design, contraction drawing, fabrication/ erection drawings shall not be held to relieve the contractor of any part of his obligation to meet all the requirements of the contract.

The Engineer-in-Charge will have the right to ask the contractor to make any changes in his fabrication/ erection drawings which, in the opinion of the Engineer-in-Charge, may be necessary to make the finished construction conform to the requirements and intents of these specifications and drawings inclusive of all modifications, revisions etc., and that may be made and informed to the contractor from time to time during execution of work.

6.2. SUBMITTALS

Within 28 (twenty-eight) days from the date of issue of the letter of Acceptance but before procuring or mobilization of equipment and plants to the site, the contractor shall submit to the WBSEDCL, complete details of equipment and plants proposed for fabrications, erection, painting and testing of the steel liner shells.
The contractor shall specify in his bid and subsequently also, if required by the WBSEDCL, the source(s) from which the Contractor shall procure steel plates required for the steel liner. In case the specified source is not acceptable to the WBSEDCL, the contractor shall be required to substitute the source by an acceptable source. Additional suppliers and change of suppliers shall be subjected to the approval of Engineer-in-Charge.
At least **28 (twenty-eight) days** prior to procuring or dispatch of the steel plates to the site, the contractor shall submit to the WBSEDCL the following:

- Certified quality test reports from the manufacturer of steel plates.
- If the materials are to be arranged from several sources, the estimated quantity to be procured from each source and proposed schedule of supply.

At least 28 (twenty-eight) days in advance of fabrication, the contractor shall submit to the WBSEDCL the schedule of fabrication of the entire work.

Well in advance the Contractor shall submit to the WBSEDCL the shop and field drawings etc. along with design calculations and information as stated hereunder:

- Fabrication drawings of all the straight shells.
- Development drawings including design for bends, reducer cones, bifurcation and bulkheads and their fabrication drawings.
- Drawings exhibiting plate-cutting schedules clearly identifying as to how the Contractor intends to utilize each of the steel plates.
- Drawings of manhole arrangement for piezometers connections etc as applicable
- Design and drawings of inspection trolleys.
- Steel liner assembly drawings indicating the shell numbers, position of manholes and other important features and clearly identifying the shop welds and field welds. Drawings showing edge preparation details (weld groove design) and any other

relevant details for the various types of joints involved.

- Drawings showing edge preparation details (weld groove design) and any other relevant details for the various types of joints involved.
- Statement showing weights of the fabricated components.
- Drawings indicating arrangement for hydrostatic shop testing of steel liner components.
- Drawings indicating identification markings intended to be made for radiographic inspection of welds.
- Drawings showing details of embedment of rail track and other arrangement intended for handling and erection.
- Any other drawings or calculations that may be required for the clarification of the work.
- The contractor shall certify that drawings furnished by him have been checked before submission and he shall be responsible for the correct fitting of the parts.
- Method/ procedures for handling and transportation of various assemblies, specials and equipment to be used therefore.
- Arrangement/ procedure for handling/ erection of steel liner assemblies and specials etc. into the Shaft along with details of equipment to be deployed, procedure for alignment and welding in field.
- Detailed procedure for sand blasting and applying necessary primer etc. in shop and coats of paint to be applied in shop/ field along with necessary tests there for.

At least 28 (twenty-eight) days prior to commencing radiographic examination, the Contractor shall submit details of all radiographic equipment, processes and procedures for the approval of the WBSEDCL. The type and make of the radiographic films intended to be used shall be also got approved from the WBSEDCL.
The WBSEDCL reserves the right to require any additional information deemed necessary to be included in the submitted documents.

6.3. STANDARDS

The designs, fabrication, installation, painting and testing of steel liner shells, shall conform to the following Indian standards or where not covered by these Standards, to the equivalent International Standards:

Steel Plates and Other Materials

Sl No.	***Material***	***Standard***
A	Steel plates for Penstock steel liner	ASTM A 537 Class-I

B	M.S. Bolts, studs, nuts and washers	IS:1364 Grade S-Semi precision or Equivalent.
D	Gaskets or jointing materials	BS: 1737 or relevant IS Specifications.
E	Welding electrodes	AWS-E-11018-M, FIIA 4 EG-G or Equivalent IS/International Standards for ASTM A 537 Class-I (Respective IS Code/ Other international standards to be followed)
F	Paints	
	Zinc Rich Primer	AWWA C210-78 or equivalent IS/International Standards
	Cold applied	
	Coal tar epoxy paint	

The Contractor, while examining the plates, shall ensure that all requirements of the material specifications have been fulfilled by the manufacturer of the steel plates. In the certification, the Contractor shall also state that the necessary certified results of chemical, mineralogical and mechanical tests (e.g. yield-strength, tensile strength, minimum elongation, notch, toughness test etc.) and heat treatment etc. have been furnished by the manufacturer and all required inspections have been carried out by the Contractor. The contractor should submit to the owner the certified results of themanufacturer.

Welding electrodes	IS:2825-1969 ASME
Inspection & Testing	IS:2825-1969 ASME Code AWWA-C-203- 78 SNT-TC-IA

In case of the conflict between the above standards and the specifications given herein, the specifications shall take precedence.

6.4. FABRICATION

6.4.1. GENERAL

Fabrication of steel liner shall be strictly in accordance with the fabrication drawings.
The size of the plate will be determined by multiplying internal diameter plus thickness by TT (pi). The plate length as far as possible will be close to the required size. However, if more than one plate is required for the Shell, the minimum number of plates will be used.
The concentration of the welded joints shall be such that no two main seams come together under an acute angle or cross each other. Where it is not possible to comply with this

requirement, the intersection of these welds shall be radiographic, 100 mm each side of such intersection. The longitudinal joints shall be staggered, wherever possible by introduction of circumferential joints by at least five times the thickness of the thicker plate.
Longitudinal seams of steel liner sections with manholes and piezometers connections etc. as incorporated in the drawings shall not intercept such openings. The designs size and location of these openings shall be selected as required in IS: 2825 (1969) or as indicated in the drawings.
Manholes shall be provided with suitable handles, flanges and covers, properly machined and shall be complete with bolts, nuts, washers, gaskets, etc.

6.4.2. CUTTING OF PLATES AND PREPARATION OF EDGES

Cutting shall be done preferably by machining. In case flame cutting is resorted to as 'per' the recommendations of steel manufacturer/ supplier, which has the approval of the E-I-C, a depth of 2 mm to 4 mm or as recommended by the steel manufacturer shall be removed by grinding. Further heat input in case of flame cutting shall need to be controlled as per the recommendations of the steel manufacturer so as not to affect basic properties and strength of quenched and tempered steel.

Plate edges shall be made in conformity with the specification drawings to suit 'V' or 'U' welds as applicable to various thicknesses for all longitudinal and circumferential welds in shop. Edge preparation for all circumferential joints in field shall be to suit single 'U' or 'V' joint with backing strip.

- While marking of plates shall be as per approved fabrication drawings, Standard/ accepted procedure for marking edges of steel plates conforming to the above specifications can be prepared by planning, flame burning, chipping, grinding or arc grounding. Edge preparation details shall be covered in fabrication drawings.

  Edge preparation of steel conforming to the above shall preferably be done by planning. In the event of flame cutting followed by chipping and necessary grinding, oxy-acetylene torches may be employed such that basic properties of steel arc not affected. In the gas cut edge preparation, 2 mm to 4 mm of metal shall be removed from gas cut surface by machining or grinding.

6.4.3. BENDING OF PLATES

Plates for shell section shall be formed to required shape by cold bending process only such that it does not impair the quality of steel. All plates shall be initially pinch type cold formed/bent on plate bending machine which shall ensure a circular shell from the calculated circumferential length of shell of the required internal diameter. Curvature of bent shells shall be checked with the help of necessary templates. Correction of curvature neither by blows nor by hot forming shall be permitted.

6.4.4. PLATES OF UNEQUAL THICKNESS

Where two plates at a welded joint differ in thickness, the thicker plate shall be trimmed to a smooth taper as per IS: 2825 or as indicated on the drawings.

6.4.5. STIFFENER RINGS AND BACKING STRIPS

Stiffener Rings

Stiffener rings, wherever required, shall be fabricated from minimum number of circumferential sections butt welded together and properly fitted, and welded to the plates/ ferrules such that the plates of rings shall be normal to the axis of plates/ ferrules.
The butt welds in a stiffener ring shall be so positioned as to have proper staggering with reference to main longitudinal butt welds in the pipe shells. The holes/ openings shall be drilled in the stiffener rings as per drawings and the same shall have smooth finish.

Backing Strips

The contractor shall prepare backing strips intended to be used for field circumferential joints out of 10 mm thick steel plates of the same grade as of steel liner. The width of the backing strips and method of its attachment to the shells pipe shall be indicated in the approved drawing. The contractor shall carry out all necessary cutting, machining, welding etc. for preparing and attaching the backing strips.

6.5. MANHOLES, NOZZLES ETC.

All manholes, nozzles, flanges and other accessories (including covers, O-rings, bolts, nuts, washers and plugs etc.) as may be required, shall be installed on the steel liner sections as shown on the drawings.

6.6. EXPANSION JOINTS :

Necessary expansion joints to be provided as per approved design drawings and relevant IS code. The design drawing of expansion joints to be approved by WBSEDCL. The contractor will arrange necessary testing as per relent IS code as per applicability without any extra cost.

6.7. BENDS, BIFURCATION PIECE AND REDUCERS

- Bends shall be made of short segments of pipe as per the approved drawings.
- Segments of each bend shall be made with equal deflection angles, except for the end ones, which shall be of half the deflection of the other segments.
- Such segments shall be formed from cut places, with necessary marking.
- For change in diameter of steel liner, reducer pipe shall be provided.
- The Contractor shall furnish his proposal for preparing, testing and transporting and erection of bends and reducer cones clearly indicating the extent of work intended to be done at the factory and at the site workshop as well as during erection.
- The bends shall be so fabricated as to have a staggering of about 60 degrees between the longitudinal welds in the consecutive bend courses when installed.
- The reducer cones shall have to be fabricated as per the design as may be finalized in consultation with the suppliers of turbine generating sets and approved from WBSEDCL.

6.8. BULK HEADS

Bulk head shall be required for testing of specials. The bulk heads shall be fabricated as per the design and drawings approved by the WBSEDCL to meet the requirement of test pieces. The design & drawing of bulk heads to be submitted by the contractor. CWC Penstock manual and relevant IS code is to be followed.

6.9. ALIGNMENT AND TOLERANCES

Alignment for longitudinal and circumferential joints in shop and circular joints in field for shells made from steel can be permitted with only minimum number of fit up dogs/cleats which shall be properly welded and neatly removed after alignment to ensure no injury to the parent plates.
But while aligning shells welding of temporary cleats etc. for alignment of shell shall preferably be avoided as far as possible to ensure that no inadvertent damage occurs to parent plate of shell due to welding or removal of cleats later on. The fabricator, therefore, shall be required to develop a capsule/mandrill fitted with screwed, piper jacks/hydraulic jacks which shall provide perfect alignment of one circular shell with another shell as well as control the gap between them without necessitating welding of fit up cleat/ dog etc.
Tolerances to be maintained as per standard practice and IS code, Guidelines etc.

6.10. WELDING

6.10.1. GENERAL

After the edges of the plates have been prepared for welding, as aforesaid, these shall be subjected to a thorough visual examination for flaws, cracks, laminations, slag inclusion or other defects, if any, and no plate(s), where such defects are observed shall be used for fabrication without the concern of the Engineer-in-Charge. The edges of plates shall be free from foreign materials such as rust, scale, paint, oil, slag from the flame cutting or other contaminations of the fusion pieces. The surfaces to be welded shall be free from foreign materials such as grease, oil or marking paint. Irregularities, infusion faces which are likely to affect the quality of welding shall be removed by grinding before welding is commenced.
Welding shall be done by a process which shall exclude the atmosphere from the molten metal viz. by hand welding with shielded arc method and wherever practicable, automatic welding machines using shielded arc or submerged arc method shall be used. The type of joint to be welded shall be either a single or double 'V' or 'U' as shown on the approveddrawings. All welding shall be in accordance with the requirements of relevant standards.
Weld metal shall be deposited in successive layers and each layer shall be cleaned of all slags and other deposits before applying the next layer. There shall be at least one layer of metal deposited above the surface.

The reverse side shall be prepared by chipping, grinding or flat-gouging so as to secure sound metal from the reverse side. Where fillet welds are used, the sections to be joined shall be held firmly in position while being welded. To ensure the matching of section at joints, expanding struts or spiders may be used. Temporary welds, where used to hold the sections in positions, shall be removed so that they shall not become a part of the permanent welded joints. Whenever possible, joints shall be welded in the flat position. Welded joints shall be free from craters, depressions and other irregularities/ defects. After the welding is complete, all weld splatter shall be removed.

The welding of temporary attachments to the steel liner sections for the purpose of handling or aligning of sections with each other shall be limited only to those essentially required, subject to the approval of the Engineer-in-Charge. All such attachments shall be removed by careful chipping or flame cutting and damage if any, to the steel liner shall be repaired. The end tab plates shall be provided to each end of the longitudinal joint for welding. Such end tab plates shall be removed after the welding is completed.

6.10.2. WELDING PROCEDURES

(1) Mandatory practice of Welding High Tensile Steel:

a) Fitting:
High tensile steel shells bent to a true circle shall be fitted with sufficient fitting up equipment and finger bars to properly maintain alignment and gap during welding. Tack welds in the joints are allowed to maintain the alignment and gap during the welding operation.

b) Welding Process:
Longitudinal and circumferential joints shall be butt welded by either the shielded metal arc (manual) process or the submerged metal arc (automatic welding machine) process. Suitable electrodes shall be used to ensure proper and satisfactory welding of joints between steel liner shells and disc/spherical valve.

c) The Filler Metal:
For welding High tensile steel with EHT steel, the filler metal shall conform to that of High tensile steel.

d) Nature of welding Current:
The current used for welding shall be direct current reversed polarity.

e) Cleaning:
All slag and flux remaining on any welding shall be removed before laying down the next successive bead.

f) Defects:
Any defects that appear on the surface of any bead of welding shall be removed by chipping, grinding or arc gouging before depositing the next successive bead of welding.

g) Peening:
In general, light peening shall be done only as an aid to cleaning the weld beads. No peening shall be done on the first or the last passes. However, at points of high concentrated welding stress each bead after the first may be thoroughly peened to the extent that all the ripple marks shall be smoothened out. The cover or wash pass shall not be peened.

h) Treatment of Backside of Welding Groove:
The back side of manual welding grooves shall be back chipped or arc gouged to sound clean metal sufficiently wide to allow free manipulation of the welding electrodes. The backside of the automatic welding grooves need not be back gouged provided a satisfactory qualified procedure has demonstrated 100 percent penetration and fusion can be secured without back gouging.

i) Stress Relieving:

All weld joints and manhole openings, bifurcations etc. shall be stress relieved as a whole after welding according to section VIII ASME latest edition or IS:2825 (IS Code for unfired vessels), or other acceptable International Standards. However, material over 32 mm thick shall be pre-heated to a minimum temperature of 200°F during welding.

j) Field Welding:

The shop assembled pieces shall be aligned on the Site along the alignment. Sufficient finger bars shall be used on circumferential joint to maintain the alignment during the welding.

(2) Mandatory practice for Welding EHT Steel.

The welding of EHT steel required certain mandatory precautions, when welding with either the shielded metal arc (manual) or submerged arc welding (Automatic Processes).

(3) In the fabrication and installation of steel liner, welding shall be performed at two different locations viz. at the fabrication shop and at the installation site.

a) Fitting:

EHT steel bend to a true circle shall be fitted with sufficient fitting up equipment and finger bars to properly maintain alignment and gap during welding. Tack welding of joint shall not be allowed.

b) Welding Process:

Longitudinal joint shall be of butt welded type shielded metal arc and submerged arc welding processes. Suitable electrodes shall be used to ensure proper and satisfactory welding of joints.

c) Circumferential Welding:

When the longitudinal welding is completed, the circumferential joint shall be fitted up with sufficient fitting up equipment and finger bars to maintain alignment during welding.

d) Welding Materials:

Welding material shall be taken as per relevant Standard specifications and keeping in view any special recommendation for welding material specifications, storage instructions etc. of steel manufacturer.

e) Maintenance of Welding Electrodes:

One of the most important considerations in welding is to preclude hydrogen from the weld metal as much as possible because hydrogen is a major cause for cracks. The CO_2 and MIG process are particularly suited for this purpose.

However, most steel liners are fabricated and installed using the covered electrode and/or the submerged arc welding process. Coated electrodes and the fluxes shall be re-dried before use and their handling shall be closely controlled so that they shall not absorb moisture from atmosphere of 400°C for 3 hours in a baking oven and then removed and transferred immediately to storage ovens maintained at 120°C-175°C before use. Only the amount of electrode that shall be consumed in one-hour period shall be removed at any particular time. If the rods are exposed to atmosphere for more than one hour, they shall be

re-dried. The re-drying shall be done only once. The flux taken out of the container shall be used as promptly as possible and if it is left outside for more than 60 minutes, it must be re-dried. The re-drying can be done as often as necessary. The reclaimed flux used for welding EHT steel usually contains rust and other impurities.

All these impurities shall be carefully removed and the flux shall be re-dried at a temperature of 400°C-500°C. Re-drying must be done only once or twice. The flux that has picked up oil or dirt or which has become fused during previous welding shall be discarded.

f) Nature of Welding Current:

The current used for manual and automatic welding shall be direct current, straight polarity.

g) Pre-heating:

Pre-heat and inter pass temperature of 150°C-200°C (as may be recommended by plate manufacturer) shall be required and maintained. The preheat shall be uniform and continuous. A gas burner or electric strip heater shall be used for heating the tack welds, longitudinal and circumferential joints in the shop as well as in the field. It is necessary to heat each part over a width of 100 mm or more and to maintain satisfactory temperature control by using automatic thermostats. The manufacturer of steel plates may recommend certain procedure with regard to pre-heating/ post-heating of weld joints, which shall be strictly followed by the Contractor. This will be guided by relevant standard.

h) Welding Techniques Manual Welding:

When manually welded, the arc length shall be held as short as possible consistent with maintaining satisfactory operation. The straight forward stringer bead method shall be preferred for welding of EHT steel. Weaving shall be permissible if a steady arc length is maintained, but the width of the weave shall not exceed three times the diameter of the electrode used in the vertical position and twice the diameter of electrodes used in the down flat position (diameter of core wire). When welding is performed in the vertical position, allbeads shall progress from bottom to top, except that the first pass shall be uphill or downhill and the finish or wash beads shall be run from top to bottom using 3.2 mm or 4 mm diameter electrodes using either 2 or 3 stringer beads to cover the uphill passes. The tack welding of jigs shall also be welded under thesame conditions asfor regular welding (welding of the main body). The bead length shall be 80 mm minimum. In periods of high wind, the operator and joint shall be protected to prevent the protective gas blanket of the welding arc from being blown away. No surface to be welded unless the work is properly protected.

Submerged Arc Welding:

In submerged arc welding, penetration is relatively great and the chemical composition of the deposited metal varies widely with dilution of the base metal. For this reason, mechanical properties or crack sensitivity of the deposit metal are easily affected by the speed of cooling. Therefore, in the selection of wire, fluxes, sufficient consideration shall be given to the type of joint, built up method of preheat temperature, interposes temperature welding heat input etc.

i) Cleaning:

In making multiple welds, extreme care shall be taken to remove all slag from the weld beads before starting to deposit subsequent beads. Particular attention shall be given to the removal of thin lines of slag which tend to remain in the crevices along the bead edge.

j) Defects:

Any defects that appear on the surface of any bead of welding shall be removed by chipping, grinding or arc gouging before depositing the next successive bead of welding.

k) Peening:

In general, light peening shall be performed only as an aid to clean weld beads.

l) Treatment of Backside of Welding Groove:

The backside of manual welding groove shall be back chipped or arc gouged to sound clean metal sufficiently wide to allow free manipulation of the welding electrode. The back side of the automatic welding grooves need not be back gouged provided a satisfactory qualified procedure was demonstrated 100 percent penetration and fusion can be secured without back gouging.

m) Flame Gouging:

Flame gouging shall not be permitted as excessive local heating is possible with resulting detrimental effect to the base metal.

n) Field Welding:

The shop assembled pieces shall be aligned on the site along the alignment. Sufficient finger bars shall be used on circumferential joint to maintain the alignment during the welding. No tack weld in the joints shall be permitted. As there is no access to weld the joint from outside, only inside welding is contemplated with back up strip.

o) Pre-heating and Interpass Temperature:

Preheating and interpass temperature shall be 150°C-200°C.

(4) Method of Pre-heating:

Electric strip heaters with automatic thermostat controls shall be used for recording the temperatures. Alternatively, gas burner shall be used forpre-heating, if plate can be uniformly heated and to maintain satisfactory temperature control when thermostats are not available, frequent use of cryons is required.

(5) Qualification of Welders:

All welders assigned to manual welding shall have successfully passed the test conducted by the Contractor as prescribed for welder qualification in IS: 2825 or section IX of ASME Boiler and pressure Vessel Code. If in the opinion of the Engineer-in-Charge, the work of any welder becomes at any time or appears questionable; such welder shall be required to pass another qualification test.

(6) Welding Procedure Qualification:

When considered necessary by the Engineer-in-Charge, the welding procedure qualification test shall be undertaken. The aim of this qualification is to confirm the choice of the filler metal and of the welding process for a well-defined base material (steel plate) and to make sure that the final features of welded joint reach the guaranteed values to the satisfaction of the Engineer-in-Charge.

Qualification of the welding procedure shall take place before manufacture and erection begins. It shall relate to every quality of steel and every welding process provided for. It shall be done under the same conditions as those prevailing during manufacture, such as, for instance shape of chamfers, work preliminary to welding, number of runs, position preheating, annealing etc.

As a general rule, a test plate shall consist of two strips (about 400 mm x 800 to 1000 mm) welded edge to edge in the longitudinal direction. Its thickness shall be approximately equal to the greatest typical wall thickness for the steel or the welding process provided for. This test plate shall be treated in the same manner as the shop or erection welds. Inspection shall be carried out for the following or as directed by the Engineer-in-Charge.

a) 100% radiography or/ and ultrasonic test.
b) One tensile test, test specimen with parallel faces.
c) One bending test weld ground flush-direct bending.
d) One bending test weld ground flush-reverse bending.
e) One tensile test of filler metal (cylindrical test specimen).
f) One series of test specimens to determine the full impact value on the outer fibres and in the core.
g) One impact test in the transition zone (3 test pieces).
h) One test to determine the differences of hardness (base metal, outer fibres transition).
i) One chemical analysis of the deposited metal.
j) One microscopic examination.
k) One micrographic examination (plate, transition weld).

If required, for weld ability of base materials and filler metal, additional test like X-Groove Restraint Cracking Test, Diffusible Hydrogen Test etc. shall be conducted.

(7) Production welding tests:

a) During Production, the Contractor shall, when directed by the Engineer-in-Charge, carry out production tests on welded joints to: monitor the soundness and properties of welds on a routine basis confirm that newbatches of welding consumable produce welds with mechanical properties and soundness in accordance with the specifications. The production test weld may be run-on or run-off tabs or separate test plates which simulate as closely as practicable the production weld being checked. The size of the production test plates shall be described herein. All production test plates shall be welded in the presence of the Engineer-in-Charge or his authorized representative.

b) Production test weld plates shall be welded at approximately the following frequency

- 1 test weld per 100m of longitudinal welds in the steel liner shells welded by automatic processes.
- 1 test weld per 200m of circumferential welds in the steel liner shells welded by automatic processes.
- 1 test weld par 100 m butt welds welded by manual or semi-automatic processes.

In general, the frequency shall be greater than average at the commencement of each welding procedure and shall be arranged to test new supplies of consumables, electrodes, welding wire and flux, as their use is commenced in production welding.

c) The production test weld plates shall be radio graphically examined to ensure that the standard of welding is at least equal to that required in production. The test plate shall be rejected if rectification is required for more than 5 percent of the weld length. If the mechanical tests or radiographic examination of a production required for a procedure weld, then that welding procedure shall be disqualified and further welding with that procedure shall not be permitted. The procedure shall be resubmitted for re- approval when the cause of the failure of the production weld has been determined by the Contractor. The failure of the test weld, to comply shall not in itself be grounds for the rejection of production welds performed in accordance with the approved weld procedure prior to the failure of the test weld.

(8) Workmanship

a) All steel liner assemblies and specials shall be manufacture and finished in a thorough workman like manner equal to the best modern engineering practice in the manufacture and fabrication of steel liner components not withstanding omissions, if any, in the specifications and the approved drawings. Dimensions shown on the drawings shall be adhered to closely limiting to the maximum tolerance specified in the relevant Standards.

b) Where finished surfaces are specified or required for parts or materials, they shall be smooth as specified and almost free from tool marks.

c) Wherein average surface is required, smooth surface shall be produced but slight tool marks shall be allowed.

(9) Repair of Welds

a) Defects in weld such as cracks, pinholes, incomplete fusion, incomplete penetration or porosity detected as a result of radiographic/ultrasonic inspection shall be removed by chipping or any other mechanical means or by oxygen grooving, gouging, until sound metal is reached on all sides of the weld. The resulting cavity shall then be filled solidly withheld metal deposit strictly as per the welding procedure specified in Para 6.9 of IS: 2825. Portions of welds that have been repaired shall be radio graphed/ ultrasonic tested and repaired till the defects are removed to the satisfaction of the Engineer-in-Charge.

b) All areas of weld on which repairs have been carried out shall beexamined 100 percent by the method specified for the original weld.

(10) When a weld has been examined for 100 percent of its length and the examination shows many unacceptable defects distributed over its length or when the defects envisage need for rectification of more than 25 percent of the weld length, the entire weld length may be rejected and the weld cut out and re-welded and shall be re-examined by the method specified for the original weld. Recommendation from Steel Suppliers.

a) The contractor shall note that steel supplier may recommend certain procedures/ precautions in respect of fabrication and erection of steel liner which he shall follow. If special type of electrodes and special processes such as preheating and post heating etc. are recommended, such electrodes shall be procured and shall be used according to the instructions of the manufacturer of the steel plates.

b) For material specification of Penstock, Refer Clause no. 6.3 of Vol. 6 Part - II of Technical Specifications of HM Work.

c) The latest statistic of welding shall be followed even if the manufacturer of steel plates does not furnish any assistance contemplated.

6.10.3. NON-DESTRUCTIVE TESTS

The non-destructive tests shall be carried out as applicable IS code. "Recommended practice for non-destructive testing, personnel qualifications and certification" of the American society for non-destructive tests or other International Standards.

6.10.4. RADIOGRAPHIC AND ULTRASONIC INSPECTION

(1) Radiographic examination

a) Radiography shall be performed in accordance with ASME Boiler and pressure vessel code Section-V of Article-2. The image quality indicator shall be of wire type and sensitivity shall be at least 1.5 percent or better. All radiography shall be conducted using lead intensification screens. The acceptance standard for radiography shall be stated herein.

b) All radiography shall be performed and supervised by the experienced personnel qualified or trained for the job from the institutes such as Bhabha Atomic Research Institute or other reputed Institute of Non-destructive examination.

c) Prior to undertaking radiography, identifications markers shall be placed adjacent to the weld intended to be radio graphed. The images of such markers shall clearly appear in the radiographs. It shall be ensured that actual weld and its radiographs are mutually identifiable up to completion and acceptance of the work.

d) The Contractor shall provide at his own expense all materials including radiographic films and all consumables, equipment etc. necessary for radiographic examination and shall perform all radiographic examination in accordance with the requirements of these Specifications and of the Engineer- in-Charge within 8 working hours after taking the exposure. The films will then become the property of theProject.

e) Along with each radiograph, the Contractor shall furnish his interpretation report, in duplicate, in the proper Performa. The Engineer-in- Charge shall be free to make independent interpretation and ask for the repairing of welds if necessary.

f) Sections of weld the radiograph of which show any of the following types of imperfections shall be judged unacceptable.

Any type of crack or zone or incomplete fusion or penetration;

Porosity or rounded indications in excess of that specified by the acceptance standards given in Appendix–IV of ASME Boiler and pressure vessels code Section – VIII Div. 1.

g) Radiographs shall not be taken until 24 hours after welding have been completed.

(2) Ultrasonic examination

a) Ultrasonic examination shall be performed in accordance with the Article – 5 ASME Boiler and pressures vessels code Section V. The relevant reference from ASTM specification E-164-74 shall be also taken. The ultrasonic examination shall be performed and supervised by experienced and qualified personnel. If necessary special type of transducers and/ or higher

test frequency etc. shall be adopted to improve the reliability of the examination. The equipment with recording facility shall be used for ultrasonic examination. The records in such case shall be furnished and the same is the property of the Project.

b) All indications which produce a response greater than 20% of the reference level shall be investigated to the extent that the operator can determine the shape, identity and location of all such reflectors and evaluate them in terms of the acceptance standard given below:

-Discontinuities shall be unacceptable if the amplitude exceeds the reference level and discontinuities have length which exceeds 1/3t where 't' is the thickness of the weld being examined.
-Where discontinuities are interpreted to be crack, lack of fusion or incomplete penetration, they shall be unacceptable regardless of discontinuity or signal amplitude.

(3) The marker shall not be removed until all the welds have been accepted.

(4) Defective welds shall be arc air gouged or chipped out, re welded, re-X- rayed and the cycle repeated until satisfactory results are obtained.

(5) Radiographic/ ultrasonic tests shall be conducted as per table given below:

Type of Joints	Shop testing	Field testing
All longitudinal joints	100 percent X-ray	-----
Circumferential joints, of ASTM-516	100 percent X-ray	100 percent Ultra sonic testing (accessible field circumferential joints shall be 100 percent X-ray examined)

Butt joints in anti-percolation and stiffener rings shall be examined ultrasonically as directed by the Engineer-in-Charge. At least one joint shall be examined for each ring.

Ultrasonic Examination, Radiographic Examination or combination of both to be used as per direction of E.I.C/ Controlling Officer.

All longitudinal joints shall be radiographed for 100% length. The circumferential joints shall be spot radiographed for 10% length of each joint. All T-Junctions between longitudinal and circumferential joints shall be radiographed. CWC Penstock manual and relevant IS code is to be followed.

All field welds, if not spot radiographed or such joints which are difficult to be radiographed or inaccessible to radiographic examination may be subjected to Ultrasonic examination in lieu of radiographic examination.

6.10.5. INSPECTION

All fillet welds joining diaphragm plates, rings, lugs, etc. shall have smooth transitions into the sides of plates with toes of the welds made before depositing the major bead. The surfaces shall be ground to merge smoothly into the plate surfaces. The fillet joints are subjected to magnetic particle testing. The procedure of carrying out the above test shall be as per relevant standards. Where magnetic particle testing is not possible, dye penetration test shall be undertaken as per suitable codes with the approval of the Engineer-in-Charge. No separate payment shall be made in this respect.

6.10.6. ADDITIONAL EXAMINATION

The Engineer-in-Charge may direct the use of visual, dye-penetrant, magnetic flux and ultrasonic methods and equipment to supplement the radiographic examination. These addition methods will be used to ensure that welds do not contain unacceptable defects.
The Contractor shall make available continuously throughout the Contract, technician and all equipment necessary for ultrasonic examination of the welds.
The Engineer-in-Charge will direct which welds are to be examined.

6.11. HYDROSTATIC TESTING

Hydrostatic shop testing shall be conducted in shop. Details of the testing procedures and test beds to be used shall be furnished to the WBSEDCL for approval.

All the pipe shells, bends, wye pieces, taper pieces, expansion couplings etc. shall be in general subjected to test pressure equal to 150 percent of the design pressure or a test pressure producing stress not exceeding 90 percent of yield stress in shell, whichever is less.

In the case of extra high tensile steel liner, a test pressure which produces a hoop stress in pipe shall be equal to ½ the minimum UTS of the materials or ¾ yields point of the materials, whichever is less, shall be adopted.

During testing each piece shall be subjected to a test pressure as indicated on the drawings.

Suitable vent(s) shall be provided at a high point to vent possible air pocket while the pressure shaft shells, bends, bifurcations etc. are being filled.

The test pressure shall not be applied until the steel liner section and its contents reach the same temperature which shall preferably, be not less than 15°C.

Before applying pressure, the equipment shall be inspected to see that all joints are leak proof and to ensure that all low pressure filling lines and other appurtenances that shall not be subjected to the test pressure, are disconnected.

After being completely filled with water, the pressure in steel liner assembly to be tested shall be increased slowly and uniformly until the specified test pressure is reached.

The test pressure shall be applied three times successively increasing and decreasing at uniform rate but not lowering the pressure below 0.75 times the operating pressure and shall then be held at the specified test pressure for such a time as it considered sufficient for inspection of plates all welded joints and all region around openings but the period shall in no case be less than ten minutes.

All defective welded seams and all defects in steel plates discovered during the hydrostatic pressure test shall be marked and after draining out the water they shall be satisfactorily repaired. After repair and radiography, all sections shall again be subjected to a hydro-static pressure test. This procedure shall be repeated till satisfactory.

6.12. ERECTION TROLLEYS

Erection trolley would be required during construction period only. No separate payment shall be made in this respect.

6.13. PAINTING

6.13.1. GENERAL

All steel liner assemblies shall be cleaned and painted as here in after specified.

(1) Machines surfaces and screw threads to be in rolling or sliding contact shall be shop coated with a rust preventive compound before transportation.

(2) Inside surface shall coat in shop with zinc rich epoxy primer and cold applied coal tar epoxy paint.

(3) Completed coatings, in all liner shall be done in accordance with following schedule:

6.13.2. PAINTING SCHEDULE

Cleaning and painting of steel liner shall be done in accordance with following schedule:

Item	Paints or coating materials	Total no. of coats	Dry film thickness of paint coats
Inner & outer surface	a. Zinc rich epoxyprimer	2	Each coat minimum of 50 microns
	b. Cold applied, coaltar epoxy paint	3	Each coat of 150 microns.

6.13.3. PREPARATION OF SURFACES FOR PAINTING

Weld spatters; burrs or any other objectionable irregularities shall be carefully removed or repaired by suitable means before cleaning. Any grit or dust remaining from the cleaning operation shall be completely removed from the surfaces by brushing, air blowing, suction or other effective means before the surfaces are accepted for painting. In the event of rust formation or when the surfaces become otherwise contaminated in the interval between cleaning and painting, re cleaning shall be required to be done. Surface preparation shall be in accordance with the method given below:

All oil, grease and dirt shall be removed from the surface by the use of clean mineral spirits, xylol or white gasoline followed by wiping with clean wiping materials, except that for surfaces which required coal tar coating, the cleaning solvent shall be xylol. Following the solvent cleaning, the surface to be painted shall be cleaned to base metal to remove all rust mill scale and other tightly adhering objectionable foreign materials by sand blasting or grit blasting. A clean, dry, gypsum and salt free quartz sand having grain size 0.7 mm to 1.5 mm shall be used for sand blasting. Blast cleaning shall be accomplished with abrasives of such particle shape, hardness and gradation as to effectively clean the metal and have roughened surface suitable for tenacious adhesion of subsequent coating. The surfaces which have been thus, cleaned shall be primed as soon as practicable after such preparation has been completed, but in any event prior to deterioration of the prepared surface.

6.13.4. APPLICATION PROCEDURE AND QUALITY CONTROL OF PAINTS

Paint and coating materials to be applied shall be in a thoroughly mixed condition at the time of application and shall not be thinned except where hereinafter specifically provided. Paint shall not be applied when temperature of the steel surface to be painted is less than 3°C above the dew point or when the weather is frosty/ foggy or when the relative humidity is enough to cause condensation on the surfaces to be painted. Paint shall be applied by airless spraying or brushing. The Contractor shall make available on Site necessary equipment to measure the thickness of painting coats. Suitable means shall be provided to prevent segregation during the painting operation.
Each coat of paint shall cover completely and uniformly the surface being painted and shall be free from runs, sags and blisters. Except as, otherwise specifically provided, each coat shall beallowed to dry or harden sufficiently before a succeeding coat is applied. Coverage, application and preparation of various paint materials shall be as follows:

i. Rust Preventive Compound:

Rust Preventive Compound shall be applied by any convenient method which shall ensure coverage of the surface with a heavy uniform coating not less than 0.4 mm thick.

ii. Cold Applied Coal Tar Epoxy Paint:

The Contractor shall specifically furnish brand, name of paint and the details of the relevant Specifications or accepted Standard practice for application procedure. Primer drying time, before first coat of epoxy paint can be given, shall be indicated. Similarly, drying time between each successive coat of epoxy paint after application shall not deteriorate at any ambient temperature from 5°C-75°C.

iii. Zinc Rich Epoxy Primer:

The zinc rich primer shall be applied in two coats by brush or by spray over sand blasted surface. The zinc rich primer shall be stirred properly at regular intervals during applications. Thinning of zinc paste shall be permitted but only with suitable fluid, as directed by the Engineer-in-Charge. The addition of suspension fluid shall not exceed 15 percent. The second and subsequent coats or primer shall not be applied earlier than 24 hours after the application of previous coat.

6.13.5. CLEANING AND REPAIR OF SHOP PAINTED SURFACES

Metal work painted in shop or field shall be handled with care so as to preserve the coatings in best practicable condition. Before proceeding with the regular painting or coating operation, the Contractor shall clean and repair all areas of shop coat which are defective or damaged areas that are loose, weekly bonded, blistered, abraded, rusted or otherwise defective shall be removed to clean metal by scraping, chipping, power wire brushing or other effective means.Areas, thus prepared shall be cleaned of all dust, dirt and other contamination using clean rag and clean solvent. These surfaces shall then be repainted in accordance with the painting schedule and shall be required to pass acceptance tests as specified.

6.14. TRANSPORTATION

6.14.1. DISPATCH AND TRANSPORTATION

The transportation of the fabricated shells and accessories from the shop to the Site of erection shall be started only after obtaining approval of the WBSEDCL. The safe transport

and handling of the steel liner from workshop to the Site and from Site store, if any, to the work Site shall be done by the contractor. He shall deploy suitable transportation and handling equipment such as trailors, lorries, loading and unloading hoists, winches, rails, steel rope, jacks etc. The contractor shall include and provide for spiders, saddles or supports, etc. for securely fastening and protecting the steel liner assemblies in transit so as to avoid any damage to the liner or to the paint done in shop. The Contractor shall be fully responsible for all loss and damage caused by or occasioned by any defect in handling or transportation. Defect, if any, caused to the pipe courses or painting during transportation and handling shall be rectified by the contractor to the satisfaction of the Engineer-in-Charge.

6.14.2. MATCH MARKING AND WEIGHT

Each part of the steel penstock or other auxiliary assemblies shall be legibly marked to show their relative position in the finished marking. On each assembly to show top of field/ shop vertical, the direction of flow and the serial number shall be made with light steel stamps. The approximate weight of each piece or assembly to be dispatched shall be painted as well as indicated in tags attached to the assembly. A list of the weight of assemblies/ components dispatched by the contractor from shop to the Site of erection shall be submitted to the WBSEDCL simultaneously.

6.15. ERECTION

6.15.1. GENERAL

The steel penstocks shall be assembled and installed accurately to line and grade as shown on the drawings, and as directed by the Engineer-in- Charge. After successful erection of steel penstocks assembly/ assemblies as per approved drawings, concreting and grouting etc. of steel Penstocks wherever applicable shall be done before erection of next assembly is undertaken. Adequate supports provided for supporting the steel penstocks shall be done before erection of next assembly is undertaken.

6.15.2. ERECTION PROCEDURE

Alignment and Welding:

a) The steel penstocks shall be installed on Site in correct grade and alignment.
b) The responsibility for accurate alignment and erection of shells, wyes and bends etc. with reference to the control points rests with the contractor.
c) Any defects in the alignment of the steel penstocks shall be rectified by the contractor.
d) Sufficient finger bars shall be used on circumferential joints to maintain the alignment during the welding operation.
e) No tack welding shall be allowed in case of pressure vessel quality; high strength quenched and tempered steel.
f) Field welding inside the steel penstocks shall be done with back up strip on the outer surface at the joint.

However, for ASTM-A-517 Gr. 'F' or equivalent steels 'U' type welded joints shall be used after omitting the backing strips.

6.16. TOLERANCES

The tolerances in the alignment and shape of the erected steel liner shall be as mentioned below or specified in other acceptable International Standards:
Out of straightness of the shell shall be less than (2L/1000) for the total cylindrical length. The difference between the maximum and the minimum diameter at any cross section of the erected cylindrical length shall be within the specified limits. For single welded butt joint with backing strip and double welded butt joint with double 'V', the minimum separation of edges of shells to be welded shall not exceed 10 mm and 3 mm respectively unless otherwise directed by the Engineer-in-Charge. The maximum extra inner and outer thickness of welding shall be less than 3 mm.

6.17. CLEANING AND PAINTING IN THE FIELD

After erection, concrete back filling and grouting, all temporary fixtures/ appurtenances, debris etc. inside the steel liner shall be carefully removed. At least 200 mm wide strip of pipe along the field welded joints shall be thoroughly cleaned before painting. The same treatment shall be required at the spots where bars or other temporary steel pieces were installed to facilitate erection of steel liners. The entire interior surfaces of steel liner shall be cleaned and painted as per specifications. Suitable cover as per IS codes and other relevant codes shall be provided in case of cut and cover penstock.

6.18. DRAWING APPENDED TO THE BIDDING DOCUMENTS

The drawings enclosed with the Bidding Documents are made a part of the specifications for facilitating the prospective bidders in the preparation of their bids for the work covered under these specifications. These bidding drawings are preliminary and not exhaustive and for bidding purpose only subject to improvement/ revisions. Fabrication and erection of steel penstocks assemblies and accessories shall be done on the basis of fabrication/ erection drawings approved by the WBSEDCL. Such fabrication/ erection drawings shall be prepared by the Contractor and shall be based on the construction drawings with additions/ alterations and modifications, if any, from time to time during execution of the contract.

6.19. MATERIALS

The materials used in the fabrication and erection of the steel penstocks shall comply with specifications as laid down in these specifications. Where materials are not specifically covered by detailed material specifications, the contractor shall furnish the best available commercial grades of materials or articles to the satisfaction of the Engineer-in-Charge.

6.20. QUALITY CONTROL AND INSPECTION

6.20.1. GENERAL

The Contractor shall maintain a quality control system to the satisfaction of the Engineer-in-Charge which shall establish that all requirements of these specifications including material, fabrication and inspection are fulfilled during fabrication and installation of the steel liner inside the tunnel. This is very important in view of use of extra high tensile quenched and tempered steel. The site welding inside the tunnel may have humidity in addition to difficult working space and ventilation problems. Procedures have to be established to thoroughly

implement preheating and post heating, requirement of welds, to facilitate installation Work inside the tunnel. The steel liner assemblies need to have required accuracy to reduce defects like circularity, misalignment, angular distortion etc. Procedure of check sheets and inspection records shall be adopted to ensure the quality control as per these specifications. Check sheets and inspection records shall include the following, in addition to any other requirements considered necessary by the Engineer-in-Charge.

i) At Fabrication Shop:
Check sheet for gas cutting
Check sheet for bending
Inspection report on shop fabrication
Check sheet for fit up
Check sheet for material check
Check sheet for dimensions
Check sheet for hydrostatic testing
Radiographic testing records

ii) At Site shop:
Check sheet for each pipe assembly
Check sheet for level and alignment
Quality control sheet for welding Consumables
Ultrasonic/ radiographic testing records
Quality control sheet for repair welding
Inspection report on painting
Inspection report on final dimensions

The contractor shall also follow recommendations, if any, of steel plate manufacturers to ensure quality in welding and erection.

6.20.2. RECORD RETENTION

The contractor shall have a system for maintenance of radiographs/ ultrasonic testing register and manufacturer's data reports to the satisfaction of the Engineer-in-Charge.

6.20.3. TEMPERATURE AND HUMIDITY CONTROL

Necessary temperature and humidity control shall be maintained during the welding operation in shop as well as in field to the satisfaction of the Engineer-in-Charge. In field, extremely unfavourable conditions like low temperature and high humidity may prevail. Therefore, particular care shall be required to be taken during welding operations in field. For field welding, particularly of extra High Tensile steel penstocks assemblies special care shall be necessary to ensure that absolutely no water is entrapped, since low hydrogen electrodes are used for welding.

6.20.4. GUARANTEES AND INSPECTION OF PLATES

The manufacturers of pressure vessel steel plates, to be used for fabrication of steel penstocks shells and specials etc., shall be asked by the Contractor to furnish necessary mill test certificates etc., in respect of plates to be supplied by them conforming ASTM-A 537 Class-I and make necessary recommendations with regard to matching filler wire/ welding electrodes, preheat temperature, heat input control and post weld heat treatment etc.

The contractor shall examine completely each plate for its soundness in respect of any incipient defects e.g. indentations, roll marks, laminations and projections etc., and uses the same for fabrication only after completely satisfying himself that each plate is suitable for undertaking fabrication and necessary testing thereafter. Overall responsibility for quality control for proper fabrication, erection, testing, etc., shall ultimately lie with the contractor.

6.20.5. INSPECTION/ CHECKING OF CONTRACTOR'S WORK

The contractor shall provide to the Engineer-in-Charge in shop as well as in field, all labour, materials, instruments and apparatus etc., for checking and testing of work being done or completed by the Contractor. Any defects coming to the notice of the Engineer-in-Charge shall be rectified by the contractor till satisfactory results are achieved. Necessary record for such tests or checking of work at various stages of fabrication, erection, and painting and testing shall be maintained by the Contractor duly signed by Engineer-in-Charge. However, this checking of work at various stages, tests tolerance, level etc. by the Engineer-in-Charge, shall not be held to relieve the contractor of any part of Contractor's obligation to meet all the requirement of these specifications and drawings or responsibility for correct fitting and satisfactory operation of the equipment.

6.20.6. ACCEPTANCE TESTS AND WARRANTY

After completion of erection the steel penstocks shall be filled with water and its stability and tightness at accessible locations, if any, shall be thoroughly checked to the entire satisfaction of the WBSEDCL. The acceptance, however, shall not in any way absolve the contractor of his responsibility for any damage that may occur to the steel penstocks or its accessories within the maintenance period.

6.21. MEASUREMENTS OF STRAIGHT SHELLS, BENDS, WYES REDUCERS, STIFFENER RINGS, BACKING STRIPS, MANHOLES, REDUCERS MATCHING PIECES AND BULK HEAD

(1) The measurement for payment, for fabrication, delivery, hydrostatic testing, installation and erection of the steel penstocks components namely straight shells with stiffeners, matching pieces, bends wyes and reducers will be as per final contract value and in line with payment terms.

(2) Rates will include all costs associated with Design. Engineering, fabrication and delivery to the storage area including the cost of furnishing all plants, equipment, staging, hauling and storage facilities and services, welding of all joints in the pipe shell which makes up the components of the steel penstocks and corrosion protection of the external surfaces. These rates will also include the cost of all materials, construction facilities, professional and technical services, transport, equipment, labour, assistance in testing and other necessary charges.

(3) The radiographic examination shall be made as directed by the Engineer-in-Charge. No extra Payment for the radiographic examination, ultrasonic dye penetration or magnetic particle inspections of welds shall be made to the contractor.

Notes:
No extra payment shall be made for corrosion protection. The rate quoted by the bidder/contractor shall be inclusive of this work.

- Any steel penstocks assembly(s) or components thereof transported without obtaining the approval of the WBSEDCL shall be at the contractor's own risk and costs.
- Any steel shells or accessories thereof damaged during transportation, handling or erection in the tunnel shall be replaced or if approved by the Engineer-in- Charge, repaired and re-erected by the contractor without any extra cost to Project.
- No extra payment will be made for the following:

a) Temporary supports installed by contractor for his convenience and safety of his workmen/ equipment during fabrication, transportation and erection of steel liner assemblies and their components.

b) Any type of temporary steel support to be finally embedded in the concrete.

 Replacement of any defective materials or work.

Any fabrication or erection work commenced prior to the approval of the relevant shop/field drawings by the WBSEDCL shall be at the contractor's own risk and cost. The costs of all equipment, labour, materials etc. and all costs of carrying out mechanical testing for production welding tests as per these specifications shall be borne by the contractor and shall be deemed to have been included in the rates for the relevant items in the Bill of Quantities. The record of the production tests shall be furnished in a proper Performa.

7. GATES

7.1. TYPES OF GATE

The details of the gate are tabulated here under

Sl. no.	Type Of Gate	Location	Quantity
1.	Vertical screw hoist type(manually operated)	In ADIT-II tunnel at the junction of Lodhama main tunnel with ADIT-II tunnel	1(one)
2	Stop-log Gate	In both ADIT-II Tunnel and Lodhama Main tunnel	2 (two)

3	Silt Flushing Valve with Screw hoist (manual)	Forebay	2 (Two)
4.	Penstock Gate Vertical Sliding screw hoist type(Electrically & manually operated)	Forebay	1(one)
5	Tail race channel gate, Vertical Sliding screw hoist/monorail hoist type (electrically & manually operated)	Tail Race Channel	2(two)
6	Stop-log Gate with hoisting arrangement (To be used for both the TRC gate)	Tail Race Channel	1(one)

7.2. DESIGN DATA

The gates shall be designed for the following conditions:

Parameter	Unit	Design requirement
Type of hoisting		As mentioned in tender document
Capacity	Ton	Adequate capacity commensurate with the design
Type and material of seals	Music note 'J' type Rubber seals for sides & top and Wedge type rubber seals for bottom corresponding to IS: 11855 (Latest Edition).	
No. of sets of embedded Parts	1 Set for each gate	
Governing Indian Standard	IS: 5620 (Latest Edition).&IS: 11228 (Latest Edition)	
Permissible deflection	Permissible in structural components for gate and embedded parts shall be in accordance with Annex-B of IS: 5620(Latest Edition). The gate shall be designed for wet and accessible conditions and embedded parts shall be designed for wet and inaccessible conditions.	
Seismic Horizontal coefficient	Maximum of As per IS: 1893 or 0.15 g	
Seismic Vertical Coefficient	Maximum of As per IS: 1893 or 0.10 g	

Minimum thickness of skin Plate	12 mm
Permissible bearing and Shearing stresses in concrete	As per IS: 456 (latest edition).
1st stage concrete	M25
2nd stage concrete	M30

7.3. SPECIFICATIONS OF GATE LEAF AND EMBEDEMENTS

7.3.1. GATE LEAF

These gates are required to suit the design criteria specified in the succeeding paras. During operation, the gates shall be normally in closed position except Monsoon season when these will act as regulating gates.

These gates shall be fabricated from structural steel comprising of skin plate, stiffened by horizontal girders, vertical stiffeners and end vertical girder etc. confirming to IS 2062 The skin plate and sealing shall be on the upstream side. The skin plate shall be supported by horizontal girders at suitable intervals. The horizontal girders shall be supported by end vertical girders that in turn shall be supported by the side seals/bearing pads as shown in specification drawings shall support the horizontal girders. Bearing pads shall transfer the load to concrete through an embedded stainless steel seal seat.

The gate units will be assembled at site by using bolts. The bottom of the gates shall be shaped so as to have the best hydraulic performance. Four guide shoe assembly, two on each side of the gate shall be provided to check the side and lateral movement of the gate and to restrain the same within specified limits. They shall travel on gate guides embedded in piers/abutments.

All the gates shall have wedge type bottom seal and music note type side and top seals. The thickness of bottom seals shall not be less than 20 mm. The diameter of the seal bulb of music note type seals shall not be less than 45 mm and the thickness of stem shall not be less than 14 mm. Care should be taken that side and top seals bear evenly and with uniform pressure throughout the length on the side and top seal seats. The bottom seal should also bear uniformly on the bottom seal seat. All the seal should have perfect leak proof jointing. The bottom rubber seal shall be so provided as not to have any leakage past gate when the gate is in deflected position due to full water pressure. The seal bases shall be machined after welding to the gate leaf. The seal clamps shall be shaped suitably to prevent any cutting or damage to the seals. The gates shall be operated under unbalanced head except Gate maintenance is proposed at deck level. Each gate unit shall have complete lifting attachments and fittings as necessary for operation of the Gate. The design of the gate and its components shall conform to IS: 5620 (Latest Edition) in general and with the provisions specified in these specifications. The gates shall be stored in the respective gate grooves. A suitable removable wire mesh grating at the top of the gate shaft at deck level shall also be provided.

7.3.2. RUBBER SEALS

Specification of Rubber Seals should conform to IS 15466 (latest edition)

7.4. SPECIFICATIONS FOR SCREW HOIST

Design of Screw hoist shall confirm to IS: 11228.

7.4.1. WALKWAYS, LADDERS AND RAILINGS

All ladders, platforms and walkways necessary to provide access to the operating platform shall be provided. Clips shall be provided on all open edges of the walkways and platforms. Standard railings with two horizontal pipe rails shall completely enclose all walkways. The railings and ladder rungs on the outside of the crane shall be made of steel having fittings of the flush jointed type. Railings shall be provided along the open sides of the walkways, platform, stairs and other locations where required.

7.4.2. HOIST STRUCTURE/ TRESTLE

Suitable hoisting structure/ trestle for operation of screw hoist &Motor etc. shall be provided of structural steel confirming to IS 2062 and shall be designed as per IS 800 as per IS 875, IS 1893, operation & vibration loads of gate, if required.

7.4.3. MECHANICAL EQUIPMENT

The hoist shall be designed in accordance with the Latest Edition of suitable IS codes. All mechanical equipment shall be simple and substantial in design and capable of being easily erected, inspected, painted and taken apart. The hoist shall be operated Electrically/Manually as specified.

7.4.4. STEM & SCREW THREAD

The stem shall be made of Structural steel conforming to IS 2062, or Forged steel conforming to IS: 1570/ IS: 1875 or Corrosion Resisting steel conforming to IS: 1570 (Part 5). It shall be of galvanized or nickel chrome plated in the unthreaded portion, if so required. The stem shall be conforming to IS: 4694 or Acme thread shall be cut on the stem at the other end for transmission of power.

7.4.5. TORQUE REQUIRED TO OPERATE THE HOIST

The torque required to operate the hoist be estimated considering the friction and the inclined plane effect between the stem and the nut on the threads, and the friction at the trust pads. This may be estimated for loads corresponding to both the starting and running conditions, and for the designed capacity of hoist. The thread and the thrust collars should be kept well lubricated. In this regard relevant IS code, manuals, Hand books to be followed.

7.4.6. THRUST BEARINGS

Anti-friction Thrust bearings (single row ball SKF TYPE or equivalent). Thrust bearings are provided where the torque required to operate the hoist exceeds the capacity of two persons. The size is governed by the dimensions of the thrust collar and has more than the required capacity.

7.4.7. PEDESTAL & OPERATING HANDLE

The pedestal shall be fabricated or cast and shall be mounted on hoisting platform. The centre line of the operating handle shall be maintained at a height of 900mm to 1000mm from the floor. The pedestal shall be designed as a column against crippling due to total hoist load.

7.4.8. BONNET AND BONNET COVER

Design and provision should be kept as per IS 9349 (latest edition) as per applicability

7.5. MATERIALS

Gates shall be fabricated from structural steel confirming to IS: 2062, IS: 226 & IS: 800 latest edition and ribbed bars IS: 1786. All the materials shall be of tested quality, new, unused and free from defects and of the grade/ classification prescribed in approved Drawings. If a material is not specifically referred in approved specifications/ drawing, then contractor shall furnish materials of the highest standard commercial quality suitable for the intended used. All the materials shall be as per technical specifications and specification drawings appended with the tender documents and shall be of tested quality, new, unused and free from defects. The contractor shall furnish the test certificates for each lot of material, if so required by the Employer. Plates with laminations discovered during welding or during inspection shall be rejected. Materials not supplied according to the technical specifications and specification drawings shall be rejected, removed and replaced. Material for different components is recommended as under:

Sl. no.	Component Part	Materials Recommended	Code
1	Structural parts of gate leaf including skin plate, stiffeners, horizontal girders, diaphragms, track base, seal base, seal seat base, liners, seal clamp, lifting lugs, structural parts of lifting beam rail guide, sill beam, anchor bolts, load carrying anchors etc.	Structural steel until and unless specified else where	IS 2062
2	Wheels	Cast-steel/forged steel	IS:1030, IS: 2004
3	Self-aligning spherical roller bearings	Standard SKF make or equivalent approved	

		make	
4	Wheel pins	Chrome nickel steel or corrosion resisting steel	IS: 1570(V), Cr 2013
5	Bushing	Bronze	IS 305 ,IS 318
6	Track base, sill beam, side seal seat base	Structural steel	IS 2062
7	Seals	Rubber	IS: 11855 & IS: 15466
8	Track Plate	Corrosion resistant steel	IS: 1570(V), Cr 2013
9	Seal seats &Seat fasteners	Stainless steel	IS: 1570(V) 04 Cr 19 Ni 9
10	Ballast if any	Cast Iron	IS: 210
11	Base plate, anchors, bridge beams, columns, stiffeners, bracings, lugs, gantry-girders etc.	Structural steel	IS: 2062 Rolled sections IS: 808
12	Wire rope	Improved plough	IS: 2266

NOTE: IS2062 may also be considered for support structure only.

7.6. MANUFACTURE

All the work shall be performed and completed in a thorough workman like manner as per the best modern practice in the manufacture and fabrication of materials of the types covered by these specifications. The work shall in all cases be of high grade and carefully performed to the satisfaction of the authorized representative of the Employer. The contractor shall warrant all materials and workmanship furnished by him to be free from injurious and defective materials or defective workmanship and shall bear all cost of the repair in case of any error for which he is responsible. Workmanship shall conform to the

relevant standards laid down by the Bureau of Indian Standards. All sharp corners, which can damage the matching parts, shall be rounded and chamfered.

7.7. TOLERANCES AND CLEARANCES

Where tolerance or fits are not specified on the drawings, the contractor shall follow the best modern shop practice for apparatus of the type covered by these specifications and drawings, due considerations being given to the special nature of function of the parts and to the corresponding accuracy required to secure proper operation.

7.8. FABRICATION TOLERANCES

All components shall be fabricated in accordance with the relevant I.S. Codes

Installation tolerances shall not exceed 1.5 times the corresponding fabrication tolerances or the tolerances specified in relevant codes on gates whichever is more stringent. Fabrication of the gates shall be suitable for the achievement of such tolerances during installation.

7.9. SURFACE FINISH

Finished Surface

Where finished surfaces are not indicated or specified on the drawing, the type of finish shall be that type which is most suitable for the surface to which it applies and shall be consistent with the class of fit required.

A smooth finish will be required for all surfaces in sliding or rolling contact and for surfaces in permanent contact, where a tight joint is required.

Unfinished Surfaces

As far as practicable, all work shall be laid out to secure proper matching of adjoining unfinished surfaces. Where there is a large discrepancy between adjoining unfinished surfaces, they shall be chipped and ground smooth, or machined to secure proper alignment.

Unfinished surfaces shall be true to the lines and dimensions shown on the drawings and shall be chipped or ground free of all projections and rough spots. Depressions or holes not affecting the strength or usefulness of the parts shall be filled in a manner approved by the Employer or his authorized representative during the inspection.

Protection of Finished Surfaces

Finished surfaces shall be thoroughly cleaned of foreign matter. Finished surfaces shall be protected with wooden pads or other suitable means. Unassembled pins or bolts shall be oiled or greased and wrapped with moisture-resistant paper or protected by other approved means.

Castings

Casting should be done in accordance with IS1030 and relevant IS code and from the approved steel casting shop.

Forging

Forging, unless otherwise specified, shall be in accordance with IS: 2004 (Latest Edition).

8. RESPONSIBILITIES OF CONTRACTOR

The contractor shall be responsible for the under mentioned activities but his responsibility shall not be limited to the same:

a) The quality of materials and workmanship in all the item of work
b) Strict adherence to the dimensions of parts shown on approved drawings unless deviations are specifically authorized in writing by the engineer or owner.
c) Strength of all parts of gates hoists and associated equipment when operated under the worst conditions of load and under conditions of closure during periods of maximum flow discharge as applicable.
d) It is Contractor's responsibility to ensure that all components supplied in accordance with these specifications shall fit correctly to each other. In the event of any field modifications being required due to errors in shop fabrication, Contractor shall bear the full cost of such modifications. Any such changes shall be shown on the drawings and duly approved and accepted in writing by WBSEDCLs, before being executed by Contractor.
e) Satisfactory performance of the entire work under all operating conditions without signs of undue strain, and without Breakage, breakdown or deterioration of any of the parts due to faulty or incorrect or unsuitable material, workmanship or design.
f) Freedom from vibrations of any part or parts under the most severe operating conditions beyond permissible limits.
g) The water tightness of the gate seals, joints, valves, bearings, stuffing boxes, and controls.
h) The strength, accuracy and adequacy in all respects.

The contract documents and specifications do not specify in complete detail the various components of the equipment. The contractor shall supply and erect all equipment in a complete shape, which will meet the requirements regarding performance, durability and satisfactory operation. The principal parts of the equipment are mentioned in these specifications which outline the general features to be adopted in design. Any deviations from the specified requirements shall be done only with the approval of the owner.

VOL – 6 : PART-III- TECHNICAL SPECIFICATIONS FOR ELECTRO-MECHANICAL WORKS

ABBREVIATION AND ACRONYM LIST

A	Ampere
AC	Alternating Current
DC	Direct Current
Deg	Degree
Hz	Hertz
kVA	Kilo Volt Ampere
kV	Kilo Volt
kW	Kilo Watt
kA	Kilo Ampere
MVA	Mega Volt Ampere
MW	Mega Watt
Ph / ϕ	Phase
V	Volt

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1. GENERAL TECHNICAL CONDITIONS

1.1. SCOPE OF WORK

The scope in this contract covers the Design, Engineering, Manufacture / Procurement, Quality Assurance, Quality Control, Shop Assembly, Shop Testing, Delivery at Site, Site Storage and Preservation, Installation, Commissioning, Performance Testing, Acceptance Testing, Training of Employer's personnel, Handing Over to WBSEDCL and Guarantee upto the Defect Liability Period of the Electrical & Mechanical works covered under this contract for Lodhama-II Small Hydro-electric Project (2 x 5 MW).

This section provides the General Technical Conditions applicable to all sections hereafter specifying the detailed technical specifications for respective equipment / system forming E&M installation of the project.

The specifications of the equipment have been given in the upcoming sections.

Any equipment even though not specifically covered in the specifications in various sections, but required for successful completion and operation of the plant, shall be deemed to be covered under the scope of supply without any extra cost.

The contractor shall be responsible for complete engineering of the plants and prepare layout drawings, schematics, piping drawings, cable schedule, interconnection drawings, construction and installation drawings etc. and submit to Employer for approval.

The contractor shall prepare operation and maintenance manual for operation and maintenance of all equipment and plant as a whole.

The scope shall also cover the operation and maintenance of the plant by the contractor initially for 30 (Thirty) days after final commissioning. During this period, the O&M staff of the Employer shall be trained by the contractor for operation and maintenance of plant.

The contractor shall prepare completion report of the plant indicating technical details of equipment installed, as-built drawings, operation and maintenance manual of the plant expenditure details etc. and submit the same to the Employer before final commissioning of the plant.

1.2. SYSTEM PARAMETERS

The following system parameters will be adopted for the entire plant systems.

Sl. No.	System	Variation	Short Circuit (rms)	Purpose
1	33 kV solidly earthed system	+/- 10 % Volt, +3 % to –5 % Freq.,	25 kA for 3 sec.	Evacuation of power
2	11 kV, 3Φ, 50 Hz, earthed through DTR. and Neutral grounding transformer (NGT) limiting earth fault current about 10 Amps for 5 minutes.	+/- 10 % Volt, +3 % to –5 % Freq.	25 kA for 3 sec.	Generation

Sl. No.	System	Variation	Short Circuit (rms)	Purpose
3	415V, 3Φ, 4 wire, 50 Hz, solidly earthed system	+/- 10 % Volt, +5 % to –5 % Freq., 10% combined variation of voltage & frequency	40 kA for 1 sec.	For plant auxiliary including LV motors (rated up to & including 180 kW) , welding, space heating, Emergency Load and other 3Φ and 1Φ Load requirements
4	110 V DC, 2 wire, system	+10 % to -15 % Volt	As required	For control & protection, annunciation and emergency lighting system
5	Motor Starting Voltage requirement.	80 % for motors upto 4000 kW. 85 % for other motors.	-	The transient voltage on running motors while another motor is starting shall not be less than 75% of the motor's rated voltage.

1.3. MATERIALS

All materials forming the equipment shall be of first class commercial quality, as normally used for these types of equipment, considering strength, ductility, durability, best engineering practice and the normal or severe operating service to which the equipment may be subjected, free from any defects and imperfections, of recent manufacture and unused, and where indicated, of the classifications and grades designated therein. All material shall be the most suitable for the purpose and shall comply with the latest specifications of Bureau of Indian Standards, or the American Society for Testing and Materials (ASTM), or approved equivalent standards.

If the supplier desires for any reason to deviate from or use materials not covered by these specifications he shall state the exact nature of the deviation or exception and shall submit for the approval of Employer complete specifications of the materials he proposes to use along with the reason of such deviation. All materials, supplies, and articles not manufactured by the supplier shall be the products of recognized reputable manufacturers.

1.4. CORROSION RESISTING MATERIALS

Corrosion resisting materials shall be used in the main units, accessories and appurtenances as follows:

a. Bolts or nuts, when either are subject to frequent removal.
b. Bolts projecting from concrete, with nuts subject to removal.

All sliding surfaces which operate in water shall have non-ferrous liners, if not otherwise specified.

All sliding surfaces subject to continuous contact with grease over extended periods without movement shall be bronze or bronze faced.

Bronze hinge pins shall be provided for all man-doors.

Substitutions for specified materials shall be made only with the approval of Employer. The Supplier shall be responsible for the suitability of materials to be used in the construction of the equipment covered in various Sections of these specifications.

To the extent feasible and without adversely affecting the strength and durability, materials for field welds, wherever may be required, shall be used such that those do not require preheating or stress-relieving.

1.5. MATERIAL TESTS

All materials, parts and assemblies thereof which are to be used under this whole job, shall be tested, unless otherwise directed, according to the applicable IEC / BIS, ASTM standard or the best modern approved commercial method for the particular type and class of work. The supplier shall prepare specimens and perform tests and do analysis to demonstrate conformance of various materials with the applicable specifications herein. In-case the Supplier desires to use stock materials not manufactured specifically for the equipment covered by these specifications, he shall submit satisfactory evidence to the Employer that such material conforms to the requirements in which case tests on these materials may be waived. Certified mill test reports of plates will be acceptable. Routine test reports for minor components will be acceptable.

Four certified copies of test reports shall be furnished to Employer after the tests are made. The results of these tests shall be in such form as to provide means of determining compliance with the applicable standard(s) and requirement. When desired by the Employer, all tests or trials shall be made in the presence of the representative of the Employer.

The supplier shall keep the Employer informed in advance of the time of starting and of the progress of the work in its various stages so that arrangements can be made for inspection.

No materials shall be dispatched until all tests, analysis and inspection before dispatch have been completed and certified copies of tests reports have been accepted.

The cost of all tests and trials shall be borne by the Contractor.

Acceptance of materials, parts and assemblies, or the waiving of the inspection thereof by Employer, shall in no way relieve the contractor of the responsibility for furnishing equipment meeting the requirements of these specifications.

1.6. DESIGN STRESSES

1.6.1. GENERAL CRITERIA

Appropriate factors of safety shall be used throughout the design, and especially in the design of all parts subject to alternating stresses or to shock loading or to most severe operational loadings, including those due to electrical short circuit faults. The supplier shall furnish for record of Employer complete information, including computations, regarding the maximum unit stresses used in the design.

The life of plant and equipment supplied shall be not less than thirty five (35) years.

1.6.2. ALLOWABLE UNIT STRESSES UNDER RUNAWAY CONDITIONS

The maximum unit stress in any component or part, due to operation at the guaranteed maximum runaway speed, shall not exceed two-thirds (2/3) of the yield strength of the material.

1.6.3. ALLOWABLE UNIT STRESSES UNDER NORMAL OPERATING CONDITIONS

Under the most severe operating conditions, the unit stresses in the materials shall not exceed the values shown in Table below:

Sl. No.	Material	In Tension	In Compression
1	Cast iron	One-tenth (1/10) of the ultimate strength.	700 kg/cm^2
2	Steel Forgings, Cast Steel and Alloy Cast Steel	One-fifth (1/5) of the Ultimate Strength or one-third (1/3) of the Yield Strength, whichever is lower	One fifth (1/5) of the ultimate strength or one third (1/3) of the yield strength, whichever is lower.
3	Plate Steel for principal parts subject to hydraulic stresses	One-fourth (1/4) of the Ultimate Strength but limited to 1050 kg/cm^2	One-fourth (1/4) of the Ultimate Strength but limited to 1050 kg/cm^2

For other materials, not covered in the above Table, used in the construction of the generator, turbine, and associated equipment, the maximum stresses in tension or compression due to the most severe operating conditions shall neither exceed one-third (1/3) of the Yield Strength nor one-fifth (1/5) of the Ultimate Strength of the material. Maximum stresses in shear shall not exceed 210 kg/cm^2 in components made from cast iron and shall not exceed sixty percent (60 %) of the allowable stresses in tension for other materials.

Maximum stress in torsional shear in the main shaft of generating unit shall not exceed fifty percent (50 %) of the allowable stress in tension.

For temporary overloads exceeding generator continuous overload capacity at unity power factor, unit stresses not exceeding half (1/2) of the Yield Strength will be permitted.

1.7. TECHNICAL DOCUMENTS

1.7.1. GENERAL

The Contractor shall furnish their detailed list of Drawings / Guaranteed Technical Particulars (GTP) / Documents / Catalogues / copy of Published Papers and other required documents as depicted in various sections of this tender document as per applicable format.

The Employer reserves the right to request the Contractor for additional documents as may be required for proper understanding and definition of constructional, operational, co-ordination or other matters.

All documents to be supplied shall be submitted in accordance with the agreed schedule of program so that any comment and change requested by the Employer can be taken into account before starting of the manufacture in the workshop and / or erection or installation at the Site.

If the Contractor fails to submit such documents, he shall be responsible for any additional cost and/or delays that may cause due to execution of changes suggested by the Employer. The Contractor shall not be relieved of his responsibility on the guarantee and/or execution of the material / equipment / job after the approval of the drawing and computations by the Employer.

The preparation of drawings, computations or other technical documents shall not be sublet by the Contractor without the written consent of the Employer. In such a case the Contractor shall be fully responsible for such documents.

1.7.2. DRAWINGS / DOCUMENTS SHALL BE SUPPLIED UNDER THE FOLLOWING HEADS

1.7.2.1 Loading Drawings
1.7.2.2 Foundation Drawings
1.7.2.3 Arrangement Drawings
1.7.2.4 Outline Drawings
1.7.2.5 Design Drawings
1.7.2.6 Single Line Diagrams (SLDs)
1.7.2.7 Circuit Diagrams
1.7.2.8 Installation Drawings
1.7.2.9 Connection Diagrams
1.7.2.10 Block Diagrams
1.7.2.11 Logic Diagrams
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1.7.2.13 Terminal Diagrams
1.7.2.14 Material (Guaranteed Technical Particulars) and Plant Specifications
1.7.2.15 List of pipes, valves, fittings etc.
1.7.2.16 List of pumps, strainers & filters etc.
1.7.2.17 List of motors, heater, motor operated valves
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1.7.2.19 Cable Lists, Cable schedule
1.7.2.20 List of Measurements
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1.7.2.23 Workshop Test Schedules
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1.7.2.25 List of Tools and Appliances
1.7.2.26 Complete list of Spare Parts

1.7.2.27 List of Consumables

1.7.2.28 List of Plant Identification Numbers

1.7.2.29 Any other documents found necessary by the Employer etc.

The Cables Lists shall include following minimum details for each individual cable:

- Cable number, in accordance with Identification System, Cable termination at each end, connection point at each end with cubicle / plant identification and terminal numbers
- Cable type, No. of cores, Material, number and size of conductors
- Continuous current rating in air, ducts and ground
- Rated voltage
- Overall diameter
- Cable routing

1.7.3. CALCULATIONS

GENERAL:

In addition to the drawings, the Contractor shall submit to the Employer for checking, the appropriate calculations for determining the main sizes, dimensions and operational characteristics, clearly indicating the principles on which the calculations were based, if so desired by the Employer. The calculations shall include the formulas, standards, test results, basic assumptions, etc. Submission of the calculation without baseline information will not be accepted.

SHORT-CIRCUIT CALCULATIONS:

The short-circuit calculations shall be performed in accordance with relevant Indian Standards or IEC-60909.

Wherever applicable, the following maximum and minimum values for protection system layout shall be calculated for the individual plant components:

- Initial symmetrical short-circuit capacity
- Symmetrical breaking capacity
- Peak asymmetrical short-circuit current
- Sustained short-circuit current (rms)
- Moreover, the following values shall be calculated for solidly or partially earthed network systems:
  - Maximum single-pole short-circuit current
  - Maximum earth fault current as determined by the earth resistance
  - Maximum contact voltage as determined by the values as stated above.

VOLTAGE DROP CALCULATIONS:

The voltage drop calculations considering all applicable factors as per standard shall be determined for different networks / feeders of the complete electrical system.

EARTHING NETWORK CALCULATIONS:

The Earthing Network Calculation shall determine on basis of the short-circuit currents the relevant design criteria for the layout of the plant's Earthing Network and the potential gradient control system, such as:

- Earthing resistance (To be measured at site by the contractor)
- Earth conductors (material, size, depth of burial, spacing between parallel grid conductor etc.) and electrodes (material, size, number, depth of burial etc.)
- Mesh network and other means for potential gradient control for different locations (mesh widths and dimensioning)
- Maximum Touch Voltage, Step Voltages, Generator Earthing System Calculation.

The calculation shall prove the correct selection of the generator earthing equipment. The report must contain:

- Details of Soil Treatment, if any,
- Maximum allowable Touch Voltage & Step Voltage, Ground Potential rise
- Verification for Touch and Step Potential
- All test certificates of the relevant parts of the system.

1.8. WORKMANSHIP

Workmanship shall be of the highest grade and in accordance with the best modern practice for the manufacture of high-grade machinery, not withstanding any omissions from these specifications or associated drawings.

Machining of renewable parts shall be accurate and to specified dimensions according to the drawing so that replacements made may be readily installed. The supplier, at his own expense, shall keep and maintain sufficient templates, gauges, patterns, or other records used in the manufacture to enable him to make repair and furnish replacement parts for future needs.

Finished members shall be free from kinks or bends. Shearing shall be done accurately and all portion of the work neatly finished. Corners shall be square and true unless otherwise shown on the plans. Bends, except for minor details, shall be made by approved dies or bending tools. When heating is required for the satisfactory working of the metal, it shall be allowed to cool in such a manner that will not destroy the original properties. The ends of the pipe shall have all burrs removed.

All threads shall be clean and accurately cut before assembling. Screwed parts shall be lightly lubricated or coated with jointing compound as may be applicable before connection. All screwed connections shall be made adequately and no such force shall be used which may permanently deform the material. Threads shall be metric.

1.9. MACHINE WORK

Unless otherwise shown on the approved shop drawings, all allowances, tolerances, and gauges for metal fits shall conform to applicable IEC / Indian Standard / ANSI Standard for the class of it as shown or otherwise required. Sufficient machining allowance shall be left on placing pads to ensure true surface of solid material. Finished contact or bearing surfaces shall be true and exact to ensure full contact. All machined parts shall be accurately machined and like parts shall be interchangeable. Drilled holes for bolts shall be accurately located and drilled to templates when necessary or specified. The holes for fit-up bolts or dowels shall be carefully reamed and the bolt or dowel shall enter with a light driving fit. Bolt and screw threads shall conform to applicable Indian Standard or to IEC standard.

1.10. TEMPLATES AND GAUGES

All parts that may require renewal shall be made to template and gauge so that original and spare parts will be interchangeable. One set of all special gauges and templates necessary for site erection and runner maintenance shall also be supplied which shall become the property of the Employer.

1.11. ELECTRIC WELDING

GENERAL REQUIREMENTS:

All welding shall be performed by the electric-arc method, or by a process that excludes the atmosphere from the molten metal, and where practicable, using automatic machines. Complete procedures for both shop and field welds shall be submitted to the Employer for approval.

PREPARATION FOR WELDING:

Members to be joined by welding shall be cut accurately to size, with edges sheared, flame cut, or machined to suit the required type of welding and to allow thorough penetration and good fusion of the weld with the base metal. The cut surfaces shall be free of all visible defects such as laminations, surface defects caused by shearing or flame cutting operations, or any other injurious defects. The surfaces of plates to be welded shall be free from rust, grease, and other foreign matter along the edges prepared for welding.

STRESS-RELIEVING OF GENERATOR PARTS:

For principal stress carrying parts, localized stress-relieving will not be permitted for shop-welded parts. All weld-fabricated parts except minor parts, those where stress is not important, or those which are specifically exempted from stress-relieving shall be stress-relieved as a unit prior to final machining. Radiographic and ultrasonic examination of welds will be required, as specifically stated in these Specifications, and when, in the opinion of Employer, doubt exists as to the quality of certain welds.

Any such radiographic and ultrasonic inspection shall be at the expense of the contractor. The contractor shall furnish all special materials, equipment, or techniques required for pre-heating or post-heating of members to be joined by field welding.

STRESS-RELIEVING OF TURBINE PARTS:

Design and construction of welded joints shall conform to the applicable requirements of IS: 2825 or the ASME Boiler and Pressure Vessels Code, Section VIII. Machine parts, including all parts directly and permanently attached to the turbine shall be stress-relieved prior to final machining. The stress-relieving furnace shall be equipped with suitable recording thermometers to record the temperature of the furnace and parts during the heating and cooling of the parts.

All temperature records shall be submitted to the Employer for record purposes. Localized stress-relieving will not be permitted for shop welded parts. Field welding of stress-relieved parts will not be permitted.

QUALITY OF WELDS:

The design of welded joints and the welding procedures for both field welds and shop welds, in addition to conforming to the requirements set forth in the applicable code and/or in these specifications, shall meet the following requirements for workmanship and visual quality:

i. Butt welds shall be slightly convex, of uniform height, and shall have full penetration.
ii. Fillet welds shall be of specified size, with full throat & with legs of equal length.
iii. Repair chipping, or grinding of welds shall be done in such a manner as not to gouge, groove, or reduce the base metal thickness.

RADIOGRAPHIC INSPECTION:

All welds of components subjected to penstock hydrostatic pressure and welds of other important stress-carrying parts shall be 100% radio-graphically inspected where practical, and shall conform to quality requirements of IS: 2825 or ASME Code for radiograph quality welds. Where radiographic inspection is not practical, other non-destructive testing such as ultrasonic, dye-penetrant, magnetic particle, or a combination of tests, shall be used.

1.12. STEEL CASTINGS

GENERAL REQUIREMENTS:

Castings shall be free from injurious defects and shall be free of foundry irregularities – such as projections, ridges, hollows, honey-combing, pock marks, or chip marks, so that they will not require surface smoothing operations in the field prior to painting. The location of existing defects shall be determined, and they shall be completely removed to sound metal. The structure of the castings shall be homogenous and free from excessive non-metallic inclusions. An excessive segregation of impurities or alloys at critical points in a casting will be cause for its rejection. All castings involving welded fabrication shall be stress relieved.

REPAIR WELDING:

No repairs of major defects shall be made to castings without prior approval from the Employer. Defects shall be considered major when the depth of the cavity properly prepared for welding exceeds 20 percent of the wall thickness or 25 mm, whichever is smaller.

Welding of defects shall be performed only by qualified welders shall conform to the best modern welding practice.

If the removal of metal to uncover a crack or remove a defect reduces the stress-resisting cross-section of the casting to such an extent that the computed unit stress in the remaining metal is less than 30 percent in excess of the allowable stress, the casting may, at the option of Employer, be rejected.

Casting repairs by welding of major defects at any stage of manufacture after the first heat treatment (annealing) shall be stress-relieved. Minor defects or imperfection that will not ultimately impair the strength or service ability of the castings, may be repaired by welding in accordance with accepted commercial casting practice without securing approval. However, an accumulation of minor defects which in the opinion of Employer casts serious doubt as to the general quality of the casting may constitute cause for rejection.

DIMENSIONS:

Thickness and other dimensions of the castings shall conform substantially to the dimensions on the drawings and shall not be reduced by shop or foundry practices to the extent that the resulting stresses in the metal will exceed the stresses allowed under these specifications. Castings shall not be warped or otherwise distorted, nor shall their dimensions be oversize to such an extent as to interfere with proper fit with other parts.

SURFACE FINISH:

a) Surface finish shall be indicated on the detail drawings and shall conform to the requirements of ANSI B46.1 "Surface Roughness, Waviness and Lay", or other approved equal standard.

b) All parts shall be free from burrs, sharp edge and imperfections in cutting, machining and welding.

1.13. PIPING AND VALVES

Piping, tubing and pipeline materials and equipment forming part of the generating units shall be of appropriate materials, size and type to suit the function and performances and shall conform to the relevant & applicable standards. The piping shall be complete with requisite valves, automatic valves, drain plugs or cocks, test plugs or cocks, sight flow indicators, flow meters, flow relays, thermometers, pressure switches and other necessary instrumentation and devices to provide desired function and operation with ease and flexibility and easy maintenance. The valves which are to be kept normally in open or in closed position, shall be provided with suitable locking arrangement.

Suitable support system for the piping and valves comprising hangers, brackets, hooks, pedestal etc, shall be designed and provided. Pipelines may undergo expansion or contraction under service conditions and adequate provision / allowance shall be made for the same. The support system shall be rigid enough to prevent piping vibration when in operation. Spare branch connections provided for any future extension of piping shall be provided with isolating valves whose open ends shall be protected with blank flanges or caps as the case may be. Dismantling pieces with flanges, or unions shall be provided for ease of disconnection of piping for servicing.

Connections with equipment or apparatus may be of flexible pipe to enable easy connection and disconnection.

All items of pipelines shall be thoroughly cleaned individually before installation and after erection, in stages/on completion, by proper method. It shall be ensured that they are perfectly clean inside before putting into use.

The layout shall be such that valves, gauges / indicating instruments, are conveniently located to enable easy access for operation and reading. Piping may be embedded in concrete or laid in trenches where unavoidable. Otherwise piping shall be installed in ducts/openings on floors, walls or ceiling as necessary. The layout shall not interfere with movement of Operation and Maintenance (O&M) personnel.

Horizontal piping runs may, where necessary, be sloped to facilitate drainage. Lagging of piping runs where necessary, shall be provided.

For ready identification of different piping system functions, each piping system shall be painted near all operating points and also on each separate section, with two bands of colour, the wide band twice the width of the narrow one. An arrow showing the direction of flow shall also be marked, generally, the narrow band shall be in the direction of flow. The colour coding shall be done as per relevant IS/International Standards.

All operating valves on a piping shall be painted with the colour mentioned above. Each valve shall have, suitably fitted to it, a name plate indicating the function of the valve in an indelible manner.

The gaskets shall be of requisite material, thickness to suit service conditions.

1.14. PAINTING AND PROTECTIVE COATINGS

GENERAL REQUIREMENTS:

a) All surfaces shall be thoroughly cleaned of rust, mill scale, oil, grease and dirt prior to painting. Paint shall only be applied to dry, clean surfaces.

b) Except for surfaces that will be embedded in concrete and as otherwise specified, all un-machined or unturned internal or external surfaces shall be given at least one coating of red lead primer. Any exterior surfaces requiring welding during manufacture shall be ground smooth after welding before application of the primer coat. This shall in no way reduce the unit stresses. The primer coat shall be applied quickly after the welding and grinding is over.

c) The minimum total dry film thickness shall be 1.5 mils (38 microns) for prime finishes, 2 mils (50 microns) for lacquer finishes, and 3 mils (75 microns) for enamel finishes.

d) All needs of final touch up paint for application at site shall be included in the scope of supply.

MATERIAL STANDARDS:

The supplier shall submit the specifications and name of manufacturer of all paints which will be incorporated into the work for approval of the Employer. Paint shall dry with a surface such that touch up paint will adhere. Colour scheme will be approved by the Employer.

SPECIFIC REQUIREMENTS:

Painting requirements for particular equipment components shall be as follows:

All hydraulic passages of the turbine shall be sand ballasted and given two coats totaling 400 microns of coal tar epoxy resin paint of approved quality. Surfaces that will be embedded, in concrete shall be sandblasted and given not less than 3 coats of zinc rich primer totaling 120 microns in thickness.

Except as-otherwise-specified, the interior and the exterior steel surfaces of cabinets and cubicles shall be thoroughly cleaned after fabrication by sandblasting, pickling and rinsing, or other means, and then shall receive a rust inhibitive phosphatizing or equivalent treatment prior to painting in accordance with applicable IS or article 20-6.6.1 of ANSI standard C 37.20. Exterior surfaces shall then be primed, filled where necessary, and given not less than two coats of quick air drying lacquer or synthetic enamel. Cubicles and terminal boxes for electrical devices shall be finish-painted with semi-gloss finish in accordance with applicable IS or ANSI Standard.

Interior surfaces shall receive atleast one coat of corrosion resisting paint in accordance with the supplier's standard practice. Inside of cubicle shall be painted by suitable quality paint as approved by the Employer.

ELECTRO-HYDRAULIC ACTUATOR CABINET AND OIL SUMP TANK:

Except for the interior of the sump tank, all internal and external surfaces, un-machined surfaces of the actuator apparatus and piping located within the actuator cabinet shall be given at least one coat of suitable primer and at least two coats of oil proof enamel. The external surfaces of all piping located outside the cabinet shall be given at least one coat of red lead primer.

Interior surfaces of bearing tanks and governor oil pressure and sump tank shall be given at least one coat of compatible primer and at least two coats of white oil proof epoxy paint.

1.15. PUMPS AND ELECTRICAL EQUIPMENT: GENERAL REQUIREMENTS

1.15.1. PUMPS

All pumps forming part of the generating units and the pressure-pumping set shall be high performance, requisite type and rating and of reputed make, and shall be directly coupled to their driving motors. The pumps shall be of self priming type. If however any external means of priming are employed, these shall be stated in the offer and shall be subject to approval of the Employer. All pumps shall comply with relevant IS / IEC Codes.

The material of construction of pumps in general shall suit the service conditions and shall be resistant to abrasive effects of silt water. The pumps shall operate quietly without undue noise and vibration in their full operating range of head and flow.

1.15.2. ELECTRIC MOTORS

All motors shall comply with relevant IS or IEC for Motors and Generators. Supplier shall be fully responsible for determining that the motor duty cycle, rating, performance, tests and mechanical arrangements are all suitable for the plant and compliant with the relevant standards for the application at the hydel power station and in the extreme environmental and site conditions specified in this tender document.

The preferred type of AC motor is squirrel cage, totally enclosed, fan-cooled, except for single-phase motor with rating under 0.5 kW where Manufacturer's standard types may be accepted by the Employer. Motors above 1.0 kW shall be 3-phase type.

The stator insulation shall be of class-B type or higher. In each case, temperature rises shall be limited to Class-B under full continuous rated load condition.

All AC motors shall be capable of DOL starting and of continuous operation at rated output and shall also be capable of operation for a period of at least 5 minutes, with a voltage of 25% below nominal voltage at nominal frequency, without injurious overheating. The starting current at full voltage shall not exceed six (06) times the full load current. Each of the motors shall be tested at Manufacturer's works to confirm compliance with this requirement. No load loss of each motors shall be minimum.

Ball or roller bearings shall be used. Vertical shaft motors shall have approved thrust bearings. Lubrication fittings shall be provided for the bearings.

The terminal box shall be weather proof and firmly fixed to the motor frame. The terminal studs shall be adequately sized and shall be identified properly. All terminal boxes shall have approved cable adapter plates, sealing chambers or conduit entries. The arrangement of the terminal box shall be such as to facilitate installation of cables and allow interchanging of any two phase leads without disturbing the sealing compound, if this is used at cable terminations.

Where practicable, the motor end cover shall be removable from the driving end and shall have a removable plug for checking the speed by means of a tachometer.

All motors having a mass of 50 kg or more shall be fitted with lifting lugs.

1.15.3. STARTERS AND CONTACTORS

Motors starters and contactors shall be equipped with short circuit protection and local disconnection devices. Preferably, all starters shall be from one manufacturer. The control circuit voltage shall be obtained from a 415/240 V isolating transformer with

primary circuit breaker and secondary fuse. The secondary winding of this transformer shall be grounded.

The operating coils of the contactor shall be connected between the grounded side of the transformer and the control contacts.

Starters and contactors shall comply with applicable IS / IEC and shall be suitable for DOL starting, uninterrupted electrical duty, and capable of 30 operations per hour. They shall be installed in ventilated enclosures for indoor installation and weatherproof enclosures for outdoor installation. The enclosures shall be complete with locks, cable sealing boxes, conduit entries, cable gland plates, bus bars, internal wiring, terminal boards and other necessary items as required by the duty of the starter or contractors.

Starters and contactors shall be of minimum size compatible with motor size and capable of satisfactory operation, without damage, for a period of 5 minutes at a voltage 25 percent below nominal voltage, at nominal frequency.

Thermal overload and phase failure relays shall be supplied with starters for motors of 7.5 kW or higher rating. For motors of less than 7.5 kW rating, suitable rated 3-phase thermal overload relays shall be provided. Ammeters to monitor phase current shall be provided for motors above 7.5 kW.

Each starter shall have sufficient number of auxiliary contacts required for interlocking and indication purposes with at-least two spare convertible contacts.

1.15.4. MOULDED CASE CIRCUIT BREAKERS (MCCB)

All moulded case circuit breakers shall be 2-pole / 3-pole / TPN, as required, having thermal time delay and instantaneous trips with 'On-Trip-Off' operating mechanism. MCCBs used in combination with motor starters or contactors shall have the operating mechanisms interlocked with the starter or contactor cover so that the cover cannot be opened unless the CB is open. The breakers shall comply with relevant IS / IEC Codes.

1.15.5. CONTROL RELAYS

Relays used as auxiliary control devices in conjunction with motor starters and magnetic contractors shall be of the type designed for machine tool application featuring contact convertibility. All contacts shall have a minimum thermal current rating of 10A over a range of 6 to 600 V AC.

1.16. EARTHING

Earthing terminals for equipment under this specifications shall form part of equipment supplies. Earthing conductors from station earthing bus to the equipment shall be arranged by the Contractor.

1.17. QUALITY ASSURANCE PLAN (QAP)

QUALITY ASSURANCE PROGRAMME:

To ensure that the equipment under the scope of this contract whether manufactured or fabricated within the contractor's works or at sub-contractor's premises or at any other place of work are in accordance with the specifications and standards, the contractor shall adopt suitable Quality Assurance Plan (QAP) to control such activities at all points. Such programs shall be submitted by the contractor to the Employer for approval before

inspection. The applicable IS / IEC Code or equivalent standard adopted by the supplier or certification obtained by the supplier / manufacturer along with its validity period shall be stated in the submitted QAP. The QAP shall in general cover the following:

a) Qualification and experience data of manufacturer's key personnel.

b) Process of implementation of the proposed quality assurance program.

c) Detailed test report of materials, parts, components which shall include source inspection, incoming raw material inspection, testing, and verification of materials purchased for fabrication of the product to be used for this project.

d) All Type test reports.

e) All Non-destructive examination procedures including radiography interpretation reports, stress relieving time temperature charts, weld repair procedure used during fabrication, welding identification symbols etc., as and where applicable.

f) Results of all Factory tests, performed during various stages of manufacturing / fabrication as per applicable codes and standards including Radiographic test, Ultrasonic test, Magnetic particle test, Dye penetration test, Pressure test, High voltage dielectric test, Performance and Efficiency tests etc., as and where applicable.

g) Identification and traceability of parts / components / product / instruments / control devices.

h) Process control, fabrication and assembly control during manufacturing and site erection.

i) Calibration Certificates of measurement and testing devices.

j) Documentation to indicate conformance or non-conformance of product to specifications.

k) System for maintenance of quality records.

l) Process for handling, storage, packaging, transportation and delivery at site.

Sampling Plan, Acceptance & Rejection Criteria and tests to be conducted for acceptance of the item / equipment / system following relevant IS / IEC or equivalent Standards shall be clearly mentioned in the QAP submitted by the contractor for according approval from the Employer prior to inspection of the item.

Inspection reports for acceptance of the item / equipment / system duly signed by representatives of the Employer and manufacturers / contractors at the agreed inspection hold points shall contain:

- Acceptance of all the documents submitted by the Manufacturer / Supplier as per pre-approved Quality Assurance Plan (QAP).
- All acceptance test results
- Any important repair work carried out or to be carried out to make the job acceptable.
- Dispatch recommendation / Repair instruction, if any, from the Employer

IMPLEMENTATION OF QUALITY ASSURANCE PLANS:

Quality Assurance Plan shall be offered for all equipment covered under the contract. In so far practical, provisions and guidelines of IS: 14001 / ISO - 9001 will be applicable and implemented for quality control and assurance.

Detailed shop inspection / testing schedule along with the Quality Assurance Plan (QAP) shall be submitted by the Contractor to the Employer for approval prior to inspection.

Notice for inspection shall be submitted to Employer forty five (45) days prior to proposed date for inspection. All arrangements including transportation costs, fooding & lodging of Employer representatives during inspection of any item covered under this scope of contract shall be borne by the contractor. The contractor shall arrange the required bookings and send the same to the Employer's representatives nominated by the Controlling officer for that particular inspection at least 2 days prior to their actual date of journey. Where flight route is available, the contractor shall arrange the flight bookings. In case the flight route is not available the contractor may arrange the railway tickets not less than AC 3 tier class / AC road journey after discussing the same with the controlling officer of the work.

Tests as per approved Quality Assurance Plan (QAP) shall be conducted by manufacturer's personnel in presence of the representatives of the Employer and Contractor. All Inspection / Test Reports shall be subjected to Employer's review.

1.18. CLIMATIC CONDITIONS

1.	Temperature			
	(i)	Maximum Temperature	:	40°C
	(ii)	Minimum Temperature	:	- 3 °C
2.	Humidity			
	(i)	Maximum Humidity	:	97.40 %
	(ii)	Minimum Humidity	:	22.60 %
3.	EL of Turbine Center Line		:	1066 m

1.19. EARTHQUAKE

All equipment supplied shall be suitably designed to have safe operation during the earthquake of intensity applicable at the site as per relevant Indian Standards.

2. HYDRO TURBINE AND ASSOCIATED AUXILIARY & ANCILLARY EQUIPMENT

2.1. SCOPE OF WORK

This section of the specifications covers the design & engineering, material selection, manufacturing, assembly, testing at manufacturer's works, supply, delivery, storage at site, erection, testing, trial run and commissioning of two (02) nos. horizontal shaft Pelton Turbine and associated auxiliary & ancillary equipment viz. governing equipment, main inlet valves (MIV), equipment for auxiliary systems such as compressed air, cooling water, drainage & dewatering system, lubrication system, oil, water & air piping with valves & fittings, instrumentation, control and safety devices as detailed in this specifications for 10 MW Lodhama-II Small Hydro-electric Power Project at power house elevation of 1066.55 m above MSL.

The scope of supply shall also include all accessories, devices and equipment which are essential for assembly, erection, testing, commissioning and trouble free operation and maintenance of the complete unit for five (05) years even if these are not individually or specifically stated or enumerated in this specification.

2.2. STANDARDS

Turbines shall meet provisions made in the following standards (latest edition) unless otherwise mentioned.

Sl. No.	Standards	Description
1	IEC 60041	Field acceptance tests to determine the hydraulic performance of hydraulic turbines, storage pumps and pump-turbines
2	IEC 60193	International code for model acceptance of hydraulic turbines
3	IEC 60308	International Code for Testing of Speed Governing Systems for Hydraulic Turbines
4	IEC 60545	Guide for Commissioning, Operation, and Maintenance of Hydraulic Turbines
5	IEC 60609	Cavitations Pitting Evaluation in Hydraulic Turbines, Storage Pumps and Pump- Turbines
6	IS 14773	Mechanical vibrations on rotating shafts and evaluation criteria
7	IEC 60994	Guide for field measurement of vibrations and pulsations in hydraulic machines (turbines, storage pumps, and pump turbines)

Equipment complying with other Internationally Accepted Standards will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the contractor shall clearly indicate the standards adopted and furnish a copy in English of the standards adopted along with all official amendments in force as on date of opening of bid and shall clearly bring out the comparisons of the salient features.

2.3. TYPE AND RATING

Each turbine shall be of HORIZONTAL SHAFT PELTON TYPE suitable for direct coupling to Generator of 5000 kW nominal rating at rated net head of 354.24 m and per Unit rated discharge of 1.70 cumec. The turbine shall also be capable of delivering a maximum continuous overload of 10% at rated head of 354.24 m. The direction of rotation shall be clockwise as viewed from the Non-driving end.

Basic data for the design of the turbines is given below:

Sl. No.	Description	Details
1	Type	Pelton
2	Axis orientation	Horizontal
3	Rated speed	600 rpm / 750 rpm
4	No. of jets	2 jets / 3 jets
5	Full Supply Level (FSL) in forebay	1434.24 m
6	Minimum drawdown level (MDDL) in forebay	1432.24 m
7	Machine center line elevation	El. 1066.00 m
8	Maximum Gross Head	368.24 m
9	Head Loss	12 m
10	Maximum Net Head	356.24 m (corresponding to FSL when both unit are in operation at full load)
11	Design head	354.24 m (corresponding to MDDL when both units are in operation)
12	Rated discharge	Per Unit rated discharge is 1.70 cumec
13	Rated output	5264 kW + 10% COL
14	Minimum weighted average efficiency	90 %
15	Penstock diameter before bifurcation	1100 mm
16	Penstock diameter after bifurcation	780 mm
17	Total length of penstock	786 m
18	Length of penstock upto bifurcation	771 m
19	Main Inlet Valve (MIV)	Spherical type
20	Diameter of MIV	750 mm

The weights and sizes of the packages shall be within the permissible transport limitations.

The maximum output, discharge & efficiency at minimum and maximum net heads shall be indicated in the offer. The turbine shall operate safely and satisfactorily (within permissible temperature rise limit of the bearings) within the maximum and minimum

operating heads. The operating characteristics of turbine as a function of head vs. output shall be furnished during detailed engineering stage.

2.4. WATER ANALYSIS REPORT

The design of the equipment especially the type of material for withstanding erosion, corrosion, width of gaps along water passages in turbine etc., cavitations and other guarantees shall be based on the analysis of water which must be carried out by the Contractor prior to commencement of detailed design of the hydraulic equipment.

2.5. MODEL TRANSPOSITION TEST

The contractor shall submit Model Transposition Test report of the Turbine from a tested model for according approval from the owner after the award of contract. The manufacturer shall establish how the model and prototype being offered have required similarity. The efficiency and other guarantees and requirements of the turbine shall have to be established. The report shall justify all possible operating conditions of the plant. The manufacturing of any part of the prototype turbine shall be started only after according owner's approval.

The model tests shall be carried out following IEC 60193 and 60193-A in all respects. Hydraulic performance tests shall be made at various Nozzle openings to determine machine characteristics including regimes of safe operation, zones of cavitations and vibration, etc. *Prototype Efficiencies shall be derived from Model Test Report as per procedure detailed in IEC 60193 for PELTON TURBINES.*

If the test result does not justify or fulfill the guaranteed figures of output and weighted average efficiency by the contractor, the contractor shall take necessary steps towards rectification or achievement of the guaranteed values at his own cost and risk. In such case, the contractor shall not be entitled any extension of time for completion.

2.6. OUTPUT AND COMBINED WEIGHTAGE AVERAGE EFFICIENCY GUARANTEES

Within the limits of temperature rise specified in **Cl. No. 3.10,** the **rated output of the turbo-generator set at rated head** shall be stated and guaranteed**.** The Efficiencies of the turbine and generating unit shall be as high as possible. The **Combined Weighted Average Efficiency of the turbo-generator set at rated head calculated as per Cl. No. 2.7 below** shall also be guaranteed.

In addition, the maximum outputs of the turbine at full nozzle opening at rated net head shall be stated by the contractor during detailed engineering stage. The turbine shall also be suitable, safe and give efficient performance at part loads up to 40% of rated output.

The Contractor shall furnish Hill chart, details of test methods, provisions to be made for field testing, calibration of instruments for test purpose and all other relevant details within 01 (one) month after the Award of the Contract.

2.7. COMBINED WEIGHTED AVERAGE EFFICIENCY

The Guaranteed Weighted Average Efficiency (combined) of the Turbo-generator set shall not be less than 86 % and shall be determined from the field efficiency test and/or factory test values of efficiency at the rated head in accordance with the following formula for the purpose of penalty and rejection limit. The field tests and/or factory tests on the turbo-

generator set shall be carried out by the contractor as specified in IEC or equivalent International Code.

$$\boldsymbol{\eta_{TG_{avg}} = K_1\eta_{TG_{110}} + K_2\eta_{TG_{100}} + K_3\eta_{TG_{80}} + K_4\eta_{TG_{60}}}$$

Where,

$\eta_{TG_{avg}} =$ Weighted average Efficiency of the Turbine

$\eta_{TG_{110}} =$ Efficiency of the Turbo − generator set at 110% rated output at rated Head of 354.24 m

$\eta_{TG_{100}} =$ Efficiency of the Turbo − generator set at 100% rated output at rated Head of 354.24 m

$\eta_{TG_{80}} =$ Efficiency of the Turbo − generator set at 80% rated output at rated Head of 354.24 m

$\eta_{TG_{60}} =$ Efficiency of the Turbo − generator set at 60% rated output at rated Head of 354.24 m

$K_1 = 0.1$

$K_2 = 0.6$

$K_3 = 0.2$

$K_4 = 0.1$

The outputs at various nozzle openings from full opening to lowest operational opening range shall be stated by the contractor during detailed engineering stage.

The manufacturer has to provide a calibration protocol giving the rated efficiency for a given percentage of rated electrical output. In addition to the above, the contractor shall also guarantee the maximum synchronization time with grid for evacuation under stable grid conditions.

2.8. PENALTIES

For any shortfall in weighted average efficiency (as determined on the basis described in **Cl. No. 2.7** and output in the tested values at rated head from the guaranteed values, **Penalty shall be applied at the rate of half percent (0.50 %) of total unit price of turbine and generator (including price of governing system) for each one tenth percent (0.10 %) by which tested value is less than the corresponding guaranteed values**. For shortfall in weighted average efficiency & output figures by less than one-tenth percent (0.10 %), pro-rata rates will apply for computing penalty.

No tolerance shall be permissible over the test figures of rated output.

In case of efficiency, tolerance will be allowed as per relevant IEC test code.

The penalties on account of shortfall of output and Weighted Average Efficiency shall be computed separately for each unit and the total amount of penalty shall be the sum of these two. The ceiling of penalty on account of shortfall in the weighted average efficiency will be ten percent (10%) of total unit price of the turbine and generator (including price of Governing System) and the same percentage will be applicable for output also.

2.9. REJECTION LIMIT

The Employer reserves the right to reject the Turbo-generator units if the test values of either weighted average efficiency as determined by **Cl. No. 2.7** or the rated output are less than the corresponding Guaranteed Values as furnished by the contractor by **Two Percent**

(2.00 %) or more for each case of output and combined Weighted Average Efficiency after allowing tolerance (in computation of efficiency only).

2.10. RECTIFICATION TO MEET GUARANTEES

In case the specified tests as per relevant IS / IEC are proved to be unsuccessful in meeting the guaranteed values, the Contractor will be given one (01) month or mutually agreed reasonable time to improve or modify the design of the turbo-generator set or to carry out rectifications etc. at his own cost and risk, so that the guarantees are met. Extension of time with imposition of liquidated damage (LD) shall be applicable for such case.

If such attempt(s) to improve / modify the design or rectify the defect / failure or any remedial action taken by the Contractor fails, the employer will have the right to impose penalty or reject the equipment, without prejudice to other terms and conditions of the contract. The Contractor shall be bound to Employer's decision in this respect.

2.11. SPEED RISE & SPEED REGULATION

The moment of inertia of the unit, normal nozzle closing time and deflector operating time shall be so adjusted such that the maximum momentary speed rise of the unit shall be kept much below the runaway speed.

However the momentary speed rise shall not exceed 30% of the rated speed under any conditions of operation.

The turbine manufacturer shall co-ordinate with the generator manufacturer for achieving the required flywheel effect to maintain the speed and pressure rise within specified limits.

2.12. RUNAWAY SPEED

The maximum runaway speed of the unit under any combination of head and load conditions shall be stated by the contractor during detailed engineering stage. The runaway speed may be as low as possible. Turbine and Generator parts shall be designed and coordinated to withstand maximum runaway speed without any damage to its parts for fifteen (15) minutes duration continuously for every occurrence with cooling water supply 'ON' and for five (05) minutes duration continuously for every occurrence with cooling water supply 'OFF'. The bearings should operate satisfactorily under this condition without excessive specified increase in vibration and temperature. The calculated first critical speed shall be at least 15% higher than the maximum runaway speed.

2.13. OPERATIONAL GUARANTEE

The contractor shall guarantee the runner and other hydraulic passages against excessive pitting caused by cavitation for entire defect liability period (24 months) or 8000 hours of operation whichever is earlier.

Within the cavitation guarantee period of runner if any repair or corrective action are taken then after repair balance of cavitation guarantee period shall be as per the IEC 60609 provisions.

2.14. NOISE LEVEL

Maximum noise level at any of the operating conditions shall not exceed 90 dB (A) at any place one (01) meter radially away from any operating part of the unit detected in the

machine hall. Any vibration caused by the machine should not be in resonance with any part of the equipment delivered.

2.15. STRESSES AND FACTOR OF SAFETY AND GUARANTEE

All parts of turbine shall be designed and constructed to safely withstand the maximum stresses during normal running condition, speed rise, runaway speed, short circuit conditions, out of phase synchronizing and braking or grid fail application.

For maximum stresses in tension or compression due to the most severe conditions occurring during operation of the generator, turbine, and associated equipment, bidders are requested to go through **Cl. No. 1.6.3** of this Technical Specification. For Non-rotating parts, the factor of safety based on yield point stress shall not be less than three (03) at normal conditions. For over-load and short circuit conditions, a factor of safety of two (02) on yield point stress shall be permitted.

2.16. MATERIALS SPECIFICATIONS FOR MAJOR COMPONENTS OF TURBINE

Sl. No.	Components	Material	Equivalent Standard
1	Runner	13/4 Cr-Ni Stainless Steel	ASTM A 743, GR / CA 6 NM
2	Distributor branch pipe assembly	Cast steel or welded plate steel	
3	Shaft	Forged steel	ASTM A 668

2.17. GENERAL ARRANGEMENT AND CONSTRUCTION

2.17.1. GENERAL

The arrangement and construction of turbines shall be such that any removable part can be conveniently and easily dismantled & removed. The design shall also permits horizontal movement of runner shaft sufficient for adjustment of bearings. The arrangement of all the equipment should be easily accessible for operation and clearances, walkways etc. should be provided.

2.17.2. TURBINE CONSTRUCTION FEATURES

Each horizontal axis Pelton turbine shll consist of the following principal parts:

- Turbine Runner
- Turbine Housing
- Distributor
- Nozzles And Needles
- Jet Deflectors
- Instruments, Gauges And Transducers

2.17.3. RUNNER

- The Runner shall be single piece 13/4 Chromium–Nickel (13 % Cr, 4 % Ni) forged type in accordance to DIN EN 10250. The Runner shall be keyed to the shaft.

- The finished machine shall be statically as well as dynamically balanced in the works before dispatch.
- The runner shall have adequate number of double hemispherical shaped buckets sufficiently polished, ground smooth and shall be free from roughness, cracks, spots etc. Runner buckets shall be properly doweled and tested at works and dowels are to be suitably numbered. The runner shall be homologous with the corresponding model test runner. The discharge to each unit will be regulated by spears moving axially in the nozzle or by means of deflectors. The nozzle assembly shall consist of inlet bid, spear rod & its guide, seals etc.
- The needle shall be operated by oil operated Servomotor of adequate capacity to move the needle during opening & closing within the required time. The hydraulic cylinders shall be of proven design and made of suitable material.
- The jet deflector for each needle shall be operated by a common Servomotor through levers and links to stop the jet during load rejection to minimize the pressure rise in the Penstock.
- The runner should be designed to withstand various loads imposed on it during continuous overload operation and at any speed condition including maximum runaway speed and maximum head without exceeding the stress limits.
- The runner and the buckets shall have modern design and shall meet the relevant IS/IEC Standards. The hydraulic surfaces of the buckets shall be carefully machined and smoothly finished to the required shape with programmable Numerical Control (NC) boring mills.
- The dividing splitters of the buckets shall be finished in such a way that they will rotate in a single plane that passes through the centers of the nozzle openings.
- The arrangement of fitting the runner on turbine / generator shaft, ensuring proper centering and alignment of the runner shall be stated in the detailed engineering report to be submitted by the Contractor. The special tools required for mounting and demounting shall be a part of turbine assembly supply.
- The finished-machined runner has to be carefully statically balanced. A protocol has to be submitted by the Contractor prior to installation of the runner.

2.17.4. MOUNTING

The runner shall be directly mounted on the extended shaft of generator.

2.17.5. TURBINE HOUSING AND PIT LINER

The turbine housing shall be made of a welded plate steel construction embedded in concrete. The turbine housing shall be designed for a suitable number of sections required and practicable for shipping and transportation to site. The housing shell joints shall be prepared for field welding.

The turbine housing shall be properly designed to facilitate the efficient discharge of the water from the turbine runner.

The steel / concrete structure shall support the dead weight of the runner, deflector, bearings, nozzle system, pipe connection and other necessary components when the shaft is disconnected from the generator shaft. The design may consider lifting of the nozzles and runner by using lifting eyes provided in the housing ceiling and hackles.

With the bearing removed, the opening in the housing cover shall be large enough to pass the runner shaft-coupling flange.

The bottom of the housing shall include a curb ring with support brackets and jackscrews for leveling the complete housing before embedment. All tie rods and turnbuckles for holding the housing in alignment shall be supplied.

Provisions shall be furnished to effectively seal the distributor and other openings in the housing to prevent the entrance of water into the concrete behind the housing under the most severe operating conditions. If necessary fit up adjustment shall be welded on during installation at site.

ADDITIONAL PROVISIONS:

The turbine housing shall have the following provisions:

- Attachment points to be provided in the cover portion of the housing for lifting eyes as necessary to replace nozzles, deflectors and other materials and components.
- Provisions must be made for air venting. The necessary air vent ports shall be located above the runner. The air vent piping shall be manifold together for connection to an atmospheric vent pipe and shall be properly sized. The air vent piping system shall be self-draining type to the turbine discharge pit.
- A runner access door shall be provided in the turbine housing for easy operation and maintenance. The inside surface of the door shall be flush with the inside surface of the turbine housing when the door is closed. The door shall be hinged with non-corrodible pins for opening and bolted to the frame. Suitable rubber seals shall be provided at the bolted joints to prevent water leakage under the most severe operating conditions.
- A drain system to collect the oil / water leakage from the nozzles shall be provided. The nozzles must be drained to a common steel tank, located outside of the distributor at an accessible location to ensure drainage by gravity.

  The steel piping shall be arranged below the nozzles at a location protected from direct splashing of the operating water. The embedded piping from the housing wall to the steel tank shall be made of stainless steel.

  The tank arrangement shall allow checking of each drain line individually for leakage. The tank shall be provided with the necessary float controls and alarms.

2.17.6. DISTRIBUTOR

A distributor with required support structure shall be provided extending from the downstream side of the spherical valve (MIV) dismantling joint to the nozzles. The distributor shall be furnace stress relieved after welding and before machining. The welds must be 100% tested by the ultrasonic method. The distributor shall be fabricated from welded carbon steel plates, in the minimum number of sections dictated by shipping clearance requirements. Bolting flanges shall be provided on the branches to connect the nozzles to the distributor.

The sleeve type coupling connecting the distributor and its extension to the downstream side of the spherical valve must be designed as a dismantling joint. The coupling shall be designed for minimum hydraulic disturbance and head loss. A connection pipe with one expansion joint as part of the spherical valve supply shall be provided between the distributor and the spherical valve on the dismantling pipe. The connection pipe and the expansion joints shall be made of high strength fine grain steel. All bolts, nuts, gaskets and all other accessories necessary for the complete flange connection must be provided. The design shall confirm that no visible leaks up to the test pressure occur.

The design, construction and nondestructive testing shall conform to the applicable requirements of the ASME Boiler and Pressure Vessel Code, Section VII, Division 2. The distributor, the connection pipe and the expansion joints shall be designed to withstand maximum pressure that may occur during various operational condition including the pressure rise during load changes.

The lower side of the distributor has to be provided with pads for leveling during the erection. Jacks and tie down rods and turn buckles for aligning, leveling and holding the distributor in place while embedding in concrete shall be supplied. Sufficient lifting provisions shall be provided by the contractor for handling.

The complete distributor assembly must be pressure tested under a pressure of 1.5 times the maximum design pressure at site after completion of erection and before embedding in concrete. The hydraulic pressure pumping equipment, pressure test heads for each nozzle flange and the distributor inlet, gauges, valves, seals, jacks, piping and all other required tools shall be supplied by the manufacturer to perform the test.

2.17.7. POWER NOZZLES AND NEEDLES

GENERAL:

The power nozzles for supplying water to the turbine runner shall be designed for an internal water pressure to produce the required uniform jet. The power nozzles shall be equipped with servomotors, which directly operate the needles under governor control.

OPERATIONAL REQUIREMENTS:

The Electronic Governor Control System shall permit selection of only one nozzle or any combination of nozzles under normal operation. The selection shall consider the optimum use of the available water.

The operation of the needles and jet deflectors must be such as to accommodate the changes in water supply with a minimum fluctuation in the output of the unit and with a pressure rise in the penstock that does not exceed the designed withstand value.

The needles shall be balanced by springs or anyother mechanism viz. double acting servo motor to obtain closing tendency from fully open to fully closed needle position in the event of failure of governor oil pressure under the applicable operating head. Design shall be made to make closing of Nozzle/Deflector within optimum time.

NOZZLE DESIGN:

- Nozzle Body – The nozzle body shall be flanged for bolting to the distributor casing. An adjustment flange located between the two parts shall be provided to facilitate vertical and horizontal alignment of the nozzle assembly during erection. All flanges shall be provided with O-ring seals.
- Nozzle Tip – The nozzle tip shall be provided with a removable stainless steel seat ring at the point of final water discharge. Provision of removal and replacement of the seat ring shall be made without disturbing the runner. Coating of needles nozzles and seat rings shall be the responsibility of the Contractor. The water passage surface of the needle tip and seat ring shall be smooth machine finished.
- The nozzle shall conform to needle servomotor located within the water passage.

NEEDLE DESIGN:

A needle provided with a replaceable needle tip shall control the jet. The needle back shall be bolted to the needle stem to form the needle assembly.

The needle stem shall be made of stainless steel where it passes through the stem seal. The upstream end of the needle shaft is to be connected to the servomotor piston. The needle assembly and the needle shaft shall be guided by two bearings contained in the servomotor casing.

NEEDLE CONTROL:

The needle control valve and the servomotor design must permit adjusting of the opening and closing times. The rate of closing shall be adjustable to suit the required operating conditions of the turbine unit.

Electronic means shall be provided to indicate the needle position. The electric devices with the cables shall be located at a convenient place. The control mechanism shall have the provision of local control and remote control through SCADA.

SERVOMOTOR DESIGN:

- General: The servomotor shall be oil pressure actuated, double acting type and shall have sufficient capacity to move the needle through full opening & closing within the required time at maximum head with minimum governor oil pressure.
- Servomotor Support: The servomotor shall be located within the nozzle body and held by two or more hydraulically shaped ribs. The supporting ribs shall be designed to withstand the maximum reactions in both directions of the nozzle axis. The ribs shall either be welded to the servomotor casing and the nozzle body or all parts shall be a one-piece stainless steel casing.
- Servomotor Cylinder and Piston: The servomotor cylinder shall be made of cast steel and be accurately bored and provided with suitable sealing around the needle stem. Connections shall be provided on the cylinder for the pressure - oil control lines. The piston shall be fitted with piston rings shaped to give close contact and uniform pressure to the cylinder walls. Necessary seals along the needle stem shall be provided.
- Oil Piping: The oil lines shall be securely mounted within the runner pit. The piping shall extend upward into the turbine pit and connect to the control valve. The necessary pipe supports shall be provided. Pipe cases or sleeves, which connect to the runner pit roof, shall be sealed to prevent water leakage.
- Needle position indicators shall be provided for each needle servomotor.

A hydraulic locking system shall be provided in the governor for each needle servomotor by which the servomotor piston can be held securely at either end of the travel against the maximum oil pressure.

2.17.8. JET DEFLECTORS

GENERAL:

To prevent excessive pressure rise in the penstock and to ensure quick response and proper speed regulation of the unit during various operational requirement including load rejection, each power nozzle shall be provided with a jet deflector. Deflectors shall be actuated by a deflector servomotor and must be coordinated with the nozzle needles so that each jet can be quickly deflected first, followed by slow closure of the needles until the jets pass only sufficient water to maintain speed. Under normal speed control, the needle shall do the governing to reduce water wastage. On larger part load rejections, the deflector shall deflect the complete jet until the needle approaches the position required for normal turbine speed.

DESIGN AND FABRICATION:

The deflector shall be designed and fabricated using grade 13/4 Cr–Ni Stainless Steel. The deflector shall be capable of deflecting the jet completely within the required time to keep the speed rise within the specified limits during load rejection. The deflector shall be designed to withstand the maximum discharge from the nozzle without damage.

DESIGN OF THE LINKAGE:

The deflector shafts, levers and connection rods to the servomotor shall be provided with self-lubricated bearings.

The deflector shall be fastened to its shaft by key or other appropriate means. The mechanism shall be designed so that if a deflector becomes blocked or stalled, the servomotor and links shall stall against the maximum allowable design pressure.

POSITION INDICATOR:

A position indicator shall be provided to indicate at all times the setting of the deflector cutting edge with respect to the centerline of the nozzle.

DEFLECTOR SERVOMOTOR:

The deflector servomotor shall be of the oil / spring actuated type. The servomotor shall have the capacity to deflect the jets completely when the needles are fully open at maximum head and with minimum governor oil pressure. Upon loss of oil pressure the spring shall actuate the defector to deflect the jet.

The servomotor cylinder shall be of steel suitable for oil operation. The cylinders shall be designed for the maximum hydrostatic oil pressure.

Adjustable means of varying the time for full opening or closing stroke shall be provided. The rate shall be independently adjustable for both directions.

2.17.9. TURBINE FLOW METER

Each Turbine shall be provided with a Ultrasonic type Flow Meter having 0.5% accuracy for local and remote indication and recording. The flow meter shall be capable of measuring instantaneous flow in cumec (m^3/s) from 10 % to 125 % of design discharge with error not exceeding half percent (0.50 %). The instrument shall be calibrated during field acceptance tests.

2.17.10. THERMOMETERS, TEMPERATURE DETECTORS (DTT)

The Temperature Detectors shall be provided for turbine guide bearing and lubricating oil. DTTs shall be Vapour Pressure Type with alarm and trip contacts. RTDs shall be used in combination with temperature scanner.

2.17.11. OIL LEVEL GAUGES AND OIL LEVEL RELAYS

Oil Level Gauges shall be of the Float Gauge Type and shall be fitted with appropriate Protective Devices. They shall be so constructed that there is no oil leakage.

2.17.12. LUBRICATION SYSTEM

For Lubrication of the rubbing surfaces of turbine and main inlet valves, Greaseless lubrication system shall be provided.

2.18. INLET VALVES

The Main Inlet Valve of the Turbine shall be the SPHERICAL TYPE of dia. 750 mm for connecting to penstock of dia. 780 mm. The penstock shall be provided with a reducer piece at its downstream extremity. The valve shall be suitable for all transient operating conditions and maximum water hammer situation. The valve operating system shall be SCADA compatible.

The valves shall be operated by oil pressure and closed by counterweight, so that it is capable of being closed automatically under all emergencies. All associated equipment such as servomotors, oil pressure units, counter weights, etc. shall be provided. The inlet valve shall be provided with main operating seal and maintenance seal. The valve seals and seal seat rings shall be replaceable type and shall be made of stainless steel.

The valve shall be complete with inlet pipe, outlet pipe with dismantling joint, drain pipe and by-pass arrangement for equalization of pressure on either side of the valve prior to starting of the unit etc. A manually operated guard valve (needle valve) shall be provided for maintenance of the by-pass valve. An Air Relief Valve to admit air while draining the distributor and to vent the distributor while filling from by-pass line shall be provided. The Penstock drainage system shall be included in the scope of supply of spherical valve.

2.19. GOVERNING EQUIPMENT

TYPE AND DESCRIPTION:

The Governor shall be electro-hydraulic digital electronic type with combined Proportional, Integral and Derivative functions (PID type) conforming to IEC 308 suitable for fully automatic control. All the basic functions of the governor shall be specific software based. The governor will receive signal from Speed Signal Generator (SSG) directly fitted on the generator shaft and transmit an amplified signal to the servomotor through electro-hydraulic transducer. The governor shall be complete with oil pressure vessel, sump tank, oil pumps, piping and valves. The electrical / electronic equipment of the governor shall be arranged in cabinet and located in control room. The control equipment shall be suitable for 110 Volts DC. The governor shall be suitable for interfacing with SCADA system.

PERFORMANCE CHARACTERISTICS:

The Governor shall have stable and accurate operation characteristics with Proportioned Integral Derivative (PID) function. High sensitively and high response characteristics shall be provided. Control system shall be so designed that both remote control and local control of speed and load limiting can be carried out from control panel.

The nozzle operating time shall be adjustable from governor console and shall be such that the pressure rise in the penstock shall not exceed 20% on simultaneous load throw off of all the units.

The following minimum control & monitoring facilities shall be provided:

a) Speed adjustment control range 85% to 105% of rated speed.
b) Individually adjustable off-load, on-load stabilizing devices with automatic transfer between modes.
c) Adjustment of speed droop from zero to 10%
d) Adjustment Dead Band shall not exceed 0.02%
e) Dead time (time between sudden load change of 10% & higher and beginning of servomotor movement) shall not exceed 0.2 sec.

f) An overriding device to limit maximum needle opening in any position within the full stroke range.

g) Provision for automatic locking out, needle control mechanism and adjustable manual limit control for load shall be provided.

h) Governing shall be safe on failure of speed sensing elements, loss of oil pressure or defect in the actuating system so that under any of these conditions, the machine shall be automatically shutdown with alarm and indication.

i) Local / Remote control selector switch for selection of control either from the control panel in control room / local control from machine hall.

j) A transfer switch to enable smooth transfer from automatic to emergency manual control.

k) It shall be ensured that in case of failure of main speed sensing device, the governor shall be capable of taking speed signal from generator frequency via a PT.

The following minimum indicating and control items shall be mounted on the UCP.

a) Tachometer

b) Combined needle position and needle limit indicator

c) Speed load setting Raise/Lower switch

d) Speed Load Setting indicator

e) Automatic/emergency manual control transfer switch

f) Emergency shutdown switch

2.20. SPEED SIGNAL GENERATOR

A Speed Signal Generator shall be provided for electric speed signal source to governor, speed relays and speed meters. Separate speed sensors shall be furnished for governor control feedback and for speed relays & meters. The speed signal generator with the teeth ring shall be mounted on the non-driving end of the shaft (generator side).

2.21. PRESSURE OIL SYSTEM FOR GOVERNOR

PRESSURE OIL SYSTEM: Individual pressure oil system shall be provided for the turbo-generator units. The pressure oil system shall consist of a sump tank, oil pumping units (main & standby), oil pressure accumulator / tank, pipes, valves fittings etc. The pressure vessel shall have oil volume capable of performing three (03) full operations i.e. Close-Open-Close (C-O-C) with oil pumps being out of operation and pressure in the vessel at minimum level.

GOVERNOR OIL PIPING AND VALVES: All required governor oil piping and valves complete with flanges, bolting materials, gaskets, packing etc. shall be provided. All piping shall be of steel, suitable for maximum governor oil working pressure. All valves shall be cast or forged steel valves having flanged ends. The contractor shall supply required oil for the first filling of the oil sumps tanks etc. An additional quantity of the 10% of oil should also be included in the scope of supply. The Oil Pressure Unit (OPU) shall be complete with safety devices, fittings, control valves, pressure gauges etc.

The capacity design of the system shall be sufficient for each turbine unit, generator brakes etc. The system shall be so designed to cater two shut down operations for nozzles, deflector and inlet valve without the need of recharging the accumulator by starting OPU.

2.22. PLATFORMS, WALKWAYS AND RAILINGS ETC.

Working facilities and inspection platforms complete with supporting steel work, floor plates, gratings, stairs, hand railings etc. wherever necessary or desirable for operation and maintenance shall be provided. Chequered plating for pipe & cable trenches with provision of openings shall be provided. The hatch supports and embedded parts for hatches shall also be supplied.

2.23. MISCELLANEOUS PIPING AND EQUIPMENT

The contractor shall also provide other miscellaneous air, water and oil piping along with their accessories directly associated with the units, such as, various drainpipes, air inlet piping, governor and lubrication oil supply and return piping etc. Suitable epoxy protection shall be provided for all embedded piping. Acid cleaning shall be carried out prior to erection of the piping system.

2.24. DEWATERING AND DRAINAGE SYSTEM EQUIPMENT

Equipment for dewatering and drainage system common to all the units for seepage and left over water due to operation shall be provided. The Drainage System shall include floor drains, leakage water drains, seepage water from tailrace side etc. All the drains shall be connected through drainage header to the drainage cum dewatering sump, where two (02) pumps (main & standby) shall be installed for pumping the water to tail race channel. The pumps shall be provided with their own isolating gate valves, check valves and a common delivery header. Pump capacity shall be finalized during detailed engineering stage.

Complete requirement for drainage system including drainage pumps, driving motor, control, protective, indicating and annunciating equipment, common drainage header, delivery header and associated valves and fittings, gaskets, spacers, piping supports shall be supplied by the contractor within the scope of this contract.

2.25. COOLING WATER SYSTEM

The contractor shall design and supply complete cooling water system required for bearings of the turbines, generators and for other required equipment. The details such as quantity of cooling water required for turbine bearings and other turbine components, the pressure and purity of water required for above etc. shall be taken into account for suitable design of the whole system.

The cooling water shall be supplied by pumping water from tailrace. Total three (03) nos. of cooling water pumps, considering One (01) main pump for each unit and one (01) common standby, shall be provided to supply cooling water requirement of the two (02) units and other auxiliary equipment. The cooling water pressure shall be so designed that it shall be possible to discharge the outlets from the coolers directly to tail race.

The cooling water strainer shall be a complete unit with suitable isolating valves at the inlet and outlet being controlled by a single hand wheel and gears. The strainer design shall be such that there is smooth flow of water without excessive head losses inside the strainer. Arrangement for cleaning the strainer without interruption of service shall be provided.

A differential pressure gauge across the strainer shall be provided. The pressure gauge shall have two sets of contacts for annunciation on Unit Control Panel and Main Control Room.

The contractor shall provide all items for the satisfactory operation of the entire cooling water system, whether specifically mentioned or not in this specification.

2.26. INSTRUMENTATION, CONTROL AND SAFETY DEVICES

The Unit Control Panel (UCP) shall have the control switches, necessary starting & stopping relays, status indicators, indicating & recording instruments with alarm, annunciation etc. as may be required for control, monitoring and operation of each generating unit. The Control Philosophy will be finalized at the Detailed Engineering Stage.

Complete set of Instruments, alarms, safety devices and control system necessary for efficient & automatic operation, control and monitoring of the turbine & associated equipment in all operating conditions as well as in emergencies shall be supplied by the contractor.

Following minimum items shall be provided in the 11 kV Indoor Switchgear and Unit Control Panel for Turbine. Other details of the 11 kV Indoor Switchgear and Unit Control Panel are mentioned in **Chapter – 4** of this Technical Specification.

i. Process display window
ii. MIV OPEN/CLOSE push buttons with status indication lamps
iii. Brakes ON/OFF push button
iv. Nozzle opening raise / lower push buttons
v. Speed setting raise / lower push buttons
vi. Meter for water flow measurement
vii. Meter for net head measurement
viii. Measurement of turbine bearing oil temperature
ix. Cooling water inlet and outlet temperature
x. Water pressure, water levels of tail race and weir etc.

2.27. PREVENTIVE COATING AGAINST HYDRO ABRASIVE WEAR

Expected silt erosion damages in the various parts / components of the turbine shall be avoided by providing preventive coating on the following components:

- Nozzle ring / seat
- Needle tips
- Deflector cutting edges

Coating standards shall be of proven performances that would lead to:

- Doubled maintenance intervals
- Reduced efficiency losses

Contractor shall furnish complete details of the coating specifications and procedures in the detailed engineering report. The Design should be made considering erosion damage.

2.28. TURBINE NAME PLATE

The turbine shall bear a name plate, which provides the following minimum details in a legible and durable manner. Year of manufacture, serial no., year of commissioning, design head, guaranteed rated maximum output, guaranteed rated and maximum discharge, rated and run away speed etc. The name plate shall be visible from operating platform in the turbine deck.

2.29. COMPRESSED AIR SYSTEM

2.29.1. SCOPE OF WORK

Scope of work under this section covers the design, manufacture, shop testing, delivery, installation, commissioning, acceptance testing, handing over with guarantee of complete compressed air system as per the specifications depicted hereunder, each complete with all auxiliaries, accessories, mandatory spare parts for warranting a trouble free safe operation of the installation.

The scope of work shall be a comprehensive functional system covering all supply and services including but not be limited to following:

i. Two (02) sets of HP Compressors complete with associated accessories for governor oil system
ii. Two (02) sets of LP Compressors complete with associated accessories for air supply to generator braking, fire protection, service air supply points, other permanent / temporary installations such as draft tube drain valve, purging operation for cyclone separator / strainers etc.
iii. One (01) set of Air Receiver complete with manhole / hand-hole and flanged / screwed connections each for HP air compressor system
iv. Two (02) sets of Air Receiver complete with manhole / hand-hole and flanged / screwed connections each for LP air compressor system
v. Two (02) sets of Air Dryers complete with associated accessories each for HP and LP air compressor system
vi. One (01) no. of Pressure Reducer
vii. Service air hoses with necessary connectors etc. located in wall mounted service air enclosure as per approved drawings
viii. Pipes, valves, fittings, automatic moisture traps, drain connections, air filters, oil filters, required for the systems
ix. All pressure gauges, pressure switches, pressure transducers, temperature indicators, temperature switches, flow indicator, moisture indicator and any other instrumentation required for the system
x. Coordination and provision of necessary contacts and/or ports for integration with plant SCADA system
xi. Special tools, plants, equipment and mandatory spare parts
xii. Any other item(s) not mentioned specifically but necessary for the satisfactory completion of scope of work defined above, as per accepted standard(s) / best international practices

2.29.2. LAYOUT AND GENERAL ARRANGEMENT

HP and LP compressed air systems shall be located at the tailrace side of the machines at the Machine Hall Floor in the Power House (EL 1066.55 m). Exact location of compressed air system shall be finalized during detailed engineering.

Necessary piping, valves along with by-pass piping shall be provided to run any combination of air compressor and dryer.

The layout of the service air headers shall be designed to suit the air requirement of various systems.

2.29.3. HIGH PRESSURE (HP) COMPRESSED AIR SYSTEM

The HP compressed air system shall cater to the air requirement for oil pressure units of Turbine Governing System and Main Inlet Valve (MIV). While designing the system, the contractor shall coordinate with turbine manufacturer.

In addition, it shall also cater the air requirement for generator braking system at reduced pressure, achieved through pressure reducing system, in case of failure of LP compressed air system.

The system shall comprise of two (02) sets of HP compressors, one (01) set of HP air receivers and two (02) sets of air dryers along with necessary auxiliaries. The compressors shall have local control cubicles for control of compressors.

The normal operating pressure of the HP system shall be approx. 1.1 times of Governor / MIV oil pressure unit. Provision shall be kept for taking the air for LP receiver from HP receiver through air pressure reducing system.

2.29.4. LOW PRESSURE (LP) COMPRESSED AIR SYSTEM

The LP compressed air system shall cater the air requirement for generator brakes, fire protection system of transformers / generators, turbine inflatable air seal, various instrumentations and station service requirement.

The rated pressure of LP system shall be 7 bars approximately.

The system shall comprise of two (02) sets of LP compressors, two (02) sets of LP air receivers and two (02) sets of air dryers along with necessary auxiliaries. The compressors shall have local control cubicles for control of compressors.

The station service air shall be distributed through the wall mounted service air enclosures located as follows:

i. Two (02) nos. per unit in Power House Machine Hall Floors, one (01) in the upstream wall and one (01) no. in the downstream wall,
ii. Four (04) nos. in the service bay area
iii. One (01) no. in each control block / panel area,
iv. Two (02) nos. service air points in the auxiliary transformer cum DG Set Room,
v. Two (02) nos. service air points in the store room
vi. Two (02) nos. service air points in the control room
vii. Two (02) nos. service air points in the office room
viii. Two (02) nos. service air points in the workshop
ix. One (01) no. in battery room

x. One (01) no. in conference room
xi. Sufficient nos. of service air points in Cable tunnel
xii. Any additional connections / service air points felt necessary during detailed engineering shall be provided without any extra cost.

2.29.5. DESIGNED SYSTEM PRESSURE

Particulars	Rated Pressure	Design Pressure
HP System	1.1 times of the Governor / MIV Oil Pressure	10 % above relevant working pressure
LP System	7 bar	10 bar

2.29.6. AIR QUALITY

Characteristics of the delivered air shall be compliant with relevant Indian or International standard for air in working areas, dry, de-oiled, dusted regulation air.

2.29.7. CAPACITY OF COMPRESSOR

The rated capacity of each compressor of HP and LP compressed air system shall be such that normally one compressor shall meet the total requirement of the system and second compressor shall be kept as standby. However, control philosophy shall be designed to run both the compressors in case of emergency.

The rating of the HP air compressor shall be selected so as to initially fill the HP air receiver, pressure tanks and piping in less than 10 hours with one compressor in operation. The Contractor needs to submit the calculation supporting the selection of HP and LP air compressor rating.

2.29.8. CAPACITY OF RECEIVER

The capacity of HP air receiver shall be minimum one (01) m^3 and for common LP air receivers shall be five (05) m^3. However, Contractor needs to submit the calculation supporting the selection of the air receivers capacity after considering all operational requirements.

2.29.9. CAPACITY OF AIR DRYER

The minimum capacity of each air dryer shall be twice the capacity of each compressor so that one dryer can dry the air during running of both the compressors.

2.29.10. DESIGN AND CONSTRUCTION

A. STANDARDS

The system and equipment shall be designed, built, tested and installed to the latest revisions of the following applicable standards.

Sl. No.	Standard	Description
1	IS: 6206	Guide for selection, installation and maintenance of air compressor plants with operating pressures up to 10 bar
2	IS: 7938	Specification for air receivers for compressed air installation
3	ISO: 8573-1	Rules for air quality
4	IS: 11780	Code for selection and testing of rotary screw air compressor (Oil Flooded)
5	IS: 12258	Technical supply condition for air screw compressor (Oil Flooded) for general purpose and industrial applications
6	ASME Section VIII	Pressure Vessel Code

B. GENERAL

All equipment / items shall be designed to operate at the rated capacity in continuous mode. The system shall allow maintenance of various elements without affecting service continuity. The ambient conditions, moisture, temperature and seismicity shall be taken into account for the design and installation of the equipment.

Individual equipment construction shall be made according to current Indian or International standards.

C. COMPRESSORS

Each reciprocating type HP compressor and rotary screw type (Oil flooded) LP compressor shall be heavy duty and electric driven complete with automatic lubrication, air intake filter, oil filters, after coolers, instrumentation, water / oil separators, discharge valves, non-return valves, automatic moisture trap and other associated accessories. The compressor shall have microprocessor based state of the art control.

The motors of the compressors shall be continuous duty, enclosed in suitable enclosures and shall be capable of being started by means of direct on line starter (DOL). The insulation of motor winding shall be class 'F' with temperature rise limited to class 'B' and designed to operate at 415 V ±10%, 50 Hz ± 5%.

The compressor shall be delivered as package units on common frame with appropriate sizes AC squirrel cage motor and enclosed in suitable enclosures. Suitable anti-vibration pads shall be provided in the compressor foundation. Adequate protection shall be provided against starting of the compressor in loaded condition.

The water / oil separator shall be equipped with an automatic solenoid operated drain valve to achieve automatic draining during standstill. The compressor stages shall be equipped with discharge valves, which shall close time delayed after start to avoid compressor start against full pressure.

D. VALVES, PIPING AND INSTRUMENTATION

All embedded and exposed air piping shall be made of seamless stainless steel of minimum schedule 40. Pipe size up to 25 mm shall be minimum schedule 80.

The valves in the air lines shall preferably be full bore ball type and the material for the seat and ball shall be stainless steel. The valve shall be selected to have minimum leakage, reliable and ease of maintenance. Pressure gauges shall also be provided at the service air outlet line for measuring pressure at the remote / highest points.

Maximum limit of Total pressure drop inclusive of the pressure drop in valves and other fitting and total leakage losses in the compressed air systems be as per Relevant IS / IEC Code.

Instrumentation such as thermometer, temperature sensors, pressure transmitter, moisture sensors, pressure gauges and pressure switches shall be provided for indication, alarm, monitoring and control.

The Contractor shall co-ordinate with the turbine, governor, generator and main inlet valve manufacturer(s) to finalize the layout of the piping system.

E. AIR RECEIVERS

The pressure tanks shall be constructed from plate steel in accordance with part UW of the ASME Code for Unfired Pressure Vessels, Section VIII. The tank shall be painted on both inside and outside as per approved painting system. Thickness of inside painting shall be such that these do not flake off during operation. Prior to shipping, all threaded openings shall be closed with standard pipe plugs; Flanged openings shall be protected with blind flanges with gaskets bolted in position.

Each air receiver tank shall be equipped with pressure gauge along with required numbers of electrical contacts, two (02) nos. of safety Pressure Relief Valve (PRV), drain valve, two (02) nos. of each inlet and outlet sockets with valves and a pressure transmitter etc.

The Pressure Relief Valve (PRV) shall be set to open on 110 % of the maximum working pressure of the system. An automatic condensate drainage system shall be provided on the discharge separator to automatically drain condensate.

F. AIR DRYERS

Compressed air system shall be provided with two (02) regenerative / refrigerant type air dryers to dry the humid air. Normally one air dryer shall be used and shall have sufficient capacity to dry the air of both the compressors. The second air dryer shall be kept in standby mode for operation as and when required.

G. CONTROL AND MONITORING

The systems shall be controlled and monitored at three levels:

1. By respective local control cubicles for individual drive,
2. By Local Control Board for common services
3. By supervisory control and data acquisition (SCADA) system

The Contractor shall make provision of contacts and/or ports in local control cubicles and centralized control panel for interfacing with SCADA system for control and monitoring.

In particular, the monitored parameters shall include:

i. Pressure thresholds,
ii. Number of starts ups and shut downs,
iii. No load operation timing at start up,
iv. Air receiver pressure values,

The compressed air systems shall be equipped with following instruments and protection systems, in addition to the visual indicators, thermometers, pressure gauges, pressure relief valves etc.

a. Pressure switches for triggering start-up of the normal air compressor, back-up air compressor and air compressor shutdown
b. Pressure switch to detect low pressure in the compressed air pressure tanks for giving alarm,
c. Automatic shut down if the discharge air temperature exceeds a predetermined, adjustable value.

However, the list is indicative only and scope shall be as per approved drawings / bill of materials during detailed engineering stage.

2.30. TESTING DEVICES AND INSTRUMENTS

All devices and instruments required for testing during assembly / erection at site and field acceptance tests for fulfillment of efficiency and output guarantees shall be supplied by the contractor.

A detailed list of the above devices and instruments shall be furnished by the contractor during detailed engineering stage. In any case, all measuring instruments and devices should be calibrated and the contractor shall be required to furnish the calibration certificates to the controlling officer of the Employer.

2.31. FACTORY ASSEMBLIES AND TESTS

The Turbines and the Main Inlet Valves shall be completely assembled in factory and properly match marked and dowelled to ensure correct assembly and alignment in the field except that where necessary suitable dowels shall be furnished for insertion after field assembly and drilling.

All motors and other auxiliary equipment covered under this specifications shall be tested in accordance with the requirement of the latest edition of relevant standards.

Material tests on all important castings, forgings and fabricated steel work and important welded positions, assembly tests, dimension check, stroke measurement of working parts, operational tests on oil pressure units, oil leakage units, pumps etc. and hydraulic pressure tests on all components shall be carried out.

The equipment, such as spherical valve body, servomotors, pressure tanks, piping, coolers etc. which shall be subjected to oil (or water) pressure, shall be factory tested at a pressure equal to 150 % of max. operating oil (or water) pressure, as applicable, inclusive of maximum water hammer in such equipment for thirty (30) minutes.

Tests shall be followed as per the methods described in relevant IS / IEC Codes. Following tests shall be conducted on various components before dispatch from the works.

a) Dynamic balancing of runner
b) Complete operational test of oil pressure unit
c) All standard tests on governor
d) Operation tests of nozzles
e) Operation tests on all electro-magnetic valves, limit switches & pressure switches
f) Pressure testing of turbine guide bearing coolers.
g) Material tests for important components such as runner, nozzles, shaft, valves etc.
h) Tests on compressed air system as per relevant standard.

i) Any other test specifically required for a particular material / equipment / item as per relevant standard etc.

2.32. COMMISSIONING CHECKS / SITE TESTS

Hydraulic pressure test at maximum gross head shall be conducted by the contractor on the assembled and welded distributor piping to check for any defects and rectification of the same. The contractor shall be fully responsible for test ring, bulk head and pressure generation pump, required for carrying out this pressure test. Hydraulic pressure tests, leakage tests and operation tests (as per applicability) shall also be performed on main inlet valve and other turbine components, pressure tanks, governor sump tank, pumps, grease equipment, valves, piping systems etc.

All Pre-Commissioning Tests including but not limited to the following should be conducted by the contractor in presence of employer's representatives.

a) Static balancing of runners. Dynamic balancing may be required at the site as per necessity.
b) Measurements of Clearance between shaft and guide bearing.
c) Tests to determine opening & closing time of deflector and needle servomotors
d) Speed Governor adjustment
e) Pressure test & flow of oil pumping system
f) Checking of shaft alignment
g) Load rejection tests (at full load as well as part load as decided by the Employer)
h) Unit starting, stopping, braking, no load & no excitation run test, part load (40 %, 60 % & 80 %), full load and over load (110 %) operation tests
i) Measurement of vibration during various operating conditions
j) Operational tests of bearing (bearing heat run test etc.)
k) Pressure tests for the piping system as per relevant standard
l) Over speed test (120% of the rated speed)
m) Tests on compressed air system as per relevant standard.

2.33. COMMISSIONING

Prior to the acceptance of the turbines and auxiliary equipment by the employer, commissioning and field tests shall be carried out by the contractor in accordance with the IEC Field Test Code and the IEC Commissioning Guide. The Governor System shall be tested in accordance with the international code for tests to be conducted on speed governing system for hydraulic turbine (IEC publication No. 60308).

The contractor shall prepare a detailed Quality Assurance Plan (QAP) for the turbines and the auxiliaries and submit the same to the employer for prior approval.

The contractor shall calibrate all necessary test instruments & devices and furnish the calibration certificates to the employer before commencement of the tests.

All applicable commissioning tests listed in the IEC commissioning guide; chapter II (Publication 545) shall be carried out following the specified tests procedures.

The contractor shall recommend the method of flow measurement for field acceptance test and shall arrange the same for efficiency testing. The contractor shall also make necessary provisions on each turbine for efficiency test.

During commissioning, overall system performance shall be demonstrated by the contractor for acceptance of the same by the Employer.

2.34. OTHER TESTS

The following tests shall be made on the first unit commissioned in addition to the test specified as commissioning tests.

a) Time – rpm deceleration curve, without excitation on the generator, from rated speed to stand still.
b) Check for main inlet valve closing against preset turbine over speed limit.

2.35. INDEX TESTS

The index tests shall be performed on each unit in accordance with the IEC Field Test Code.

2.36. DOCUMENTS TO BE SUBMITTED AFTER PLACEMENT OF LOA

- Guaranteed Technical Particulars (GTP) as per **Chapter – 20 (Cl. No. 20.1).**
- Name of manufacturer proposed by the contractor for each item / equipment as per **Cl. No. 2.38**.
- Performance certificates of proposed manufacturers as per **Cl. No. 2.39.**
- All Type test reports of each similar rated products of the proposed manufacturer.
- Routine Test Report / Shop Test Report of each similar rated products of the proposed manufacturer performed earlier.
- Test facilities at manufacturer's test house.
- Declaration on Operational Guarantee as mentioned in **Cl. No. 2.13.**
- Tentative Layout drawings of the turbine and associated auxiliary and ancillary equipment matching with that of generator and auxiliaries.

2.37. DOCUMENTS TO BE SUBMITTED DURING DETAILED ENGINEERING STAGE

Six (06) sets of data sheet, manual, leaflet, drawing and other documentation as mentioned below for turbine and associated auxiliary & ancillary equipment shall be submitted by the contractor to the Controlling Officer of the employer for according approval during detailed engineering stage.

a) Layout drawings of the Power House which shall include each floor plan, cross-section and L-section; clearly indicating unit spacing, dimensions of runner, distributor, turbine housing, turbine runner settings, coupling arrangement, layout of inlet valves and other auxiliaries, governing equipment, tail race channel etc.
b) Drawings and descriptive literature on the governor and governing mechanism including graphs / curves showing performance characteristics.
c) Installation details for carrying out related civil works in the power house
d) Drawings of each piping system (oil, water and air),
e) Detailed report on control systems and instrumentation, SCADA compatibility etc.
f) Design, calculations and drawings for complete compressed air system.

The contractor shall furnish all drawings, data, manuals and other necessary literature pertaining to the equipment offered by him. The contractor shall supply the following data.

a) All Construction Drawings including equipment foundation details, power house, electrical drawings etc.
b) Detailed time schedule indicating submission of drawings, tentative date of inspection, delivery of items, installation, testing, trial run & commissioning.
c) Detailed Bill of Material (BOM) which shall include the spare parts for five (05) years of trouble-free operation & maintenance of the above system as per **Cl. No. 19.2** and special tools, plants and equipment as per **Cl. No. 19.15**.
d) Detailed Quality Assurance Plan (QAP) for model test, routine / shop test and field acceptance test including efficiency test.
e) A list of all tools, devices and instruments, necessary for field acceptance tests.

After approval, Six (06) sets of approved drawings and documents along with soft copies for Hydro Turbine and associated auxiliary & ancillary equipment shall be submitted to the controlling officer of the employer.

Further, the contractor shall submit three (03) sets of successful shop / routine test reports to the controlling officer of the employer prior to dispatch of each item / equipment.

2.38. MAKE OF COMPONENTS

The contractor shall submit proposed make of various components of the hydro turbine and associated auxiliary & ancillary equipment after placement of LOA. Final make shall be approved by the employer during detailed engineering stage based on the performance certificates submitted by the contractor. For approved makers list of WBSEDCL for various components, the bidders are requested to go through **Chapter – 21** of this Technical Specifications.

2.39. CREDENTIALS AND PERFORMANCE CERTIFICATES

The contractor shall submit Performance Certificates issued to the proposed manufacturers by the respective employer for similar kind of job. The contractor shall also furnish documents in support of supply, delivery of similar equipment / system indicating thereon names of the organization, quantity ordered and quantity supplied along with their submission after placement of LOA. Non-submission of the same will be liable for rejection of the proposed manufacturers.

The contractor shall submit Completion Certificates and Performance reports (at-least 01 year of successful operation issued by the respective employer of the job to the manufacturer) for two (02) nos. of Main Inlet Valve (MIV), each having minimum diameter of 400 mm, installed within previous twenty (20) years by the MIV manufacturer (either the contractor himself or the MIV Manufacturer proposed by him, as the case may be).

2.40. COMPLETENESS OF EQUIPMENT / SYSTEM

All items, equipment, fittings and accessories etc. for any specified equipment / system that may not be specifically mentioned in the specification but necessary for completeness of the system shall be deemed to be covered under the scope of this contract. No extra charges will be paid to the contractor for the same.

2.41. SCHEDULE OF REQUIREMENTS

Sl. No.	Description	Quantity
1	Horizontal shaft, PELTON TYPE Turbines each suitably rated to provide 5.00 MW generator output with 10% continuous overload capacity at rated head conditions; directly coupled to generator complete with governor, lubrication equipment, instruments, controls, safety devices and other associated equipment etc.	Two (02) sets
2	750 mm dia. Main Inlet Valves (MIV) of SPHERICAL TYPE complete with piping, controls and operating mechanism and necessary auxiliaries etc.	Two (02) sets
3	Cooling water system	One (01) lot
4	Oil Pressure Unit (OPU)	Two (02) sets
5	Unit Control Panels	Two (02) sets
6	Instruments, Controls and Safety Devices	Two (02) sets
7	Drainage cum Dewatering System	As required
8	Necessary Valves, Piping, Regulating Orifice, Air Scouring Arrangements, all type of consumables and other materials	As required
9	Necessary Pressure Gauges, Pressure Switches, Flow Sensing Device, Flow Meter, Level Switches etc.	As required
10	Compressed Air System as per **Cl. No. 2.29**	As required
11	Special tools, plants and equipment as per **Cl. No. 19.15**	As required
12	Spare parts as per **Cl. No. 19.2**	As required
13	Completeness of equipment / system as per **Cl. No. 2.40**	As required

2.42. SCHEDULE OF INDICATING INSTRUMENTS, DEVICES FOR TURBINE, GOVERNOR & ASSOCIATE AUXILIARIES

Sl. No.	Items	Type of Instruments	Location
1	Temperature of Bearing, Bearing Oil	RTD	DACS
2	Temperature of Bearing, Bearing Oil	DTT with alarm contacts	UCP
3	Pressure of Penstock and inlet side of distributor and u/s of MIV	PG and Pressure Switch	Local
		Pressure Transducer	DACS
4	Turbine Discharge	Indicating & recording flow meter	UCP / DACS
5	Grease Pressure	PG	CGL system (if provided)

Sl. No.	Items	Type of Instruments	Location
6	Turbine speed for Indication and Governor	Indicator	UCP / DACS
7	Speed Level	Indicator	UCP / DACS
8	Speed Droop	Indicator	UCP / DACS

3. GENERATOR AND AUXILIARIES

3.1. SCOPE OF WORK

This section of the specification covers the design & engineering, material selection, manufacturing, assembly, testing at manufacturer's works, supply, delivery, storage at site, erection, testing, trial run and commissioning of two (02) nos. of horizontal shaft alternating current Synchronous Generators of capacity 5883 kVA with 10 % continuous overload, 11 kV, 50 Hz, 0.85 (lagging) power factor for Lodhama-II Small Hydro-electric Power Project at power house elevation of 1066.55 m above MSL.

The Generators shall be complete with all fittings, accessories, instrumentation, controls and safety devices, auxiliaries such as excitation system, voltage regulating equipment, neutral grounding cubicle, cabling, terminal equipment including CTs, PTs, surge protection device, lubricating system, oil, water and air piping, valves etc. as detailed in this specification.

The scope of supply shall also include spares, special tools and testing devices, which are essential for installation, operation and maintenance for five (05) years trouble free operation of the plant, even though these are not individually or specifically stated in this specification but recommended by the respective manufacturers. All the material & workmanship shall be of suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

The generators and associated equipment shall be suitable for interfacing with SCADA system and all necessary electrical and mechanical transducers required for the purpose shall be included in the scope of work.

3.2. STANDARDS

Generators shall meet provisions made in the latest edition of following standards unless otherwise mentioned.

Sl. No.	Standards	Description
1	IEC 34	Rotating Electrical Machine
2	IS 4722	Rotating Electrical Machine – Specification
3	IS 4889	Determination of efficiency of rotating electrical machine
4	IS 1271	Thermal Evaluation And Classification Of Electrical Insulation
5	IS 12075	Mechanical vibrations of rotating mechanical machines.
6	IS 4691	Degrees of protection provided by enclosures for rotating electrical machinery

Equipment complying with other Internationally Accepted Standards such as A.S., B.S., V.D.E. etc. will also be considered if they ensure constructional features and performance equivalent or superior to standards listed above. In such a case the contractor shall clearly indicate the standards adopted and furnish a copy in English of the standards adopted along with copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

3.3. TYPE & RATING

Sl. No.	Particulars	Details
1	Type	Horizontal shaft synchronous generators
2	No. Of Generators	Two (02)
3	Rated Output	5883 kVA / 5000 kW at 0.85 pf
4	Continuous overload capacity	6471 kVA / 5500 kW at 0.85 pf (@10%)
5	Rated Voltage	11 kV
6	Power Factor	cos ϕ = 0.85 (lagging)
7	Rated Frequency	50 Hz (+ 3% to – 5%)
8	Rated speed	600 rpm / 750 rpm
9	Direction of Rotation	Clockwise as viewed from non-driving end
10	Runaway speed	As desired by turbine manufacturer
11	Moment of inertia	To suit the requirement of pressure rise and speed rise at specified deflector operating time followed by needle closing time
12	Insulation class	Class 'F' with temperature rise limited to Class 'B' at rated output (as measured by RTD)
13	Form of enclosure protection	Corresponding to Screen Protected Drip Proof (SPDP)
14	Voltage variation between phases at rated output	± 10%
15	Frequency variation	+ 3 % to – 5 %
16	Combined variation of voltage & frequency	± 10%
17	Max. ambient temperature	40°C
18	Temperature rise limit at rated output / max. output	Stator: 80°C (measured by RTDS of PT100 type), limited to Class B temperature rise. Rotor: 80°C (measured by Resistance Method), limited to Class B temperature rise.
19	Control	Manual / Auto
20	Stator winding connection	All six terminals to be brought out and neutral to be formed outside.
21	Inertia constant	As per relevant IS / IEC
22	Short circuit ratio	1.00 (minimum)
23	First critical speed	15% higher than Max. Runaway Speed
24	Cooling	Fan air cooled
25	Excitation	Static excitation system

Sl. No.	Particulars	Details
26	Stator neutral earthing	Neutral grounding transformer (NGT) with resistance on secondary (NGR)
27	Noise limit	Should not exceed 90 dB (A) at one (01) m distance from any operating part of the unit
28	Speed signal equipment	Speed signal generator

The weights and sizes of the packages shall be within the permissible transport limitations.

3.4. TECHNICAL REQUIREMENTS

a) The Generators shall be capable of delivering continuous rated output of 5883 kVA and shall have continuous overload capacity (COL) @110% of the rated output at rated power factor (cos ϕ) of 0.85 (lagging) with voltage variation limit of +/- 10% of rated voltage and frequency variation limit of -5% to +3% of rated frequency.

b) The generators shall be suitable for installation & satisfactory operation under the humidity and temperature conditions as prevailing in an hydro power station.

c) Each Generator shall be star connected. All six terminals shall be brought out and neutral shall be formed outside. Current transformers, voltage transformers and surge protection apparatus shall be provided for control, protection and metering.

d) The Generator shall be provided with static excitation system and automatic voltage regulator (AVR). The AVR shall be provided with following characteristics:
   - Automatic power factor regulator
   - Max. / min. excitation current limiter
   - Manual voltage control
   - Auto follow up control

e) The Generator shall be capable of withstanding three phase (3Φ) short circuit at generator terminal for thirty (30) seconds when operating at rated kVA, rated power factor and 5% over voltage.

f) The generator shall be designed to safely withstand any mechanical and magnetic stresses resulting from either a three phase (3Φ) or a single phase (1Φ) fault occurred at generator terminals for three (03) seconds when operating at max. power output (@110 % of the rated power output), rated power factor and 10% over voltage.

g) Refer Clause No. 2.12 of this technical specifications (Volume – 6; Part – III) for runaway speed withstand capacity of the complete turbo-generator unit.

h) The temperature rise of the stator and rotor winding shall be limited to Class 'B' at any operating condition. The generator shall be provided with Class 'F' Insulation.

i) The saturated rated direct-axis transient reactance of the generator shall be guaranteed without any tolerance and shall be less than 30%. Direct-axis sub transient reactance shall be less than 20%.

j) The maximum line charging capacity at rated voltage that can be obtained without negative excitation and with stable operation of the generator may be indicated and this shall not be less than 70% of rated kVA. There shall be no capacitive effect on the breaker required to be closed for line charging operation.

k) The Generator shall be capable of evacuating power under adverse voltage conditions (± 10 %) in the grid without any loss in efficiency and damage to the

equipment. The contractor shall confirm the same in Guaranteed Technical Particulars (GTP) to be submitted by him during detailed engineering stage.

l) Each part of generator shall be designed in such a manner that the max. unit stresses of various parts of the generator resulting from any continuous operating conditions or specified runaway speed conditions shall not exceed the desired limit mentioned in **Cl. No. 1.6** of this technical specifications.

m) Design of the damper winding should be such that the ratio of quadrature-axis sub-transient reactance to direct-axis sub-transient reactance shall not exceed 1.3.

n) The design of the generator structure and housing shall be so proportioned to avoid the possibility of resonance with higher rated frequency.

o) The body of the generator shall be properly earthed from at least three (03) points and the earthing strips shall be properly connected to the power house earth-mat.

3.5. SHORT CIRCUIT RATIO

The short circuit ratio shall not be less than one (01). The excitation system and automatic voltage regulator (AVR) shall have the necessary features to overcome the disadvantage due to low short circuit ratio from stability considerations so that the units can operate stably under all operating conditions when connected to the grid.

3.6. WAVE FORM AND POLY-PHASE SYMMETRY

a) The wave-form of the voltage between the terminals of the generator on open circuit shall be practically sinusoidal and shall not exceed the limits specified in the latest version of IS: 4722 i.e. the instantaneous values of harmonic waveform should not exceed 5% of the peak value of the fundamentals.

b) The poly-phase voltage system of each generator shall be practically symmetrical i.e. the negative sequence or zero sequence components should not exceed 5% of the positive sequence component.

c) Special steps shall be taken to eliminate harmonics, which may cause inductive interference with communication circuits. Telephone Harmonic Factor as per IS: 4722, shall not be more than 1.5%.

3.7. SPEED RISE AND RUNAWAY SPEED

The moment of inertia of the generator together with the moment of inertia of the turbine and flywheel (if any) shall be such that the maximum speed rise shall be as low as possible and shall not exceed the designed, guaranteed and specified speed rise of the units to avoid excessive stress in the equipment.

The Generator parts shall be so designed to withstand a maximum runaway speed without damage to its parts for fifteen (15) minutes for every occurrence with cooling water supply 'ON' for its bearings. The bearings should operate satisfactorily under this condition without excessive increase in vibration and temperature of oil.

The value of maximum runaway speed and the duration of withstand the same as recommended by the turbine manufacturer shall be stated in the Guaranteed Technical Particulars (GTP). The generator manufacturer shall coordinate with the turbine manufacturer to limit the speed rise within specified guaranteed value. The critical speed shall be at least 15% higher than the maximum runaway speed. The factor of safety at runaway speed conditions shall be at least 1.5.

The over speed test at maximum runaway speed shall be successfully conducted at manufacturer's works before the dispatch of the equipment.

3.8. NOISE LEVEL

The noise level shall not exceed 90 dB (A) when measured at a distance of one (01) meter from any operating component of the generator. Any vibration caused by the machine should not be in resonance with any part of the equipment. The frequency band shall be indicated by manufacturer and high vent noise shall be avoided.

3.9. INSULATION CLASS

Insulation for Stator Winding and Rotor Winding shall be provided as follows:

- Material corresponding to Class 'F' insulation, however Temperature Rise shall be limited to Class 'B' for continuous operation at 110% of the rated output.
- Insulation shall have high basic insulation level suitable to withstand system surges on account of switching surges and lightning surges.

3.10. TEMPERATURE RISE

Each generator shall be capable of delivering 110% of the rated output continuously at any voltage and frequency in the operating range and at rated power factor without exceeding the following values of temperature rise over ambient air temperature (not exceeding 40 °C) for stator winding and rotor winding as per IS: 4722.

- Maximum temperature rise 80°C (as per Class 'B' temperature rise) for continuous operation at 110% of the rated output
- Insulation of Class 'F' and temperature rise limit of Class 'B' shall be provided to ensure 25°C of safe margin at any operating condition.

3.11. OUTPUT AND EFFICIENCY GUARANTEES

Same as **Cl. No. 2.6 and Cl. No. 2.7** of this technical specifications.

3.12. PENALTY

Same as **Cl. No. 2.8** of this technical specifications.

3.13. REJECTION LIMIT

Same as **Cl. No. 2.9** of this technical specifications.

3.14. RECTIFICATION TO MEET GUARANTEES

Same as **Cl. No. 2.10** of this technical specifications.

3.15. BRAKES

Each generator shall be provided with pressure oil operated spring brakes or hydraulic brakes, which will be finalized during detailed engineering stage. The generator braking system shall consist of suitable number of brake shoes, which will operate against a

polished segmental steel brake track bolted to rotor or to any other component such as flywheel, if any.

In case of pressure oil operated spring brakes, Pressure oil at required pressure shall be made available from the Oil Pressure Unit (OPU) to be supplied under turbine and accessories. A manometer, which shows the braking pressure during automatic braking, shall be connected to the pressure pipe. The oil pressure keeps the spring of brake in tensed position while the brake will operate under spring pressure. The brakes shall be capable of being applied at a designated speed. It shall be possible for the braking equipment to retard the unit to stand still within two (02) minutes from time when brake impulse is transmitted even if brake path has considerable coating of oil. The brake blocks with a non-asbestos coating shall be designed so that at least four thousand (4,000) braking applications can be made before the brake linings have to be replaced. Brakes shall be provided with reliable limit position switches in order to indicate the position of the brakes.

Electrical breaking shall be provided to each generator unit which will operate to reduce the generator speed to a designed speed before applying mechanical brakes.

3.16. FLYWHEEL

A separate Flywheel of ample dimensions shall be supplied in case the required moment of inertia for limiting the speed rise / runaway speed is not available from generator and turbine inertia. Necessary provision for receiving the piston of the brake cylinder on application of brakes shall be made on the flywheel.

The flywheel may be coupled to generator directly or may be mounted on the shaft just before coupling. Generator manufacturer shall coordinate with turbine manufacturer to decide the best location of flywheel (if required).

3.17. PAINTING, CORROSION PROTECTION AND COATING

For all structural steel and cast iron parts including piping for areas in contact with air, oil and water the following applies:

Surface preparation:	On all cast iron and structural steel parts the rust must be removed by mechanical means (sandblasting) to obtain bare surface.
Primer coat for all areas:	2 layers of primer coat (dry thickness of each layer 40 microns).

Intermediate & Final Coats:

Type A: areas in contact with water:	After assembling the mechanical parts in the workshop of all items to be delivered, three coats of water resistant paint must be applied with each layer having a min. thickness of 100 microns.
Type B: areas in contact with oil:	All those areas will receive three coats with oil resistant paint, for example Keratol, which must be applied as finishing coat.
Type C: areas in contact with air:	All those areas still accessible after assembling on site, will receive two prime coats with different colours. The prime coat consists of a preliminary final coat in blue for the generator casing and red for all the moveable parts. The applicable RAL colours shall be provided. Internal and external surfaces of the casing and all metal parts

	shall be painted with epoxy paint that will resist corrosion due to ambient conditions. The colour of external paint other than generator casing will be confirmed during detailed design and must be of Non-hazardous and Non-toxic in nature.
Areas in contact with concrete:	Cast-in items may not receive any coating, but must be free of rust and spunk.
Cast-in items exposed to air and water:	Must be provided with a prime coat to a depth of approx. 150mm into the concrete.

Parts located in inaccessible areas, which must not be dismantled after workshop assembling must be protected as follows:

- The electrical equipment such as electric motors, limit switches, control panels etc. must receive corrosion protection according to specifications in the worst atmosphere.
- The colour coding will be determined by the Employer.
- Any coated surface damaged after or during assembling must be reinstated.

3.18. CONSTRUCTION

3.18.1. STATOR

The stator shall be constructed and assembled at works. The stator frame shall be built-up of welded plate steel in one complete assembly. Each part of the stator shall be provided with suitable lifting lugs and earthing terminals. The stator shall be sturdy to prevent distortion during transport and under any abnormal operating conditions. Bolted and dowelled joints shall be provided between the sections of the frame, being heavily flanged internally and coupled by a number of short bolts. The Core shall be built up with Low Loss High Silicon Steel laminations. Each lamination shall be coated on both sides after punching and removal of burrs with insulating varnish to minimize eddy current losses.

Ventilation ducts shall be provided at intervals along the stator core, being formed by means of nonmagnetic steel spacing bars securely welded to adjacent punching.

Sufficient number of Resistance Type Temperature Detectors (RTD) shall be installed at suitable places for monitoring temperature of stator core, stator teeth and stator winding for temperature recorder (local as well as remote).

3.18.2. STATOR WINDING

The stator winding shall be insulated with Class 'F' Insulation as defined in relevant standards. The winding of the stator shall be done fully at the manufacturer's works only.

The stator windings shall be of coil type with global VPI type insulation system.

Design of the stator shall be in accordance with relevant IS / IEC Code.

All voltage bar connections shall have silver plated surface, bolts shall be made of non-magnetic materials. The wound stator shall be dispatched to site in one piece complete set. The capacitance to ground of the windings of all the three phase shall be equal.

3.18.3. ROTOR

The rotor shall be Salient Pole / Cylindrical type. The rotor structure shall be built in accordance with the best modern practice. The factor of safety at maximum runaway speed based on yield point of material shall be minimum 1.5.

Design of the rotor shall be in accordance with relevant IS / IEC Code.

As far as possible, necessary flywheel effect shall be incorporated into the rotating parts in total (generator, turbine etc.) without adding additional weights and the same shall be determined in consultation with the turbine manufacturer. In case requisite moment of inertia is not available from the rotating parts, a separate flywheel may be provided, to get the desired flywheel effect.

3.18.4. FIELD WINDING

The Field Winding shall be insulated with Class 'F' Insulation as defined in relevant standards & shall consist of fabricated copper strips. The nominal field voltage shall be indicated. The field winding shall be adequately braced to withstand all mechanical stresses imposed during the maximum runaway speed condition. The insulated field coil shall be pre-compressed in the factory before assembly on the field pole so that there is no shrinkage and loosening of the same while in service. The pole body insulation shall be of epoxy type.

The field poles shall be provided with adequate continuous type amortisseur winding (damper winding) of the low resistance type to improve stability under single phase fault conditions. The ratio of the quadrature axis sub-transient reactance to the direct axis sub-transient reactance shall be stated in the Guaranteed Technical Particulars (GTP).

The field leads shall have sufficient length so that the connection to the slip rings can be reversed without removing or dismantling either the field leads or the collector rings. The field leads shall have at least 30% extra cross-section of copper over and above that normally required for maximum field excitation, allowing normal factor of safety. The field leads shall be neatly and rigidly fixed on the rotor with minimum bends duly taking care of centrifugal forces.

3.18.5. TERMINAL BOX

The Terminal Box shall be located on either side of the generator – one for phase connection and other for neutral connection. A separate terminal box for RTDs and space heater terminals shall be provided. The terminal box shall be capable of withstanding 25 kA fault level for three (03) seconds.

3.18.6. PHASE MARKING

Appropriate phase marking as per IS: 325 shall be provided inside the terminal box. The markings shall be indelible.

3.18.7. SHAFT

The Generator Shaft shall be made of the best quality carbon steel of properly heat-treated. The shaft shall be of adequate size to operate at all speeds including maximum runaway speed and shall be able to withstand short circuit stresses without excessive vibrations or distortion. The shaft shall be accurately machined all over and polished

where it passes through the bearings and accessible points for alignment checks. The monitoring platform and the anchoring devices for the generator must be adaptable ones and all parts shall be included in scope of supply.

The lowest critical rotation speed shall exceed the highest dynamic runaway speed by at least 25%.

3.18.8. BEARINGS

a) The generator shall be provided with 'locating bearing'.
b) The bearings shall be pad type or sleeve type, oil filled (self / forced lubricated). The oil lubrication system for the bearings shall be fail safe and shall work even in the event of power failure.
c) For ease of maintenance, the bearings shall have the provision to dismantle in two halves.
d) The bearings shall be guaranteed for minimum continuous operation for one lakh (1,00,000) hours and shall be of proven design and performance.
e) The locating bearing, beside taking the radial thrust, shall be suitable to take axial thrusts in both the directions.
f) The bearings shall be adequately insulated to prevent any harmful circulating currents.
g) The bearings shall be designed to withstand maximum runaway speed without any damage to its parts for fifteen (15) minutes duration continuously for every occurrence with cooling water supply 'ON' and for five (05) minutes duration continuously for every occurrence with cooling water supply 'OFF'.

Each of the bearings shall be provided with direct reading thermometer of dial type gauge with direct reading pointer and also, provided with signaling switches for temperature indication with two (02) sets of contacts for annunciation and tripping of the machine. The bearings shall also be provided with resistance elements of RTD Type. Wires shall be run from thermometer and resistor element to the instruments and the junction box mounted outside of the stator frame. RTDs shall be interfaced with SCADA system. The connection blocks shall be of detachable type. Pressure gauges, flow relays etc. as required, shall be provided.

The expected maximum temperature rise of the bearings shall be indicated in the detailed engineering report. The setting for annunciation and trip for high bearing temperature shall not be higher than 70°C and 75°C respectively.

3.18.9. COOLING & VENTILATION

The generator shall be provided with duct ventilated Screen Protected Drip Proof (SPDP) enclosure. Each generator shall be preferably of naturally cooled self-ventilated type.

Two axial flow centrifugal fans shall be placed on either side of shaft to provide forced air cooling. These fans shall discharge out the air from the generator enclosure.

3.18.10. VIBRATION

All rotating parts shall be designed to operate without undue vibration. Special precaution is to be taken to run the machines smoothly. The vibration of the machines shall be within the limits specified in the relevant standards (IS: 14773 / ISO: 7919).

Full balancing work shall be done at works. Fine balancing may be carried out at site to bring down vibration level within acceptable limits, if required.

3.18.11. HEATERS

The generators shall be provided with Anti-Condensation Heaters. Space Heaters of adequate rating and quantity with provision of a spare one for each generator shall be provided for maintaining surrounding air temperature of the stator above the ambient air temperature during prolonged shutdown period and keeping the generator at moisture free condition. A fan to be provided for initial start up after prolonged shut down shall be included in the scope of supply.

3.18.12. OIL & GREASE

The contractor / manufacturer shall indicate the lubrication requirements, type of grease to be used, frequency of refilling required, specifications etc. during detailed engineering stage.

The oil used for generator bearing lubrication shall be identical with that used for the turbine pressure oil system and other auxiliaries. The generator manufacturer shall co-ordinate with the turbine manufacturer to ensure the same. First filling of oil with ten percent (10%) extra quantity shall be supplied along with the generator unit.

3.18.13. SPEED SIGNAL GENERATOR

Speed signal generator shall be mounted at the non-driving end of the generating unit to measure the rotational speed of the unit. Speed Relay to monitor the speed of the generator to measure the 10%, 15%, 30%, 50%, 100%, 110% and 120% of rated speed with adequate number of auxiliary contacts (NO & NC) shall be provided.

In addition, mechanical over speed switch shall be provided on generator shaft, which shall initiate turbine trip. The mechanical speed switch shall have suitable number of auxiliary contacts (NO / NC) for annunciation / trip.

3.19. EXCITATION SYSTEM & AUTOMATIC VOLTAGE REGULATOR (AVR)

Each generator shall be provided with Static Excitation System consisting of excitation transformer, automatic voltage regulator (AVR) and thyristor full bridge rectifier. The system shall be completed along with CT and PT connected to Generator output terminal, slip rings, carbon brushes etc.

3.19.1. GENERAL

The excitation system shall be suitable for maintaining the voltage for a grid voltage variation of ±10% & for a frequency variation of +3% to –5%.

- The excitation system shall be a static potential source type and a 'high initial response' system as described in IEEE Std. 421 (Standard Criteria and Definitions for Excitation Systems) with a response not less than 2.0.
- The equipment shall be capable of continuously carrying the required excitation current at 47^0C ambient when the generator is delivering 100% rated kVA at rated power factor, rated frequency and 105% rated voltage

- It shall also be capable of carrying ceiling current for thirty (30) seconds after reaching rated temperature when the generator is delivering 100% rated kVA at rated power factor and 100% rated voltage.
- The excitation system shall be suitable for power generator/synchronous condenser operation of the unit.

The system shall consist of the following major sections arranged in a continuous line-up of NEMA-1 metal cubicles or equivalent, 14 gauge minimum, with hinged front doors (See Note 1) for access to the equipment.

(a) Excitation Transformer

(b) Power Converter

(c) Regulating and Sequencing Control

Note 1: Transformer may have bolted access panels

Doors shall be equipped with a three point latch and locking handle. Enclosures shall be suitable for lifting, rolling, skidding, and jacking and provided with roof access covers for interconnecting wiring.

The excitation equipment shall be completely factory assembled, wired, and tested. Interconnections between close connected cubicles in a continuous line-up shall be furnished for field installation.

3.19.2. EXCITATION TRANSFORMER

The excitation transformer shall be a 3φ, self-cooled, dry type with a 220^0C insulation system and a 150^0C maximum temperature rise over a ambient temperature of 40^0 C. It shall receive power directly from the generator terminals. The transformer shall be in accordance applicable standards for the kVA and voltage class. Over current relay (Instantaneous and time-delayed), over temperature detection (two stage) and grounding pad shall be included.

3.19.3. POWER CONVERSION SECTION

The power conversion section shall consist of:

a) One (01) full wave power conversion bridge with Thyristor modules capable of producing both +ve and -ve DC output voltages. The -ve DC voltages shall be capable of rapidly reducing the field current to zero to achieve a fast response system of field forcing in both directions. The module shall be complete with cooling fan, over temperature detector, gate firing and RC snubber circuit boards.

   Redundant power conversion module shall be provided to increase the reliability of the system. The standby power conversion module shall automatically be switched on to prevent any interruption of field current in case of thyristor failure occur in the lead power conversion module. A "Lead-Standby" selector switch shall be provided for ease of operation of the plant.

b) One (01) moulded case type AC breaker, non-draw-out, manually operated, with shunt trip and auxiliary switch, for Thyristor failure and DC short circuit protection. Breaker shall not trip on normal shutdown sequence.

c) One (01) AC overload relay (thermal type) for overload protection.

d) One (01) set of field flashing equipment consisting of the following:

- One (01) set of resistors to limit the field flashing current to the value required to raise the generator terminal voltage to 25% of rated voltage at no load.
- One (01) DC contactor, 2 poles, to automatically connect and disconnect the field flashing source.
- One (01) blocking diode to prevent reverse current into the field flashing source.

e) One (01) field over voltage relay front door mounted (EE).

f) One (01) DC shunt, suitably rated.

g) One (01) set of non-linear field discharge and surge suppression devices.

h) One (01) control power transformer, 3-phase (or 3 single phase transformers).

i) One (01) set of DC bus connect terminals.

j) One (01) set of field flashing source connection terminals etc.

3.19.4. REGULATOR AND SEQUENCING CONTROL

For ease of maintenance and to minimize time to repair, the regulator and sequencing control shall be digital (PLC) and an assembly of plug-in type printed circuit cards. Test points shall be provided on the front of each card so that circuit checks can be readily made while the equipment is operational. In addition, the card field assembly shall be front door mounted so that it shall not be necessary to open a cubicle door to make the regular circuit checks. The following functions shall be provided in the control system.

(a) Power Factor and Voltage Regulators

In the 'Power Factor' mode, the reactive component of generator current shall be compared to an adjustable DC reference and the amplified error signal shall be used to drive a motor operated potentiometer which raises or lowers the voltage regulator set point, thereby changing field excitation to obtain required reactive current loading. The "Power Factor" regulator shall maintain the reactive current loading on the generator within ± 5% without hunting under steady load conditions when the system voltage deviation does not exceed ± 10% from nominal.

The operation of the regulator, shall automatically be switched to 'Voltage' mode from 'Power Factor' mode whenever the unit breaker is open. Thus during the synchronizing period of time, the synchronizer can be used to drive the motor operated potentiometer to adjust the terminal voltage for synchronization.

In the 'Voltage' mode, from no-load to full load condition, the adjustable DC reference for the average generator 3φ terminal voltage and the amplified error signal applied to the excitation system shall maintain the generator terminal voltage within ± 0.5% under steady load without hunting. The range of control shall be ±10% of normal generator voltage.

The power factor and voltage regulator shall have reactive droop compensation.

(b) Field Current Regulator

The 'Field Current' regulating mode shall provide a back-up system for the 'Power Factor' and 'Voltage' regulators. In this mode, the generator terminal voltage shall be under the operator's manual control. Variations in system voltage which effect VAR loading must be compensated by adjustment of the 'Field Current' regulator set point. The range of control shall be from approximately 10% less than no-load field current to approximately 5% above maximum required field current.

(c) Selection of 'Power Factor', 'Voltage', and 'Field Current' regulating modes shall be via remote/local control. The control shall permit transfer when the unit is on-line.

(d) Minimum excitation limiter to automatically limit the decrease of generator excitation. The limiter shall hold the generator field current at a preset value determined from the reactive capability curve of the generator.

(e) Maximum excitation limiter to limit the field current after an adjustable time delay to prevent sustained field over current. The time delay shall be inversely proportional to rate of change in field current.

(f) An instantaneous over-current limiter shall be provided to prevent excitation from exceeding ceiling current.

AUTOMATIC VOLTAGE REGULATOR (AVR) shall have the following features:

- AVR shall be digital electronic type.
- The AVR shall have two operating Channels:
  1) Auto Channel (Two Channels – one main and one stand by)
  2) Manual channel

  Change-over from Auto to manual channel shall be bump-less.
- Auto mode may have three / two phases sensing. Voltage regulation at zero droop setting shall be better than 1%.
- Quadrature Droop Adjustability shall be up to 8% at rated reactive load.
- Manual Mode shall constantly follow auto mode and in case of failure of auto mode or if desired by operator, through a push button command, change over to Manual mode shall take place bump-less.
- Manual to auto mode changeover shall be possible through a null-balance mechanism. Null balance may be done between control signals or between final convertor outputs depending upon design.
- All components for auto and manual mode including power convertors and power transformers shall be separate, ensuring 100% redundancy.
- Auto mode shall have power factor controller for parallel operation with grid.
- There shall be reactive current export and import limits, which will give raise lower commands in both auto and manual mode.
- Auto mode voltage set point adjustability will be –15% to +10% of rated voltage.
- Manual mode shall be capable of supplying zero to 120% of rated excitation and shall hold excitation constant till it receives raise or lower command from operator or from internal VAR limiter.
- AVR shall have rectifier failure indication and two change-over contacts for trip and annunciation.
- The AVR shall be sensitive to the change of ± 0.25% of nominal voltage (average of 3 phases) of the generator when operating under steady load conditions for any load or excitation within operating range and shall initiate corrective action without hunting.
- After full load rejection, the AVR shall limit the maximum rise of terminal voltage to 20% of normal rated voltage and shall control the excitation at such a high speed so that the generator voltage settles down within ten (10) seconds to restore the terminal voltage to a value not more than ± 5% of the voltage being held before the

load rejection and shall maintain the voltage within these limits throughout the period of over speed.

- Necessary meters shall be provided on AVR panel with provision of remote monitoring.
- AVR panel shall have provision for self start on receiving signal from speed switch.
- The following features shall be provided with AVR.
  - Over frequency limit
  - Parallel compensation
  - Alarm indication for abnormal conditions
  - Over & under voltage protection
  - Soft start ability
  - Over & under excitation limit
  - Loss of excitation protection
  - Voltage matching
  - Auto synchronization with the grid through synchrocheck relay

3.19.5. CONTROL

Controls shall be microprocessor (PLC) based. The start-stop control shall be initiated for automatic start when the machine speed reaches a preset value, and for automatic shutdown whenever an 'OFF', 'Unit Breaker Trip' or 'Lockout' signal is received. The control shall be designed for a soft shut-down on a normal stop command, with the field current being reduced to zero by the phase control action of the rectifier before any circuit disconnect device operates.

The following controls and indicating meters shall be mounted on the control (provisions shall be made for remote control):

a) One (01) No. of 'power factor'/'voltage'/'field current' regulating mode selector switch.
b) One (01) No. of 'power factor set point adjust' switch with limit indicating lights.
c) One (01) No. of 'voltage set point adjust' switch limit indicating lights.
d) One (01) No. of 'field current set point adjust' potentiometer.
e) One (01) No. of remote / local transfer switch.
f) One (01) No. of field ammeter with isolating transducer for remote control.
g) One (01) No. of field voltmeter.
h) One (01) No. of stator voltmeter for showing generator terminal voltage.
i) One (01) regulator card file.
j) One (01) 12 point, substation monitor type Annunciator.

Following devices shall be mounted inside the control section.

a) One (01) set of auxiliary control relays.
b) One (01) no. of motor operated potentiometer with limit switches (when remote control is less than 45 meters).
c) One (01) set of required power supplies and auxiliary power transformer.
d) One (01) set of generator terminal voltage auxiliary PTs (110V AC open delta signal required).

e) One (01) No. of moulded case type control power breaker, 3-phase, single throw manually operated for station control power.

f) One (01) set of terminal blocks for control connections.

Terminal blocks shall be rated at 1.1 kV, 30 Amp minimum, except terminal blocks for signal wires which may be rated at 600 volt, 20 Amp. Each point shall be marked with the wire number. Ten percent (10%) extra terminal blocks shall be provided.

3.19.6. WIRING

The excitation equipment shall be completely factory assembled and wired. Wiring shall be neatly arranged and properly supported. Control wires shall be 2.5 mm^2 and signal wires shall be 1.5 mm^2 switchboard control wire. PT wires shall be 2.5 mm^2 and CT wires shall be 4 mm^2 switchboard wire. Power cables field flashing and field suppression circuit wires shall be extra flexible and properly sized according to the application requirement. Shielded or twisted pair of 1.5 mm^2 wires shall be used in low signal level. Wire markers shall be used at each termination of a wire except for card field wiring.

3.20. COOLING WATER SYSTEM

See **Cl. No. 2.25** – of this technical specification.

3.21. NEUTRAL GROUNDING SYSTEM (NGS)

Included in **Chapter – 4** of this technical specification.

3.22. LAVT CUBICLE

Included in **Chapter – 4** of this technical specification.

3.23. CURRENT TRANSFORMER (CT)

The current transformers shall be epoxy cast resin, dry type units conforming to IS: 2705 (latest edition). The current transformers shall be designed to withstand the thermal and magnetic stresses resulting from the maximum shot circuit current.

The accuracy class shall be 0.2 for metering and 5P20 / PS, as required, for protection. The CT locations, rating, accuracy class shall be suitable for adequate metering and protection. Details of CTs are mentioned in **Chapter – 4** as well as in the **Plant Single Line Diagram (SLD).**

3.24. POTENTIAL TRANSFORMER (PT)

One (01) set of Potential Transformer (for each unit) shall be provided in the 11 kV generator output line. The potential transformers shall be epoxy cast resin type and shall conform to IS: 3156 (latest edition).

The accuracy class shall be 0.2 for metering and 3P for protection. The PT locations, rating, accuracy class shall be suitable for adequate metering and protection. Details of PTs are mentioned in **Chapter – 4** as well as in the **Plant Single Line Diagram (SLD).**

3.25. CONTROL, METERING, INSTRUMENTATION AND SAFETY DEVICES

Each Generator shall be supplied with all equipment and devices for control, instrumentation and safety related to generator for normal and emergency operation. The minimum requirement is enclosed in the Annexure. The schedule shall be finalized during detailed engineering stage after considering manufacturer's recommendation. Any additions in the schedule shall be without price implication. The system shall be computerized and be able to communicate with the turbine governing and monitoring system. The system shall be compatible with SCADA.

3.25.1. GENERATOR PROTECTION

The following minimum protections shall be provided with each Generator:

- 3φ time delayed over current relay (51)
- Instantaneous over current relay (50)
- IDMT earth fault relay (51N)
- Generator differential relay (87G)
- Fuse failure relay (60)
- Negative phase sequence relay (46)
- Reverse power relay (32)
- Stator earth fault relay (64S)
- Field failure relay (40)
- Over voltage relay (59)
- Under voltage relay (27)
- Over flux relay (24)
- Winding temperature (RTD) relay (49G)
- Bearing oil temperature (RTD) relay (26G)
- Over speed relay (12G)
- Trip circuit supervision relay (95)
- Synchro-check relay (25) (synchronizing panel)
- Lock out relay (86)
- Any other protection as recommended by generator manufacturer

All the protective relays shall be of Numerical type with high reliability. The supplier / manufacturer shall be responsible and suggest suitable scheme required for the generator protection keeping modern trends in view. The final scheme will be decided by the employer in consultation with the manufacturer / supplier during detailed engineering stage. All signals of protection instruments shall be available for back feed signal contacts, potential free and interchangeable.

3.25.2. METERING FOR GENERATOR

The following metering shall be provided with each Generator:

- Ammeter with ammeter selector switch
- Voltmeter with voltmeter selector switch
- Multifunction Meter (MFM) for measuring frequency, power factor, kW, kWh, kVAR, kVARh etc. Although current and voltage are measured in MFM, separate

Ammeter with ammeter selector switch and Voltmeter with voltmeter selector switch shall be provided.

All the meters shall be of high accuracy class and compatible of 1 A CT secondary current.

3.25.3. PROTECTIVE AND METERING EQUIPMENT FOR GENERATOR

All the meters and relays for Generator feeders shall be installed in a separate compartment of respective 11 kV indoor switchgear panel as detailed in **Chapter – 4.**

The whole system shall be compatible with Supervisory Control and Data Acquisition System (SCADA).

Necessary control signals shall be fed to the Unit Control Panels (UCP). Two (02) nos. of Unit Control Panels (one for each generating unit) shall be provided.

3.26. TESTS

3.26.1. TYPE TESTS ON FIRST UNIT (AT MANUFACTURER'S WORKS)

The generator shall be completely assembled at manufacturer's works and Type Tests as per latest edition of IS: 4722 or equivalent International Standards shall be carried out on first generator and auxiliaries. Material tests on all important castings, forgings and fabricated steel work and important welded positions, assembly tests, dimension check, efficiency measurement etc. shall be carried out by the manufacturer following relevant standards.

3.26.2. ROUTINE TESTS ON ALL GENERATORS

Each generator shall be tested for routine tests as per IS: 4722 in assembled condition as detailed below:

- Check on physical dimensions and general arrangement
- Measurement of winding resistance
- Temperature rise tests (stator & rotor winding and bearing oil temperature)
- Dielectric test
- Measurement of Insulation Resistance (before and after dielectric test)
- Model test for efficiency
- Short circuit withstand test and measurement of reactance and time constants
- Phase sequence test and direction of rotation
- Regulation test
- Over speed test at maximum runaway speed on specified direction.
- Determination of deviation of voltage wave form desired sinusoidal waveform
- Measurement of leakage reactance and potier reactance
- Measurement of open-circuit characteristics
- Measurement of short-circuit characteristics
- Measurement of bearing current
- Load acceptance and rejection tests at selected load from 'no load' to 'full load & maximum load'

- Accuracy tests for RTDS and dial type thermometers
- Pressure tests on oil and air coolers, if applicable
- Static flux test on unwound stator frame and core assembly
- Additional Tests as recommended by the manufacturer and as desired by the employer, as mutually agreed between employer and contractor.

Tests shall be carried out in presence of Employer or his authorized representative. The contractor shall finalize the Quality Assurance Plan (QAP) in consultation with the manufacturer and make arrangement for the authorized representatives of the Employer. The Employer has the right to refuse routine tests if major deviations from type tests occur.

3.26.3. TESTS ON ROTATING EXCITERS AND REGULATING EQUIPMENT

- HV tests on exciter
- Temperature rise tests
- Measurement of resistance
- Measurement of Insulation Resistance
- Excitation response test
- Additional Tests as recommended by the manufacturer and as desired by the employer, as mutually agreed between employer and contractor.

3.26.4. ADDITIONAL TESTS

After delivery and installation of the Generators and auxiliaries at site, in addition to the aforementioned routine tests, following site tests shall also be carried out during Trial Run and Commissioning:

- Mechanical Run Tests after coupled to turbine for forty eight (48) hours
- PIV test
- Measurement of shaft voltage
- Measurement of vibration & noise level
- Measurement of Earth Resistance between Neutral & Power-house Earth-pit.
- Tests for overall response of machine and excitation system to grid voltage variation
- Adjustment of AVR tests
- Synchronization tests
- One hundred (100) hours test at Class – B temperature limits (50 hours at rated load and 50 hours at maximum load) to show rated and maximum output on the machine before releasing for commercial operation
- Efficiency tests at 60%, 80%, 100% and 110% load condition as per **Cl. No. 3.11, 3.12 and 3.13** mentioned above
- Checking and commissioning tests on all auxiliary equipment
- Additional tests as recommended by the manufacturer and as desired by the employer, as mutually agreed between employer and contractor.

During onsite test, torque must be measured as well. Tests on other auxiliary equipment like current transformers, potential transformers, lightning arresters etc. shall comply with the routine tests, as per respective relevant standards.

3.27. TESTING EQUIPMENT

All testing equipment including HV test kit and vibration measurement equipment required for testing of the generator at site shall be provided by the contractor free of charge on returnable basis. In the event of repeated testing becomes necessary, the entire expenditure on such repeat tests shall be borne by the contractor.

All Testing Equipment shall have the up-to-date calibration certificate. The contractor needs to furnish the same to the employer prior to starting of testing at site as well as at manufacturer's works, whatever the case may be.

3.28. CHARACTERISTIC CURVES

The generator characteristic values for determination of performance shall be arrived through 'circle diagram method' or 'equivalent circuit method' after conducting all tests on the generator even though they are not been specifically mentioned above.

After full cycle of testing of the machine, the Contractor in consultation with the manufacturer shall determine and furnish the following documents to the Employer:

- ✓ Equivalent circuit of the generator
- ✓ Phase diagram
- ✓ Performance characteristics like:
  - Load versus Efficiency
  - Load versus Power factor
  - Load versus Magnetizing kVAR
  - Load versus kVA
  - Load versus kW Output
  - Load Current etc.

3.29. ERECTION, TESTING AND COMMISSIONING

The Generator shall be supplied with foundation frame, sole plates, foundation bolts, jack bolts, pads and other requisite equipment for site erection and alignment. In case any of the equipment damaged during installation of the unit, the contractor shall arrange the respective new equipment from the manufacturer at his own cost and risk.

The contractor shall depute experts to carry out erection, testing and commissioning of generators and other associated auxiliary equipment and duly hand over the same after satisfactory commissioning tests to the employer. The Contractor shall train the staff of the employer for operation and maintenance of the plant.

3.30. DOCUMENTS TO BE SUBMITTED AFTER PLACEMENT OF LOA

- Guaranteed Technical Particulars (GTP) as per **Chapter – 20 (Cl. No. 20.2).**
- Name of manufacturer proposed by the contractor for each item / equipment as per **Cl. No. 3.32**.
- Performance certificates of proposed manufacturers as per **Cl. No. 3.33.**
- All Type test reports of each similar rated products of the proposed manufacturer.
- Routine Test Report / Shop Test Report of each similar rated products of the proposed manufacturer performed earlier.

- Test facilities at manufacturer's test house.
- Tentative Layout drawings of the generator and auxiliaries matching with that of turbine and associated auxiliary and ancillary equipment.

3.31. DOCUMENTS TO BE SUBMITTED DURING DETAILED ENGINEERING STAGE

Six (06) sets of data sheet, manual, leaflet, drawing and other documentation as mentioned below for Generator and auxiliaries shall be submitted to the Controlling Officer of the employer for according approval during detailed engineering stage.

A. General layout and assembly drawings showing overall dimensions of the generators indicating stator, rotor, shaft and bearings and positions of main and neutral terminals, neutral groundings cubicles, cable boxes etc.
B. Lubrication system details & description
C. Physical and schematic drawings of excitation system, automatic voltage regulator (AVR), automatic power factor regulator (APFR) with descriptive literature
D. Characteristics curves as per **Cl. No. 3.28**.
E. Drawings for connection of winding and bearing oil temperature detectors
F. All Construction Drawings including equipment foundation details etc.
G. Detailed time schedule indicating submission of drawings, tentative date of inspection, delivery of items, installation, testing, trial run & commissioning.
H. Detailed Bill of Material (BOM) which shall include the spare parts for five (05) years of trouble-free operation & maintenance of the above system as per **Cl. No. 19.3** and special tools, plants and equipment as per **Cl. No. 19.15**.
I. Detailed Quality Assurance Plan (QAP) for model test, routine / shop test and field acceptance test including efficiency test
J. Loads & moments during short circuits to enable civil foundation design
K. Design calculations for arriving at important parameters of the generator like stress analysis of stator frame, poles, head covers, brackets etc.
L. Details of foundation frame, erection method and any special grouting procedures that to be followed for base frame for erection of generator.
M. Single line diagram
N. Control circuit diagram
O. Drawing showing lifting arrangements of stator and rotor.
P. Input-Output details of AVR
Q. Details of integration with SCADA etc.
R. A list of all tools, devices and instruments, necessary for field acceptance tests.
S. operation & maintenance manual for the generator and its associated equipment

After approval, six (06) sets of approved drawings and documents along with soft copies for Generator and auxiliaries shall be submitted to the controlling officer of the employer.

Further, the contractor shall submit three (03) sets of successful shop / routine test reports to the controlling officer of the employer prior to dispatch of each item / equipment.

3.32. MAKE OF COMPONENTS

The contractor shall submit proposed make of various components of the generator and auxiliaries after placement of LOA. Final make shall be approved by the employer during

detailed engineering stage based on the performance certificates submitted by the contractor. For approved makers list of WBSEDCL for various components, the bidders are requested to go through **Chapter – 21** of this Technical Specifications.

3.33. CREDENTIALS AND PERFORMANCE CERTIFICATES

The contractor shall submit Performance Certificates issued to the proposed manufacturers by the respective employer for similar kind of job. The contractor shall also furnish documents in support of supply, delivery of similar equipment / system indicating thereon names of the organization, quantity ordered and quantity supplied along with their submission after placement of LOA. Non-submission of the same will be liable for rejection of the proposed manufacturers.

3.34. GUARANTEES

Further to the standard conditions for delivery and manufacturing, the contractor shall be obliged to provide the following assurances and guarantees:

- Efficiency and Output guarantee as per **Cl. No. 3.11, 3.12 & 3.13**.
- The contractor shall be liable for any damages to property and personnel during erection, trial runs and guarantee periods caused to the client or a third party due to proven fault by the contractor or any employee and/or sub-contractors engaged by him for carrying out his work. Production and profit losses are excluded from the above liability.

3.35. COMPLETENESS OF EQUIPMENT / SYSTEM

All items, equipment, fittings and accessories etc. for any specified equipment / system that may not be specifically mentioned in the specification but necessary for completeness of the system shall be deemed to be covered under the scope of this contract. No extra charges will be paid to the contractor for the same.

3.36. SCHEDULE OF REQUIREMENTS

3.36.1. GENERATOR AND ASSOCIATED EQUIPMENT

Sl. No.	Description	Quantity
1	3 φ, horizontal shaft, 11 kV, 50 Hz., 600 rpm / 750 rpm, synchronous generator with rated output of 5000 kW / 5883 kVA and maximum output of 5500 kW / 6471 kVA (@110% of the rated output), power factor (cos ϕ) = 0.85 (lagging) (adjustable with excitation) complete with all required accessories as detailed in this technical specification	Two (02) sets
2	Instruments, controls and safety devices	As required
3	Cooling water pumps (2 nos.), strainers, valves, piping, gauges, flow relays etc. with associated equipment	One (01) Lot
4	Special tools, plants and equipment as per **Cl. No. 19.15**	As required
5	Spare parts as per **Cl. No. 19.3**	As required

Sl. No.	Description	Quantity
6	Completeness of equipment / system as per **Cl. No. 3.35**	As required

3.36.2. INDICATING, CONTROL AND SAFETY DEVICES

Sl. No.	Items	Type	Location
A	**Indicating Devices**		
A.1	Temperature of stator core, winding, and stator teeth	RTDs	UCP / OWS
A.2	Temperature of bearings	DTT / RTD	Local / UCP
A.3	Temperature of bearing oil	DTT / RTD	Local
A.4	Level of oil in bearings	Sight glass Level relay with contact	Local UCP
A.5	Flow of water in bearing coolers	Sight glass window Flow relay	Local UCP – Alarm
A.6	Status Indications i) Generator brakes Ii) Generator heaters iii) AVR iv) Generator breaker	Indicating Lamps	Local / UCP
A.7	DC voltmeter and ammeter	Indicating Instruments	Local / UCP
A.8	Various electrical meters like voltmeter, ammeter, multi-function meter etc.	Indicating instruments	UCP
A.9	Generator hot air, cold air temperature	RTD	UCP
A.10	Rotor Temperature measurement	-	UCP / OWS
B	**Controls**		
B.1	Local / UCP / OWS control centre selection	Selector switch	UCP
B.2	Auto / manual selection of AVR	Selector switch	UCP
B.3	Manual raise / lower control of AVR	Control switch	Local
B.4	Field breaker ON / OFF	Push button	Local / UCP / OWS
B.5	Main Breaker ON/OFF	Push button	Local / UCP / OWS
B.6	Governor speed / load raise / neutral / lower selection	Spring return switch	UCP
B.7	Synchronizing selection OFF /	Selector switch	UCP

Sl. No.	Items	Type	Location
	manual / check / auto		
B.8	Needle opening and limiter position indicator	Indicator	Local / UCP
B.9	Speed of unit	Tachometer	Local / UCP / OWS
B.10	Speed setting	Indicator	Local / UCP / OWS
B.11	Needle setting	Indicator	Local / UCP / OWS
B.12	Governor balance	Indicator	Local / UCP / OWS
B.13	Control position selection for unit	Selector switch	Local / OWS
B.14	Start / stop of unit	. Push button / control	Local / UCP / OWS
B.15	Auto / manual selection for brake application	Selector switch	UCP
B.16	Manual start / stop operation of brakes	Push button	Local / UCP
B.17	Emergency stop of unit	Push button	Local / UCP / OWS
B.18	Control action shut down	Push button	Local / UCP / OWS
B.19	Additional controls	As required	As required
B.20	Wrenches, tools and special devices as required	One (01) set	As required
B.21	Pressure gauges, oil level indicators as required	One (01) set	As required
B.22	Vibration & run-off measurement device etc.	One (01) set	As required

4.11 KV INDOOR SWITCHGEARS AND STATION AUXILIARY TRANSFORMER

4.1. SCOPE

This specification covers the Design, manufacture, shop testing at manufacturer's works before dispatch, supply, delivery at site, transit insurance, storage at site, erection, testing & commissioning of indoor type 12 kV Metal Enclosed Switchgear Panels and Station Auxiliary Transformer for Lodhama-II Small Hydro-electric Power Project, at power house elevation of 1066.55 m above MSL.

The scope of supply shall also include spares, special tools and testing devices, which are essential for installation, operation and maintenance for five (05) years trouble free operation of the plant, even though these are not individually or specifically stated in this specification but recommended by the respective manufacturers. All the material & workmanship shall be of suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

4.2. STANDARDS

The equipment covered under this specification shall comply with the requirement of latest edition of following IS/BS/IEC specifications as amended up to date except where specified otherwise.

Sl. No.	Standards	Description
1	IEC: 60694, IEC: 60298, IEC: 62271-200, IEC: 60529. IS: 3427, IS: 12729, IS 12063, IS:13947, IS: 9046	AC metal enclosed switchgear & control gear for rated voltages above 1 kV & up to & including 52 kV.
2	IS: 13947	Degree of protection provided by enclosures for switchgear.
3	IS: 1901	Specification for visual indication lamps
4	IS: 5	Colors for ready mixed paints & enamels
5	IEC: 62271-100, IS: 13118, IS: 2516	High voltage AC circuit breakers
6	IEC 60056	Vaccum interrupter
7	IEC: 60185, IS: 2705 - (Part I to IV)	Current transformers.
8	IEC: 60185, IS: 3156 - (Part I to IV)	Voltage transformers.
9	IEC: 60694	Common clauses for high voltage switchgear & control gear
10	IS: 1248	Indicating electrical measuring instruments
11	IS: 8084	Inter connecting bus bars for AC voltage between above 1 kV up to and including 36 kV

Sl. No.	Standards	Description
12	IS: 8686, IS: 3231, IS: 3842	Electrical relays for power systems
13	IEC: 99-4	Metal oxide surge arresters without gates for AC systems
14	IEC: 62271-102	Alternating current disconnectors and earthing switches
15	IS: 6875	Control switches and push buttons
16	IEC: 61000	Electromagnetic compatibility
17	IS: 375	Arrangement of switchgear bus bars, main connection and auxiliary wiring
18	IS: 6005	Code of practice for phosphating iron & steel
19	IS: 1180	Distribution transformer
20	Indian electricity rules 1956	
21	Indian electricity act 2003	

4.3. UNIT OF MEASUREMENT AND LANGUAGE

In all correspondence, technical schedules and drawings prepared by the manufacturer, the metric units of measurement shall be used. On drawings or printed pamphlets where other units have been used, the equivalent metric measurements shall be added. All documents, correspondence, drawings, reports, operating and maintenance instructions / manuals and nameplate details of the equipment shall be in English language.

4.4. SPECIFIC TECHNICAL REQUIREMENTS / PARAMETERS OF 11 KV INDOOR SWITCHGEAR

4.4.1. PANEL CONSTRUCTION

Sl. No.	Item	Details
1	Nominal system voltage	11 kV
2	Highest system voltage	12 kV
3	Make	Authorized System Integrator of VCB Manufacturer will be allowed subject to compliance of Cl. No. 4.9, 4.10 & 4.15 of Volume-6: Part III
4	Type of installation	Indoor
5	Enclosure type	Dead front, floor- standing, rigid welded steel frames fully compartmentalized, metal clad, vermin proof, suitable for indoor installation and provision for bolting to the floor.

Sl. No.	Item	Details
6	Degree of protection (min.)	IP 42
7	Enclosure material	CRCA steel / Alu-zinc
8	Metal sheet thickness	2.0 mm (min.)
9	Gland plate (detachable type)	3.0 mm MS, detachable type for 3 core cable and 5.0 mm, Aluminium for single core cables. Cable compartment shall have an anti vermin guard plate for protection against entry by rats, rodents etc.
10	Compartment	Switchgear design shall comprise of fully compartmentalized execution having separate vertical sections for each circuit. Separate segregated compartments of earthed metal partitions shall be provided. There will be five (05) nos. of compartments. • Two (02) nos. for generator incoming feeder (11 kV VCB), • One (01) no. for outgoing feeder to main transformer (11 kV VCB), • Two (02) nos. for station auxiliary transformers (11 kV Load Break Switch), The system shall comprise of CTs, bus PTs (2 nos.), cables, meters, relays etc. Each compartment shall be separated from adjacent one by sheet steel barrier. Hylam sheet shall not be accepted for partition.
11	Breaker to bus bar compartment	Through seal off bushing
12	Breaker to cable compartment	Through seal off bushing
13	Breaker compartment door	Separate with lockable handle
14	Pressure relief devices	To be provided for each HV compartment
15	Bus support insulator	Non hygroscopic, track-resistant, high strength, epoxy insulators (calculation for validating dynamic force withstand capability to be submitted by the contractor during detailed engineering stage)
16	Fixing arrangement i. Doors ii. Covers iii. Gasket	Concealed hinged bolted with SS bolts and neoprene rubber gasket, washer
17	Required HV cable termination height in the cable	550 mm
18	Panel base frame	Steel base frame as per manufacturer's standard

Sl. No.	Item	Details
19	Handle	Removable bolted covers for cable chamber and bus bar chamber shall be provided with C type handles
20	Prevention of internal arc	Shall be type tested against internal arc as per provision in IEC: 62271-200. The circuit breaker, bus bars and cable compartments shall be provided with arc venting outlet. The doors for the compartments shall be capable of withstanding the effects of maximum internal arcing fault without being blown off and causing danger to personnel and other equipment This should be proven by successful testing as per relevant IEC standard.
21	Cable tray	Netted metal cable tray of suitable size at the rear side of switchgear, preferably running at the top along the panel for carrying the signal cables for SCADA interface to be provided.
22	Space heater	Thermostat control space heater with switch for isolation to be provided in breaker, HT cable & instrument compartments.
23	Multi-way terminal Block and low voltage wiring	Delinking type, rail/channel mounted, terminal connector to be used in CT circuit & screw type for other circuits. The Terminal Blocks should be suitable for respective wire sizes and covered with insulated transparent cover. Pitch should be minimum 8mm & 10mm for screw type & delinking type connectors respectively. The LV cable shall be enclosed in grounded metal conduit when routed through a HV compartment. Control wiring shall be neatly bundled and tie wrapped where applicable. Wiring shall be protected from rubbing against door flanges or other parts of the enclosure. Min. 100 mm clearance to be maintained between two rows of Terminal Block. 25% spare terminal blocks shall be provided.
24	Ferrules	a) Plastic ferrules conforming to IS to be used. Same marking is to be used at both ends of wires. b) Ferrule markings will be as follows : AC Circuit: H1, H2, H3 - - - - - Metering circuit: D11, D31, D51 - -

Sl. No.	Item	Details
		Protection Circuit: C11, C31, C51 - - REF / Differential protection CT Circuit: A11, A31, A51 - - Main DC Circuit: J1, J2, J3 - - - - - - DC Control Circuit: K1, K2, K3 - - - - Indication Circuit: L1, L2, L3 - - - - - Motor Circuit: M1, M2, M3 - - - - PT Circuit: E11, E31, E51 - - - Spare circuit: U1, U2, U3 - - - - - c) Plastic channels, inter panel wiring through PVC sleeves / suitable grommets
25	Earth bus	A ground bus rated to carry maximum fault current shall be furnished along the full length of the panel board. Each stationary unit shall be grounded directly to ground bus. All bolted joints in the bus will be made by connection of two bolts. The earth bus shall be of electrolytic copper, rectangular shape with adequate cross sectional area (50 x 6 mm min.) and shall be capable of 25 kA for 3 Sec fault level. Earthing conductors shall be of annealed high conductivity stranded copper.
26	Internal wiring	a) 1.1 kV grade PVC insulated stranded flexible copper wire to be used. b) Size of wire will be as follows: CT circuit : 4.0 sq. mm. PT circuit : 2.5 sq. mm. Main AC & DC circuit : 4.0 sq. mm. Other circuit : 1.5 sq. mm. c) A suitable wiring duct system with covers, firmly fixed on the panel shall be installed for front to rear and inter panel wiring to offer ease in inspection and maintenance. d) Wiring between terminals of the various devices shall be point to point. Splices or tee connection will not be acceptable. e) Wires shall be suitably bunched adequately supported to prevent sagging and it shall have sufficient clearance from High voltage system. f) Colour of wires will be as follows: For CT & PT circuit: R Phase: Red, Y Phase: Yellow, B Phase: Blue, Neutral: Black For DC circuit: Grey For Earth circuit: Green.

Sl. No.	Item	Details
27	Power switch & socket	5 Amp rated power socket & switch to be provided in instrument compartment
28	Illuminating lamp	9 Watt, LED type
29	Surface cleaning	Seven tank process or sand blasting
30	Painting	Powder coating with texture finish, minimum thickness of 50 microns
31	Paint shed	RAL 7032
32	Guarantee of the complete equipment	Five (05) years from the date of commissioning of the equipment
33	Elevation at which installed	EL 1071.55 m
34	Rated current at 11 kV Bus @ 50^0C ambient	1250 A
35	Auxiliary DC supply	110 V DC, shall be controlled by suitably rated MCB / MCCB.
36	Auxiliary AC supply	240 V, 50 Hz, shall be controlled by suitably rated MCB / MCCB.
37	Cable Entry	From bottom for power cable, through remote terminal box installed at the backside of the panel for control cables.
38	Interchangeability	All corresponding components of the circuit-breakers and switchgear of same rating shall be fully interchangeable
39	Dummy panels	Dummy panels, if required for cable termination purpose, shall be automatically included by the contractor. Any ad-hoc arrangement such as extension chamber at the back or bottom shall not be accepted.

4.4.2. BUS BAR

Bus bars and all other electrical connections between various components shall be made of electrolytic copper, tinned / silver plated of adequate cross-section. The bus bar section shall be of ample capacity to carry the rated continuous current of 1250 A, without excessive heating and for adequately meeting the thermal and dynamic stresses in the case of short circuit in the system up to highest fault MVA.

All bus bars shall be rigidly and firmly mounted. Spacious bus bar chamber shall be provided with use of tubular bus bar design and free from any high voltage stresses by avoiding all sharp edges and bringing them to uniform potential. Three phase bus and riser shall be adequately insulated with fire retardant non-hygroscopic anti-tracking tape / sleeve for rated voltage. Sleeve shall be heat shrinkable BPTM type of Raychem make. Bus bar shall be extensible on either side.

Bus bar shall be located in a separate metal clad chamber and shall be air insulated. It shall be adequately supported on insulators or integral epoxy spouts to withstand dynamic stress due to the short circuit current as specified.

The Bus Bar / Cubicle shall conform to the following:

Sl. No.	Item	Details
1	Material	Electrolytic copper, tinned / Silver plated
2	Size	The contractor shall furnish calculations establishing adequacy of bus bar sizes for specified current ratings / fault levels. If the calculated cross section size is less than 500 mm^2, minimum 500 mm^2 shall be provided.
3	Bus Bar sleeve	Full voltage sleeved with shrouds on joints
4	Bus identification	Colour coded (R-Y-B)
5	Bus end connection	To be capable to safely withstand stress due to max. short circuit current and thermal expansion. Necessary provision to be made for testing current transformer primary by removing insulated portion without difficulty.
6	Maximum ambient temperature for design purpose.	40^0C
7	Maximum temperature rise over ambient temperature	As per IEC: 60298 40^0C for conventional joints, 55^0C for silver plated joints
8	Minimum clearances in air (phase to earth) (without insulating sleeve)	90 mm + Correction for high Altitude
9	Minimum clearances in air (phase to phase) (without insulating sleeve)	110 mm + Correction for high Altitude
10	Minimum nominal creepage distance	19 mm/kV
11	Short time current rating for 3 sec.	25 kA
12	Rated power frequency withstand voltage (rms)	28 kV
13	Rated lightning impulse withstand voltage (peak)	75 kV
14	Continuous Current Rating (Bus bar)	1250 Amps
15	Current Density	1.6 Amp / sq.mm. (max.)
16	Correction due to high altitude	As per Relevant IS

4.4.3. CIRCUIT BREAKERS

The 11 kV Circuit Breaker shall be triple pole horizontal drawing out type suitable for installation in the switchgear cubicle. The breakers shall comply with IEC: 62271-100 / IS: 13118 / IS: 2516 conforms to latest amendment thereof.

The circuit breaker shall be spring operated, motor charged, manually released spring closing mechanism with three pole simultaneous operation. The indicating device shall show the OPEN and CLOSE position of breaker visible from front of the cubicle. The spring charging time of the motor shall not exceed 15 sec. The "TRIP" and "CLOSE" coils shall be of reliable design and low consumption preferably less than 300 W. It shall be possible to manually charge the circuit breaker operating spring in case of auxiliary supply failure.

The breakers shall be capable of making & breaking the short time current in accordance with the requirement of IEC: 62271-100 / IS: 13118 / IS: 2516 conform to latest amendment thereof.

The circuit breaker shall be isolated by horizontal racking and positively fixing the unit into any one of the following positions:

- **Service Position:** Main and auxiliary circuits connected
- **Test Position:** Main circuits disconnected, auxiliary circuits connected. Circuit breaker in its isolated position shall be completely contained in the apparatus compartment with shutters on main circuit and compartment front door closed.
- **Withdrawn Position:** Main circuits and auxiliary circuits disconnected. Circuit breaker is removed out of the cubicle

Locking of circuit breaker in the test position shall be made possible by means of key lock on the earth switch maneuver. A position indicator switch or viewing window must be provided for visual indication of the circuit breaker position.

Each circuit breaker shall be provided with following accessories.

- ON-OFF Indicator for indicating circuit breaker position.
- Trip push button
- Shunt trip coil, operating between 70 % – 110 % of rated control voltage.
- Close coil, operating between 85 % – 110 % of rated control voltage.
- Spring charging motor, operating between 90 % – 110 % of rated control voltage.
- Two trip coils and one closing coils shall be provided in all the breakers.

The switchgear shall be provided with facilities for full operation from a remote point. For local operation of circuit breakers, control switch of circuit breaker shall be located at such a height so that a man can operate standing on ground / floor. It shall be possible to trip the circuit breaker locally by mechanical means.

The circuit breaker truck shall ensure earth in both connected and disconnected positions.

An electro-mechanical device shall be provided to ensure the auxiliary circuits have been securely connected between the fixed and moving portions of the switchgear, before allowing closing operation of the circuit breaker. The voltage rating of the device shall be the same as the voltage used for the closing circuit.

Tripping and/or release coils shall be continuous rated to ensure longer life but rating should not exceed 300 W each. The electrical tripping device shall be of a type which

acts directly on the circuit breaker mechanism and shall give positive operation for a supply voltage of 70 % of nominal at DC and 85 % of nominal at AC control voltage.

Comprehensive interlocking system to prevent any dangerous or inadvertent operation shall be provided. Each circuit breaker shall be interlocked to prevent:

- the breaker being inserted into service position unless it is open
- the breaker being withdrawn from the service position unless it is open
- the breaker being closed unless it is fully in the service or test position
- remote operation whilst in the withdrawn / test position

Circuit breakers shall be mechanical latching and electrical and mechanical tripping. The operating mechanism shall be trip-free and shall include an anti-pumping device.

Circuit Breaker compartment should have automatic shutters, which shall be opened and closed by the mechanical drive of the circuit breaker. The bus bar and circuit spout covers shall be operated independently of each other. Padlock facilities can be provided on the metal shutters.

The Circuit Breakers shall have the following ratings:

Sl. No.	Item	Details
1	Type	Vacuum Circuit Breaker (VCB)
2	No of Poles	Three (03)
3	Nominal System Voltage	11kV
4	Highest System Voltage	12 kV
5	Installation	Indoor
6	Altitude above mean sea level (meter)	1071.55
7	System neutral earthing	Earthing transformer
8	Insulating level 1.2/50 micro- Sec impulse withstand volt. (between line & earth)	+/- 75 kVp
9	1 min power frequency withstand voltage between line & earth (dry & wet)	28 kV rms
10	Rated continuous current	1250 Amps: 1 No. 630 Amps: 2 Nos.
11	Short time withstand current	25 kA for 3 sec.
12	Short circuit making current	100 kA
13	Min. creepage distance between phase to ground and between CB terminals	19 mm / kV
14	Break time	Less than 80 ms
15	Make time	Less than 100 ms
16	Operating cycle	Min. 10000 operating cycles
17	Operation counter	Mechanical operation counter to be provided in the breaker trolley with count range 0 to 9999.

Sl. No.	Item	Details
18	Operating mechanism	Duty cycle O- 0.3 sec-CO-3 min-CO
19	Control voltage	110 V DC (+ 10 % to – 15 %)
20	Range of auxiliary voltage	
	Closing	85 % - 110 %
	Tripping	70 % - 110 %
	Spring charging	85 % - 110 %
21	Total opening time	Not more than 4 cycles
22	Total closing time	Not more than 5 cycles
23	Method of isolation from switchgear	Trolley mounted draw out type
24	Electrical indication	CB ON, CB OFF, Spring Charged, CB in test / service position, flush mounted type high intensity, clustered LED lamps to be used. Colour of the lamps will be as follows: a) Breaker ON : Red b) Breaker OFF : Green c) Spring charged : Blue d) Auto trip : Amber e) Test / Service position : White
25	Anti pumping	Anti Pumping Relay (94) to be provided in the breaker panel. PLA type relay / contactor is not acceptable.
26	Local remote selector switch	Switch should be 4 pole 2 ways lockable and stay put type
27	Operating mechanism	Spring / Spring
28	Mode of operation	Gang operated
29	Minimum number of spare contacts	6 NO + 6 NC
	No. of spare contacts of service and test position limit switch contact	2 NO + 2 NC
	No. of spare contacts of spring charge limit switch	2 NO + 2 NC
30	Spring charge limit switch	The circuit breaker shall be provided with motor operated spring charged closing. Spring charging by motor should be smooth and hassle free and there should be nominal sound during spring charging. Motor should be 230 Volt AC operated. Tripping of

Sl. No.	Item	Details
		the circuit breakers shall be through "shunt trip" coils rated for 110 V DC auxiliary supply. It shall be possible to trip the breaker manually in case of necessity. 2 NC : For motor circuit 1 NO : For breaker closing circuit 1 NO : For breaker closing permissive to be used in relay 1 NO : For panel spring charged indication AC operated contactor may be used for contact multiplication of limit switch, if required, for indication and spare contacts.
31	Breaker electrical operation features	
	Trip coil supervision	To be given for breaker close and open condition
	Trip coil supervision relay contact	For indication and alarm
	Master trip relay (NO) contact	Wired directly to trip coil
	Master trip relay (NC) contact	Wired to inhibit closing of breaker
	DC control supply and AC supply bus in all panels	Single DC and AC Incoming source shall be fed in all Incomers. Isolating fuse units shall be provided for incoming supplies to each switchgear unit.
	Emergency trip push button contact	Wired directly to trip coil of breaker
	PT supply in all panels	Fed by 11 kV line PT (each unit)
32	Functional requirements (interlock and safety devices)	
	Breaker compartment door opening	Can't be opened unless breaker is OFF and racked out to test / isolated position
	Breaker compartment door closing	Shall be possible even when breaker in isolated position
	Racking mechanism safety interlock	Mechanical type
	Racking in or out of breaker inhibited	When the breaker is closed
	Racking in the circuit breaker inhibited	Unless the control plug is fully engaged
	Disconnection of control plug inhibited	As long as the breaker is in service position

Sl. No.	Item	Details
33	Additional Requirement	
	Exposure to live parts	In case the breaker panel door is required to be opened during a contingency, the personnel should not be exposed to any live parts. Suitable shrouds / barriers / insulating sleeves should be provided as required.
	Operation of breaker in local	In either service or test position
	Operation of breaker in remote	Only in service position
	Protection trip	Both in local and remote position of LR switch
	Closing from local	Only when local/remote selector switch is in local position
	Closing from remote	Only when local / remote selector switch is in remote position
	Tripping from local	Selector switch in local
	Tripping from remote	Selector switch in remote position
	Testing of breaker	In test or isolated position keeping control plug connected

PARTICULARS FOR VACUUM BOTTLE:

Sl. No.	Item	Description
1	Make	CGL / BEL / SCHNEIDER / ABB / SIEMENS
2	Rated Voltage	11 kV
3	Highest System Voltage	12 kV
4	Rated Current	1250 A / 630 A (as per applicability)
5	Short Time Withstand Current	25 kA for 3 sec.
6	Insulating level 1.2/50 micro- Sec impulse withstand volt.(between line terminals and ground)	+/- 75 kVp
7	1 min power frequency withstand voltage between line terminals and ground (dry & wet)	28 kV rms
8	Frequency	50 Hz.
9	Short circuit making current	100 kA
10	Mechanical endurance capacity	30000 operation

Sl. No.	Item	Description
11	Electrical endurance capacity	10,000 operation in line with IEC
12	Minimum electrical life	100 nos. at rated short circuit current

4.4.4. CURRENT TRANSFORMERS

Current Transformers conforming to latest edition of IS: 2705 (Part I, II, III & IV) / IEC: 60044 shall be mounted inside the switchgear. CTs shall be cast resin type with insulation Class 'B' or better. Contact tips on primary side shall be silver plated. Correct polarity shall be invariably marked on each primary and secondary terminal. Secondary stud shall be of good quality brass material.

Primary shall be wound or bar type, rigid, high conductivity grade copper conductor. Unavoidable joints on the primary conductor shall be welded type, preferably lap type. Current density at any point shall not exceed 1.60 Amp./sq.mm. Suitable insulated copper wire of electrolytic grade shall be used for CT secondary winding. Multi ratio in CT shall be achieved by reconnection of secondary winding tapping. The secondary terminals shall have screw type terminals. The screw should have sufficient length for connection of at least two (02) nos. wires with plain and spring washers and minimum 10 mm clearance between the adjacent screws.

The supplier shall ensure that the CTs have adequate VA rating for the required protection & metering offered.

PS class CTs shall have low secondary resistance and high knee point voltage so as to avoid any possibility of CT saturation under through fault conditions. The contractor shall furnish calculations in support of selection of above parameters for the offered CTs.

Requirements:

a) Two (02) Sets of CT for each generating feeder as per **Plant SLD**.
   - One (01) set at Neutral Grounding System (NGS) side of each generator
   - One (01) set at the 11 kV power line of each generating unit

b) One (01) Set of CT for AVR of each generating unit as per **Plant SLD**.

c) One (01) Set of CT for 11 kV outgoing feeder from 11 kV indoor switchgear panel as per **Plant SLD**.

CTs for 11 kV power line of each generating unit and 11 kV outgoing feeder shall be installed inside the 11 kV Indoor Switchgear at respective panels. CTs at Neutral Grounding System (NGS) side of each generator shall be installed in the Neutral Grounding Cubicle. Fixing in horizontal upright condition over a base channel is preferable. CT Secondary connection terminals should be clearly visible and accessible from the back side of the breaker assembly after opening the rear cover plate. Necessary protections shall be provided for the personnel.

Name Plate of CT:

Name plate for the current transformer shall be provided with all the required details as per IEC: 60044-1 / IS 2705, including:

i. Manufacturer's name
ii. Serial number and type designation
iii. Rated primary and secondary current

iv. Rated frequency
v. Rated output and corresponding accuracy class for each secondary winding, including the rated accuracy limit factor and instrument security factor for protection and metering secondary windings respectively.
vi. Highest voltage of the equipment
vii. Rated insulation level
viii. Rated short-time thermal current and rated dynamic current
ix. Class of insulation
x. Rated continuous thermal current
xi. Property label – "Property of WBSEDCL"
xii. Guaranteed for five (05) Years

11 kV Current Transformers to be installed at Neutral Grounding System side of each generator as shown in **Plant SLD** shall have the following ratings.

Sl. No.	Item	Details	
1	Type	Cast resin type	
2	Nominal system voltage	11 kV	
3	Highest system voltage	12 kV	
4	Installation	Indoor	
5	Short time withstand current	25 kA for 3 sec.	
6	No of phases	Single	
7	Insulation class	Class 'B' or better	
8	No. of secondary winding	Two (02)	
9	Ratio	400 / 1 – 1 Amp	
10	Accuracy class	5P20	PS
11	Output burden (VA) at lower ratio	As required	–
12	Accuracy limit factor	20	–
13	Minimum knee point voltage	–	250 V
14	Max. excitation current (mA) at knee point voltage	–	30 mA at $V_k/2$ (at lower ratio)
15	Max CT secondary winding resistance	–	R_{CT} at 75^0C = 4 Ω
16	System frequency (Hz)	50	
17	Continuous over load capacity	120 % of rated primary current	
18	Lightning impulse withstand voltage	75 kV (peak)	
19	PF withstand voltage – Primary / Sec.	28 kV/ 3 kV (rms)	
20	Limit of temperature rise of windings	55^0C at rated current	

11 kV Current Transformers to be installed at the 11 kV power line of each generating unit as shown in **Plant SLD** shall have the following ratings.

Sl. No.	Item	Details	
1	Type	Cast resin type	
2	Nominal system voltage	11 kV	
3	Highest system voltage	12 kV	
4	Installation	Indoor	
5	Short time withstand current	25 kA for 3 sec.	
6	No of phases	Single	
7	Insulation class	Class 'B' or better	
8	Ratio	400 / 1 – 1 Amp	
9	No. of secondary winding	Two (02)	
10	Accuracy class	0.2S	PS
11	Output burden (VA) at lower ratio	As required	–
12	Instrument security factor	≤ 5	–
13	Minimum knee point voltage	–	250 V
14	Max. excitation current (mA) at knee point voltage	–	30 mA at $V_k/2$ (at lower ratio)
15	Max. CT sec. winding resistance	–	R_{CT} at 75°C = 4 Ω
16	System frequency (Hz)	50	
17	Continuous over load capacity	120 % of rated primary current	
18	PF withstand voltage – Primary / Sec.	28 kV/ 3 kV (rms)	
19	Lightning impulse withstand voltage	75 kV (peak)	
20	Limit of temperature rise of windings	55°C at rated current	

11 kV Current Transformers for Automatic Voltage Regulator (AVR) of each generating unit as shown in **Plant SLD** shall have the following ratings.

Sl. No.	Item	Details
1	Type	Cast resin type
2	Nominal system voltage	11 kV
3	Highest system voltage	12 kV
4	Installation	Indoor
5	Short time withstand current	25 kA for 3 sec.
6	No of phases	Single
7	Insulation class	Class 'B' or better
8	Ratio	400 / 1 Amp

Sl. No.	Item	Details
9	No. of secondary winding	One (01)
10	Accuracy class	0.2S
11	Burden	As required
12	Instrument security factor	≤ 5
13	System frequency (Hz)	50
14	Continuous over load capacity	120 % of rated primary current
15	PF withstand voltage – Primary / Sec.	28 kV/ 3 kV (rms)
16	Lightning impulse withstand voltage	75 kV (peak)

11 kV Current Transformers to be installed at 11 kV outgoing feeders from the 11 kV indoor switchgear panel as shown in **Plant SLD** shall have the following ratings.

Sl. No.	Item	Details		
1	Type	Cast resin type		
2	Nominal system voltage	11 kV		
3	Highest system voltage	12 kV		
4	Installation	Indoor		
5	Short time withstand current	25 kA for 3 sec.		
6	No of phases	Single		
7	Insulation class	Class 'B' or better		
8	Ratio	800 / 1 – 1 – 1 Amp		
9	No. of secondary winding	Three (03)		
10	Accuracy class	5P20	PS	0.2S
11	Output burden (VA) at lower ratio	As required	–	As required
12	Accuracy limit factor	20	–	≤ 5
13	Minimum knee point voltage	–	250 V	–
14	Max. excitation current (mA) at knee point voltage	–	30 mA at $V_k/2$ (at lower ratio)	–
15	Max. CT sec. winding resistance	–	R_{CT} at 75°C = 4 Ω	–
16	System frequency (Hz)	50		
17	Continuous over load capacity	120 % of rated primary current		
18	PF withstand voltage – Primary / Sec.	28 kV/ 3 kV (rms)		
19	Lightning impulse withstand voltage	75 kV (peak)		

Sl. No.	Item	Details
20	Limit of temperature rise of windings	55^0C at rated current

4.4.5. LAVT CUBICLE

The Lightning Arrester & Voltage Transformer (LAVT) cubicles for 11 kV shall comprise of lightning arresters with capacitors (for surge protection) and potential transformers (PT). LAs shall be provided to protect the generator and other equipment against lightning surge. PTs shall be provided for protection and metering. The cubicles shall be floor mounted, metal clad, dust & vermin proof, tropicalised and shall be suitably compartmentalized for accommodating the above equipment.

The cubicle shall be equipped with space heaters, thermostats, lamps & 240V AC, 5A receptacle. The bus for breaker and LAVT cubicle shall be of same design & size.

Each control wire originating from the cubicle & intended for external connections shall be brought to the terminal blocks for PT secondary wiring. PT secondary side wiring inside the cubicle shall be flame-proof, 1.1 kV grade & shall conform to relevant standards.

LIGHTNING ARRESTORS / SURGE ARRESTERS

The lightning arrestors / surge arrestors shall be metal oxide gapless type. LAs shall be capable of discharging lightning surges, switching surges and temporary power frequency over voltages. LAs shall be capable of discharging over voltages occurring during switching of unloaded transformers and lines. The Arrestors shall be capable of withstanding Maximum Continuous Operating Voltages (MCOV).

The reference current of LAs shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltages. Three (03) Nos. of 0.2 microfarad capacitor in parallel to the LAs shall be provided in each LAVT cubicle.

Name Plate of LA:

Each single pole LA shall be supplied with name plate, containing following data:

i. Name of device
ii. Manufacturer's name and trade mark, type and identification
iii. Year of manufacture
iv. Voltage rating & frequency rating.
v. Nominal discharge current
vi. MCOV (Maximum Continuous Operating Voltage in kV).
vii. Discharge class.
viii. Energy Discharge capability (kJ/kV rating)
ix. Purchase order reference.
x. Applicable standard
xi. Pressure relief rated current in kA rms (if applicable)
xii. Serial number

Lightning Arrestors shall conform to IEC-60099-4 as per following details:

Sl. No.	Item	Details
1	Type	Metal oxide gapless
2	Installation	Indoor

Sl. No.	Item	Details
3	Rated voltage	9 kV
4	Maximum continuous operating voltage (kV_{RMS})	10
5	Nominal discharge current (kA_P)	10
6	Temporary over voltage withstand capability (kV_{RMS}) for 10 sec.	12
7	Insulation Housing withstand voltages i) Lightning Impulse(Dry) ii) Power frequency(wet) • for 10 kA • for 5 kA	Minimum values as per IEC
8	Min. creepage distance acceptable (mm)	300
9	(Min.) High current impulse withstand (4/10) (kV_{Peak})	65
10	Max. lightning impulse (8/20 microsecond impulse) residual voltage (kVp) : • 5 kA • 10 kA	34 –
11	Maximum steep impulse (1/20 micro-seconds impulse) residual voltage at 10 kA (kVp)	28
12	Maximum switching surge (30/60 microsecond wave) protective level (kVp) • 500 A	21
13	RIV / Partial Discharge (micro-volt / pico-coulomb) when energized at 1.05 times its continuous operating voltage shall not exceed	1000 microvolt / less than 500 pico-coulomb
14	Rated Frequency (Hz.)	50

POTENTIAL TRANSFORMERS

Potential Transformers (PT) shall be three (03) nos. cast resin single phase PT (Withdrawable/Fixed type) with insulation Class 'B' or better. Service position locking mechanism shall be provided and rigidity of primary stud point with earth bus in service position shall be confirmed by the contractor. Secondary stud shall be of good quality brass material.

Contact tips of primary / secondary contacts shall be silver plated. Correct polarity shall be distinctly marked on primary and secondary terminal. Secondary terminal studs shall be provided with at least three nuts, two plain and two spring washers for fixing leads. The stud, nuts and washers shall be of brass, duly nickel plated. The minimum outside diameter of the studs shall be 6 mm. the length of at least 15 mm shall be available on the studs for inserting the leads. The space clearance between nuts on adjacent studs when fitted shall be at least 10 mm.

Burden mentioned in the SLD is tentative. The supplier shall ensure that the potential transformers have adequate VA rating for required protection & metering offered.

Requirements:

a) One (01) set of PT shall be provided in the 11 kV power Line from each generating unit at the LAVT Cubicle as per **Plant SLD.**

b) One (01) Set of PT for AVR of each generating unit as per **Plant SLD**.

PTs shall be rail mounted on top of the unit and connected on bus side. It can be plugged into and withdraw from service by pulling or pushing the PT by the handle provided on the PT. This action traverses the PT along the rails and shall automatically operate the spout shutters. The shutter drive also forms a latch which holds the PT in the service position and this latch shall be required to be released before PT can be isolated. Access to the PT and the reinforcement in the panel for allowing a person to stand on the top should be provided. Sealing arrangement of the PT with the carriage and secondary fuses are to be provided. PTs shall be mounted in a separate cubicle in LAVT unit.

Name Plate of PT:

Name plate for the voltage transformer shall be provided with all the required details as per IEC: 60044-2 / IS: 3156 Standards, including:

i. Manufacturer's name
ii. Serial number and type designation
iii. Rated primary and secondary voltage
iv. Rated frequency
v. Rated output and corresponding accuracy class for each secondary winding,
vi. Highest voltage of the equipment
vii. Rated insulation level
viii. Class of insulation for the equipment
ix. Rated voltage factor and corresponding rated time.
x. The use of each secondary winding and it's corresponding terminals
xi. Property Label –"Property of WBSEDCL"
xii. Guaranteed for five (05) Years

The PTs in the 11 kV power Line from each generating unit at the LAVT Cubicle shall conform to the requirement of IS: 3156 / IEC 60044 shall be rated as follows:

Sl. No.	Item	Details	
1	Type	Cast resin type	
2	Nominal system voltage	11kV	
3	Highest system voltage	12 kV	
4	No of phases	Single	
5	Installation	Indoor	
6	Ratio	$11/\sqrt{3}$ kV / $110/\sqrt{3}$ V / $110/\sqrt{3}$ V	
7	Insulation class	Class 'B' or better	
8	Frequency	50 Hz.	
9	No. of secondary windings	Two (02)	
10	Accuracy class	0.2	3P

Sl. No.	Item	Details
11	Rated burden	As required
12	Rated voltage factor	1.2 for Continuous, 1.9 times for 30 sec.
13	PF withstand voltage – Primary / Sec.	28 kV / 3 kV (rms)
14	Lightning impulse withstand voltage	75 kV (peak)
15	PT secondary circuit	Shall be brought out from the place of installation to the 11 kV indoor switchgear for protection and metering requirements

The PTs for AVR of each generating unit shall conform to the requirement of IS: 3156 / IEC 60044 shall be rated as follows:

Sl. No.	Item	Details
1	Type	Cast resin type, indoor
2	Nominal system voltage	11 kV
3	Highest system voltage	12 kV
4	No of phases	Single
5	Ratio	$11/\sqrt{3}$ kV / $110/\sqrt{3}$ V
6	Insulation class	Class 'B' or better
7	Frequency	50 Hz.
8	No. of secondary windings	One (01)
9	Accuracy class	0.2
10	Rated Burden	As required
11	Rated voltage Factor	1.2 for Continuous, 1.9 times for 30 sec.
12	PF withstand voltage – Primary / Sec.	28 kV / 3 kV (rms)
13	Lightning impulse withstand voltage	75 kV (peak)
14	PT secondary circuit	Shall be bought out from the place of installation to the 11 kV indoor switchgear for protection and metering requirements

4.4.6. NEUTRAL GROUNDING CUBICLE

Neutral Grounding System shall consist the following items / equipment.

ISOLATING SWITCH

The neutral shall be earthed through an 11 kV, 400 A isolating switch provided with a pad lock arrangement to enable grounding of only one generator neutral at a time.

NEUTRAL GROUNDING TRANSFORMER & GROUNDING RESISTOR

Each generator neutral shall be grounded by 11 kV / 110 – 220 V distribution transformer with loading resistor connected to secondary side to restrict earth fault current to a safe value. The short time rating of the distribution transformer shall be min. one (01) minute.

GROUND BUS

Ground bus shall be connected with the power house earth-mat. No bolted joints will be allowed. Only welded joint shall be used for earthing network.

CUBICLE

The cubicles shall be metal clad, dust & vermin proof, tropicalised and shall be suitably compartmentalized for accommodating the above equipment. The cubicle shall be fabricated from cold rolled sheet steel of min. 2 mm thickness. Degree of protection for all indoor cubicle shall be IP-42. The cubicle shall be supplied complete with the base mounting arrangement, foundation bolts and internal illumination. Each cubicle shall be equipped with Space Heaters, Thermostats & 240 V AC, 5 A receptacle.

4.4.7. CABLE TERMINATION

Suitable single compression type, heavy duty brass cable glands with check nuts, rubber sealing ring and brass washers mounted on a removable gland plate shall be supplied to support all power and control cables entering the switchgear and panels. Cable glands shall incorporate built in facility for earthing the armour of cable. Cable glands shall be tin-plated to avoid corrosion.

Power Cable shall be 12 kV grade, XLPE insulated, PVC sheathed, armoured and suitably sized. Sizing of the 11 kV Power cables at various feeders are indicated in the plant SLD. Cables for each equipment must be tagged with permanent metal tag of impregnated cable number as per drawings at each equipment terminal end as well as in the mid portion of the cables at certain distances as instructed by the employer.

Power cables shall be of aluminium conductor and control cables of copper conductor conforming to relevant Indian Standard. Necessary crimping type tinned copper lugs shall be provided for power and control cables.

The cabling chamber shall have adequate dimensions to accommodate creepage distances and stress cones involved in the case of termination of XLPE insulated, aluminium conductor armoured multi-cables to be used for each phase. Cabling chamber shall be dust & vermin proof and proper gaskets shall be provided to avoid ingress of moisture and dust.

4.4.8. TERMINAL BLOCKS (TB)

Terminal Blocks (TB):	1.1 kV grade, min. 10 amps rating, Nylon 66, screw type suitable for 2 nos. Lead
Terminal for CT & PT secondary leads:	With provision for shorting with screw driver operated sliding link. a) CT shorting links shall be provided to short CT circuits under live system condition. b) Isolation links shall be provided on the PT circuits, trip circuits and alarm for easy isolation without disconnecting the wires from TBs.

Spare terminals:	25% in each TB row
TB shrouds & separators:	Moulded non-inflammable plastic material
Clearance between 2 sets of TB:	100 mm min.
Clearance with cable gland plate:	250 mm min.
Clearance between AC / DC set of TB:	100 mm min.

4.4.9. INDICATING METERS

Flush mounted, back connected, dust proof with Industrial Grade "A" classification meters conforming to latest edition of relevant Indian Standard shall be provided with each panel.

CT OPERATED AMMETER:

Analog ammeters for measuring load current of each phases shall be provided for 11 kV power lines.

Aux. AC Power	:	230 V AC
Aux. DC Power	:	110 V DC
CT Ratio	:	400 / 1A
Accuracy Class	:	0.5 or better

DIRECT AMMETER:

One (01) no. separate digital ammeter to be provided for measuring heater current consumption in all the panels.

Display	:	3 ½ -Digit Display,
Aux. AC Power	:	230 V AC
Aux. DC Power	:	110 V DC
Accuracy Class	:	0.5 or better

DC AMMETER:

One (01) no. analog DC ammeter to be provided in the DC Control circuit for measurement of DC current.

PT OPERATED VOLTMETER:

Analog voltmeter for measuring Phase to Phase system voltage shall be provided for 11 kV power lines.

Aux. AC Power	:	230 V AC
Aux. DC Power	:	110 V DC
PT Ratio	:	11000/√3 / 110/√3 V
Accuracy Class	:	0.5 or better

DC VOLTMETER:

One (01) no. analog DC voltmeter to be provided in the DC control circuit for measurement of DC voltage.

MULTI-FUNCTION METER (MFM):

One (01) no. 3φ, four wire CT / PT operated, fully static AMR (Automatic Meter Reading) compatible MFM along with TTB to be provided for 11 kV indoor switchgear panel in a

separate metering chamber. Necessary wiring to be provided with separate terminal block (suitable for CT / PT connection) for MFM connection.

The data stored in the meters shall not be lost in the event of power failure. The meter shall have Non Volatile Memory (NVM), which does not need any battery backup. The NVM shall have a minimum retention period of ten (10) years.

Meter shall have scroll lock facility to display any one desired parameter continuously from display parameters. Auto display cycling of each parameter should be minimum 10-12 Seconds. The time between two auto display cycles shall be 100-120 sec. OBIS code in display is not required.

Type:	3φ, four wire CT / PT operated, fully static AMR compatible along with TTB
Display of measured values:	The meter display shall have seven (07) digits (complete) for energy counter with alphanumeric digits for parameter identifier and tamper indication with backlit LCD of min. 10 mm height, wide viewing angle suitable for temperature withstand of 70°C. LCD shall be of Super Twisted Nematic (STN) type.
Frequency:	50 Hz ± 5%
Accuracy Class:	0.2S
Secondary Voltage Rating:	Suitable for operation from 110 V Ph-Ph, (3P, 4W); 63.5 V Ph–N.
Voltage Variation:	- 30 % to + 20 %
Current Rating:	I_{BASIC} = 1 A; I_{MAX} = 2 A
Max. Continuous Current:	As per IS 14697:1999 (2004)
Starting Current:	0.1% of I_{BASIC} at unity power factor
Power Consumption:	The active & apparent power consumption, in each voltage circuit, at reference voltage, temperature and frequency shall not exceed 1.5 W and 8 VA. The apparent power taken by each current circuit, at basic current, reference frequency and temperature shall not exceed 1.0 VA.
Power Factor:	0 Lag – Unity – 0 Lead
DLMS Test Certificate:	Manufacturer must have test certificate for conformance to DLMS from CPRI of Category – 'C'.

The MFM shall have the features to display the following minimum parameters.

- Meter serial number
- Real time & date (DD/MM/YYYY)
- Cumulative power off hours
- Cumulative active energy (cumulative sign / legend must be given)
- Cumulative reactive energy lag (do)
- Cumulative reactive energy lead (do)
- Cumulative apparent forward energy – lag only (do)
- Phase sequence & phase correspondences of voltage & current
- Instantaneous secondary voltages and currents –phase wise (P-N)
- Signed instantaneous power factor – phase wise
- Instantaneous net power factor
- Signed instantaneous active power

- Instantaneous apparent power
- Instantaneous frequency
- Front cover open count
- Connection check
- Self diagnosis including LCD Test etc.

4.4.10. RELAYS FOR PROTECTION AND CONTROL

Relay Type:	Numerical with self monitoring features
Mounting:	Flush mounted IP 5X with key pad on front
Relay characteristics:	Numerical IED with multiple characteristics like IDMT, DMT, instantaneous with compatible choices of time delays and multiple settings for multiple functions like over current, earth fault etc. along with control of breaker, measurement and status etc.
Relay communication:	As per IEC 61850
Relay input signal:	From CT & PT, with auxiliary DC supply
Relay terminals:	Shall be screw type terminals large enough to accommodate 4.0 mm^2 cables and shall be located at the back of the relay.
Relay contacts:	Shall make firmly without bounce and the relay mechanism shall not be affected by panel vibration or external magnetic field.
Electromagnetic compatibility:	Relay thermal rating shall be such that the fault clearance times on any combination of current and time multiplier settings shall not exceed the thermal withstand capability of the relay. Compliant to EMC directives as per IEC.
Relays for auxiliary, supervision, trip & timer:	Static or attracted armature type with short pickup time of less than 30 ms.
Relay reset:	Self reset contacts except for master trip relays
Operation indicators:	With hand reset operation indicators (flags) or LEDs with push buttons for resetting, for analyzing the cause of operation
Test facility:	In built. Necessary test plugs shall be provided.
Auxiliary supply:	Operate on available 110 V DC supply. To reduce the effect of electrolysis, relay coil shall be so connected such that they are not continuously connected from the positive pole of the station battery.
Master trip relay:	High impedance and high speed relay flush mounted having coil cut-off contact with at least 4NO and 4NC contact and electrical reset facility capable to make, carry and break trip coil current of circuit breaker and capable for future integration with SCADA. It should be immune to capacitance discharge currents and leakage current. Operating time should be less than 20 ms. Terminals shall be screw type to accommodate 4.0 mm^2 cable and located

	at the back of the relay. Terminals shall be clearly marked. Contact configuration shall be drawn on the relay casing.
Fault recording:	Relay shall have the facility for recording of various parameters during a fault. It should be possible to set the duration of record through settable pre fault and post fault time. It should be possible to down load the data locally or from SCADA remotely.
Performance:	As per Plant SLD

4.4.11. ANNUNCIATION SCHEME

6/8 window annunciator shall be provided in each panel. It should be microprocessor based, having inbuilt accept / reset / test / mute push buttons for trip and non-trip functions. It shall have provision of inbuilt watch dog and fast fault indication with trip and non-trip alarm viz. AC supply fail, main DC supply fail etc. The functional details and scheme shall be finalized during detailed engineering stage.

4.4.12. CONTROL WIRING

Control cables shall be 2.5 mm^2, 4 mm^2 and 6 mm^2 multi-strand copper and shall enter from bottom. Terminals provided by manufacturer in the cubicles for external connection shall be suitable for such sizes. All units shall be furnished completely factory wired up to terminal blocks ready for external connections. Control wirings shall not be less than 2.5 mm^2 copper wire and the CT secondary wires shall not be less than 4 mm^2 copper. All wires connecting the equipment on the front to the internal portion of the cubicle shall have suitable flexible arrangements to facilitate frequent opening and closing of the door.

All wires shall have PVC insulation for 1.1 kV and shall be suitable for switchboard wiring and comply with the requirements of IS: 1554-Part-I (latest issue). Each wire shall bear an identifying ferrule or tag at each end or connecting point.

All the operating coils and small wires shall withstand as erected, a Power Frequency Withstand voltage of 3 kV for one (01) minute.

All outgoing control wiring, including that for connecting between shipping sections shall terminate on terminal blocks preferably vertically mounted on the side of each cubicle. Suitable supports shall be provided for the incoming cables. The terminal blocks shall be arranged to provide maximum accessibility to all conductor terminations and any arrangement preventing ready access to other terminal screws will not be accepted.

All spare contacts of the relay and circuit breaker auxiliary contacts shall be supplied and wired up to the terminal block. Current transformers which are unused shall be wired up to the terminal blocks and short circuited.

The terminal blocks shall be made of a moulded non-inflammable plastic material with bases and barriers moulded integrally. Each block shall have washer-head binding screws for external circuit wire connections, marking strip for circuit identification and moulded plastic cover. All terminals shall be clearly marked with identification numbers or letters to facilitate connections to external wiring.

Terminal blocks shall include separate terminals for testing the relays, instruments and short circuiting of the CTs if these facilities are not provided elsewhere in the manufacturer's equipment. Not more than two wires shall be connected to any

terminal. The terminals for CTs shall be of disconnecting type with automatic shorting of CT secondary terminals.

4.4.13. CONTROL SUPPLY ARRANGEMENT

Two suitable Moulded Case Circuit Breakers (MCCB) shall be provided in every switchgear board to receive two feeders of 110 volt DC control supplies. A selector switch for selection of either of DC sources shall be provided. The DC control power supply shall be tapped for each cubicle through separate MCCB.

Secondary control and protection bus-bar suitably located and running along with entire length of each switchgear board shall be preferred. In case inter panel looping is adopted for secondary control and protection, suitable arrangements shall be made inside the panels. When a unit of switchgear comprises of more than one shipping section, all materials and drawings required for the interconnections in the secondary bus-bars shall be furnished by the manufacture for use during installation. The bus-bar / looping wires of copper shall be of adequate cross-section for their respective requirements.

Separate set of HRC fuses shall be provided for each breaker for following circuits:

i. Common fuses for closing and tripping circuits.
ii. Spring charging motor circuit.
iii. Indicating lamp circuit.

4.4.14. INTEGRATION WITH SCADA SYSTEM

The switchgear panels shall be fully integrated and interfaced with power plant SCADA system in respect of alarm, indication, control, protection and metering. Suitable transducers for conversion of analogue signal to digital signal compatible for SCADA system, as required, shall be provided.

4.4.15. NAME PLATE OF SWITCHGEAR

Material:	Material shall be stainless steel / anodized aluminium and shall not be deformed under the service condition. The entries shall be 3 mm thick and 100 mm x 150 mm size (approx).
Lettering / numbering:	Engraved, shall be indelibly marked by engraving with black letters / numbers letter on white background or vice-versa as specified. Each major equipment shall be provided with a rating plate containing the required information as specified in the relevant IEC standard.
Name plate for feeder description:	On front and rear side of each panel giving feeder description. On the rear side the name plate shall be fixed on the back cover.
Identification plates / labels at each cubicle and each instrument:	Approved design (not stickers)
Manufacturer Name Plate:	On front top door of panel

Name plate of switchgear shall include:

- Name of the manufacturer and year of manufacturer
- P.O. no. and date
- Type, designation and serial no.
- Rated voltage and current
- Lightning impulse withstand voltage
- One (01) minute power frequency withstand voltage
- Rated frequency
- Rated current
- Breaking capacity
- Short time current making capacity
- Operating sequence
- Rated voltage of closing and opening coil
- Rated voltage of spring charging motor
- Property Label — "Property of WBSEDCL"
- Guarantee for five (05) Years

4.5. STATION AUXILIARY TRANSFORMER (SAT)

4.5.1. SCOPE

This specification covers design, manufacture, testing, supply, delivery and installation of 11/0.415 kV, 250 kVA, dry type indoor Station Auxiliary Transformers (SAT) for the Lodhama-II SHEP.

4.5.2. CONNECTIONS

The primary (HV) winding shall be connected in delta and the secondary (LV) winding in star with vector group Dyn11. The neutral of the secondary (LV) winding shall be brought out to a separate insulated terminal. The size (cross-section) of the neutral connection conductors and jumpers must be of same size as that of the phase connecting conductors and jumpers which shall be properly supported and insulated.

4.5.3. TERMINAL ARRANGEMENT

HV side of the SAT: 11 kV, 3C x 35 mm^2, 1R, armoured aluminium XLPE cable.

LT side of the SAT: 1.1 kV, 3½C x 300 mm^2,1R, armoured aluminium PVC insulated cable.

Suitable size cable end box with non-magnetic gland plate shall be provided for both HV & LV side of SAT. However, the above terminal arrangement will be finalized during detailed engineering.

4.5.4. TECHNICAL REQUIREMENTS AND RATING

All indoor type SATs shall be 3φ, dry type, natural air cooled. Ratings, characteristics, etc. shall comply with the requirements of the IEC 60726. The transformers shall be provided with a protective enclosure. The contractor shall furnish the calculations on the sufficiency of the rating of the SATs during detailed engineering stage.

All The SATs shall have low loss and low noise level type with moisture-proof, tropicalized, flame resistant and self-extinguishing insulation. The transformers shall be free from partial discharges up to 150% of the rated voltage. The transformers shall be able to withstand all forces caused by a short circuit on the low voltage terminals without any damage. All open metal parts shall be highly protected against corrosion.

Current density of HV and LV windings of all transformers shall not exceed 1.4 Amp/mm^2.

Sl. No.	Item	Details
1	Type of transformer	Dry type
2	No. of phase	3
3	Installation	Indoor
4	No. of transformers	2
5	Rated kVA	250
6	Minimum % Impedance at principal tap, rated kVA and rated frequency	4.00 %
7	Winding material	Copper
8	System earthing	HV Side non-effectively earthed and LT side effectively earthed
9	Connection of transformer	
	HV Winding	Delta
	LV Winding	Star with neutral directly earthed
10	Vector Group	Dyn11
11	Rated frequency	50 Hz
12	Rated voltage	11 kV / 0.415 kV
13	Voltage variation limit	+/- 10 %
14	Frequency variation limit	+/- 5 %
15	Type of winding Insulation	Uniformly Insulated
16	Type of bushing	Porcelain
17	Class of Insulation	Class 'F'
18	Temperature rise over an ambient temperature of 40°c	40^{0}C / 45^{0}C
19	Insulation level of winding	
	Rated PF withstand voltage (HV/ LV)	28 kV / 3 kV (rms)
	Rated lightning Impulse withstand voltage	75 kVp
20	Insulation level of bushings / bushing insulators in cable box	
	Voltage class of bushings (HV / LV)	17.5 kV / 1.1 kV
	Rated PF withstand voltage (HV / LV)	38 kV / 3 kV (rms)

Sl. No.	Item	Details
	Rated lightning Impulse withstand voltage	95 kV
21	Creepage distance of bushing (HV / LV)	300 mm / 75 mm
22	Max. flux. density in core / yoke under over voltage conditions	Not exceeding 1.9 Tesla
23	Current density of HV and LV windings	1.4 Amp/mm^2
24	Voltage withstand capacity during sudden disconnection of load	
	1.4 times the rated voltage	For 5 sec.
	1.25 times the rated voltage	For 1 minute
	1.1 times the rated voltage	Continuous
25	Max. no-load loss at 75^{0}C at 100% loading	550 W
26	Max. total loss at 75^{0}C at 100% loading	3000 W

4.5.5. CORRECTION FOR HIGH ALTITUDE

All the transformers, being located at more than 1000 m above MSL (EL 1067.55 m), necessary corrections for temperature rise and insulation levels / electrical clearance shall be applied as per relevant standards while installing the transformer at site.

4.5.6. SHORT CIRCUIT TEST

The Manufacturer shall provide short circuit test report on similar or higher rating transformers. The Transformers shall have short circuit withstand capacity of 25 kA for 3 sec. This capability shall be demonstrated by short circuit type test if required. The transformers shall also be designed for operation at unbalanced loading conditions. Transformers shall be free of partial discharges over the range of operating voltages.

4.5.7. INTEGRATION WITH SCADA SYSTEM

The control and operation of SATs shall be suitable for co-ordination and integration with SCADA System and necessary contacts and/or ports for the purpose shall be provided.

4.5.8. DESIGN AND CONSTRUCTION

a) GENERAL

The materials and workmanship shall be of suitable commercial quality as have proven successful in the respective uses in similar services and under similar conditions. Corresponding parts of all equipment and spares shall be of the same material, dimensions, workmanship and finish and shall be interchangeable.

b) CORE

The core shall be of high grade Cold Rolled Grain Oriented (CRGO) annealed steel lamination, having low loss and good grain properties, coated with insulation, bolted together to the frames firmly to prevent vibration or noise. All core clamping bolts shall be effectively insulated. The complete design of core must ensure fixed core losses with

continuous working of the transformers. The Employer reserves the right to get the product tested from any Government recognized laboratory.

The transformer core shall not be saturated for any value of V/f ratio to the extent of 112.5% of the rated value of V/f ratio (due to combined effect of voltage and frequency) without injurious heating at full load conditions. The contractor shall furnish necessary design data in support of the same.

c) FLUX DENSITY

Flux density should not be more than 1.9 Tesla at rated voltage and frequency. The value of the flux density allowed in the design shall be clearly stated in the offer along with graph during detailed engineering stage.

The no load current shall not exceed 1.5% of the full load current at rated voltage. The no load current shall not exceed 3% of the full load current when the applied voltage is 112.5 % of the rated voltage.

d) TIE BOLTS

i. Eight (08) nos. of tie-rods of 20 mm. dia. high tensile steel in vertical formation.
ii. All top and bottom yoke nut bolts, if any, shall be MS and painted with heat and corrosion resistant paint before use.
iii. Drawing of the building of core to be approved before start of work.
iv. The base channels of the core shall not be cut channel.

e) WINDING

- Material: Electrolytic copper
- LV winding: conventional spiral winding should be in even layers. so that the neutral formation will be at top.
- Coil insulation (HV/LV): insulated with Class 'F' insulation paper with vacuum pressure impregnated process in varnish.
- Coil spacers and duct: For sectional winding, high temperature epoxy fiberglass or porcelain and for disc winding, epoxy fiberglass (minimum Class 'F' insulation & above) shall be used.

f) CURRENT DENSITY

Current density for HV and LV winding should not be more than 1.4 Amp/mm^2. (However, ± 5 % tolerance for LV winding is permissible) for copper conductor.

g) LOSSES AND GUARANTEE

The losses at rated voltage shall be tested as per relevant IS. No tolerance shall be permitted over the test figures of the losses.

The no-load loss in kW at rated voltage and rated frequency and the total losses in kW at rated output, rated voltage and rated frequency shall be guaranteed by the contractor. However, Max. no-load and total loss at 100% loading and at 75^{0}C shall be 550 W and 3000 W respectively.

h) TRANSFORMER ENCLOSURE

The transformer enclosure shall be of robust construction and shall be built of electrically welded MS sheet wire mesh or perforated sheet for ventilation. The core is to be securely clamped with heavy structural angle and should hold the entire core and coil assembly in place to ensure most efficient magnetic circuit and quiet functioning of the

transformer. All joints of enclosure and fitting shall be tight. The enclosure design shall be such that the core and winding can be lifted freely. The enclosure plates shall be of such strength that the complete transformer may be lifted by means of the lifting lugs. The top cover shall have no cut at point of lifting lug. The shape of the enclosure shall be rectangular, no other shape will be accepted. The enclosure will be fabricated by welding at corners. The enclosure should comply with IP 43 protection as per IS 13947 amended up to date. Horizontal or vertical joints in the enclosure side walls or its bottom or top cover will be allowed. The bottom plate of the enclosure shall be min. 2.5 mm thick and holes of 2.5 mm of diameter punched sheet for free air circulation.

Sl. No.	Item	Details
A	Side wall, top and bottom plate thickness	2.5 mm
B	Lifting lugs	Four (04) nos. of heavy-duty eye bolt/lifting lugs suitable reinforces by vertical support shall be provided.
C	Pulling lugs	Four (04) nos. of heavy duty pulling lugs shall be provided to pull the transformer horizontally.
D	Top cover-fixing bolts	GI nut bolts of ½" dia./screws with one plain washers shall be used for top cover fixing, spaced at 9" apart.
E	Rollers	Four (04) Nos. 150 mm. diameter and 75 mm width

i) HT & LT BUSHING

For 11 kV, 17.5 kV bushing will be used and for 433 volts, 1.1 kV bushing shall be used. Bushing of the same voltage class shall be interchangeable. Bushing complying IS 3347, amended up to date, shall be mounted on the side of the enclosure and not on the top cover. Only sheet metal pocket shall be provided for mounting of HV bushing and the same shall not be fixed on pipes. Sheet metal pocket shall be designed in such a way that all HT bushing shall remain parallel and equidistance throughout. Bushings having type tested as per IS 3347, amended up to date, shall only be acceptable. Minimum Creepage distance for HV and LV bushings shall be 300 mm and 75 mm respectively.

j) HT / LT CABLE BOXES

HT & LT terminal for cable connection shall be brought out through sidewall mounted bushing to a cable end box. Cable end box shall be self-supporting, weatherproof, air filled type with sufficient space inside for termination and connection of cables.

Cable end box shall be furnished complete with removable gland plate and double compression brass glands. The arrangement shall be such as to permit the core & coil assembly without dismantling the cable installation.

- The HT and LT cable box shall be fixed on the opposite sides. The cable box shall detachable from the main body with suitable mounting arrangement.
- The LV cable box shall be suitable for terminating the cable, which will approach the boxes vertically from the bottom.
- Enclosure shall be fitted with HV / LV cable boxes as per the table given below.

Voltage	Details
11 kV	3 P-1G air filled cable box suitable for 3 core XLPE aluminium cables up to 95 mm^2 & glands suitable for above cables.
0.415 kV	4 P-2G air filled cable box suitable for 3.5 core XLPE aluminium cables up to 300 sq.mm. with copper flats fitted on LT studs.

- Cable gland suitable for HT / LT cable box shall be provided as follows:
  HT: 3 core x 35 mm^2 XLPE cable
  LT: 3 ½ core x 240 mm^2 PVC insulated cable

k) INTERNAL CONNECTION

HV WINDING:

- All jumpers from winding to bushing shall be of copper and shall have cross-section larger than that of conductor.
- Inter-coil connection shall be made by crimping and brazing.
- In case of copper winding delta joints shall be made with brazing only.
- Lead from delta joint shall be connected to bushing bus by brazing only.
- Lead from bushing bus bar to cable box bushing rod shall be bolted.
- HT bus shall be of EC grade copper flat having a cross section of 25 x 6 mm^2 (min.)

LV WINDING:

- LT star point shall be formed of copper flat of sufficient length and cross section. Lead from winding shall be connected to the copper flat by brazing. Any other arrangement shall be subject to the approval of the employer.
- All jumpers from winding to bushing shall be of copper and shall have cross-section larger than that of conductor.
- Transformer LT winding connection to bus bar shall be made by brazing.
- LT bus bar shall be of suitable size & rating.
- Lead from LT bus bar to cable box bushing shall be bolted. Use copper jumper of appropriate size of copper jumper. LT Line Bus Bar current density shall be 2 Amp / mm^2 maximum.

l) TERMINALS

- Brass rods of 12 mm. dia. for HT with necessary nuts, check nuts and plain thick tinned washers.
- Tinned copper rods of 30 mm. dia. for LT extension of cable lug connections, with necessary nuts, check nuts and plain thick tinned washers.

m) RATING PLATES

- Rating plate and circuit diagram shall be provided following relevant Standard.
- The entries of the rating plate shall be indelibly marked (for example by etching, engraving or stamping).
- The markings viz. name of the manufacturer, order no., Sl. no., capacity, month and year of manufacturing, "Property of WBSEDCL" of Transformer shall be engraved on transformer enclosure, below LT bushings. The engraving can be done on separate

plate which shall be firmly welded to enclosure and shall form integral part of the enclosure.

4.5.9. FITTINGS

The Fittings on the transformers shall be as under:

Sl. No.	Item	Details
1	Rating and diagram plate	1 No.
2	Earthing terminals with lugs	2 Nos.
3	Lifting lugs	Four (04) nos. (for enclosure)
4	Platform mounting channel (with holes suitable for axle of roller)	2 Nos.
5	HT & LT bushing	3 nos. of HT bushing & 4 Nos. of LT bushing shall be provided with P.G. clamps as per relevant IS 3347 amended up to date.
6	Rollers	4 Nos.
7	Pulling lugs	4 Nos.
8	Cable Box	One (01) no. each for HV & LV with glands and connecting sockets

4.6. TESTS

4.6.1. TYPE TESTS

All the apparatus, instruments etc. mounted on the switchgear shall be subjected to type tests in accordance with the requirements of IEC 60298 / 60694 or any other relevant IS / IEC. Type test reports in lieu of the type tests made on the similar equipment may be acceptable at the discretion of the employer. The employer, however, may insist on carrying out the type tests on the exact product to be used for the project, in case it is not available or not performed within ten (10) years from the date of this NIT publication. The charges for carrying out the type tests shall be borne by the contractor.

SWITCHGEAR PANEL (WITH CIRCUIT BREAKER INSTALLED):

i. Dielectric tests including lightning and power frequency withstand voltage test on auxiliary and control circuits
ii. Temperature rise tests
iii. Measurement of the resistance of the main circuit
iv. Short time withstand current and peak withstand current tests
v. Verification of degree of protection
vi. Radio Interference Voltage (RIV) test
vii. Short circuit test with basic duties & partial discharge test
viii. Mechanical operation test
ix. Single phase breaking capacity test
x. Cable charging breaking current test

xi. Internal arc test as per IEC 62271-200
xii. Electromagnetic compatibility tests (EMC)
xiii. Horizontal acceleration due to seismic force (if available)
xiv. Test for auxiliary devices
xv. Verification of correct wiring

The type test certificates for bought out items shall be submitted for approval of employer.

CIRCUIT BREAKER:

i. Mechanical endurance test as per M2 Class of IEC

CURRENT TRANSFORMER:

i. Short time current test
ii. Impulse voltage withstand test
iii. Temperature rise test

POTENTIAL TRANSFORMER:

i. Impulse voltage withstand test
ii. Temperature rise test

STATION AUXILIARY TRANSFORMER:

i. Dynamic short circuit withstand test to be conducted as per Cl. No. 16.11 & 16.11.4.4. of IS: 2026 (Part-I) 1977.
ii. Impulse voltage withstand test
iii. Temperature rise test
iv. Pressure test on tank

COPIES OF TEST CERTIFICATES IN RESPECT OF FOLLOWING BOUGHT OUT ITEMS:

i. Vacuum Interrupter
ii. Insulators
iii. Bus bar material
iv. Terminal connectors
v. KEMA / CPRI Certification for relay / IED i.r.o. IEC 61850 compliance

Note: All the type test report on switchgear panel & circuit breaker to be conducted with offered vacuum interrupter.

TYPE TEST AFTER ROUTINE TESTS:

The employer shall have the right to ask the contractor to perform the type tests again, after routine test, on the sample chosen from any lot offered for inspection following relevant Indian Standard from CPRI / NABL accredited / Government recognized test house or laboratory in presence of the employer's representative. The contractor shall be liable to arrange the same.

The amount charged by the test house / laboratory only for carrying out such type tests will be reimbursed to the contractor on production of necessary supporting documents.

4.6.2. ROUTINE / ACCEPTANCE TESTS

All the switchgear panels shall be tested in accordance with the requirement of IEC 62271-200. Tests shall be carried out on the circuit breakers as per the requirement of IEC 62271-100. Current transformers and Voltage transformers shall be tested in accordance with the requirement of IEC 60044 – 1 / IS 2705 and IEC 6044 – 2 / IS 3156 respectively. Relays shall be tested in accordance with IEC 60255 & energy meter shall be tested following relevant IS.

All Acceptance tests shall be carried out at manufacturer's works on every lot offered for inspection following relevant IS & IEC in presence of the employer's representatives. Selection of samples for acceptance test as well as rejection and retesting shall be guided by relevant IS. The entire cost of acceptance and routine tests that to be carried out shall be deemed to be included in the quoted price by the contractor.

COMPLETE SWITCHGEAR PANEL:

i. Dimensional checks
ii. Operational tests
iii. Primary injection tests
iv. Calibration tests on relays and instruments
v. Power frequency withstand test
vi. Insulation test
vii. Contact resistance test of primary joints

CIRCUIT BREAKER:

i. Design and visual checks
ii. Operational tests
iii. Dielectric test on the main circuit, control and auxiliary circuits
iv. Measurement of resistance of the main circuit
v. Timing test
vi. Test certificate for all resin cast / moulded components of circuit breakers whose partial discharge measurement are specified in the relevant IEC (No. 62271-100, Cl. No.6.2.9) shall be furnished by the manufacturer.

CURRENT TRANSFORMER:

i. Polarity test and verification of terminal markings test
ii. Ratio and phase angle error test (accuracy class; composite error test)
iii. Power frequency withstand tests
iv. Inter-turn over voltage tests
v. Partial discharge measurement
vi. Knee point voltage for PS Class current transformers

POTENTIAL TRANSFORMER:

i. Polarity tests and verification of terminals
ii. Power frequency withstand test
iii. Determination of errors
iv. Partial discharges measurement

RELAY:

i. Relay pick-up test for all functions and phases
ii. Relay timing test for all functions and phases
iii. Conformance test as per IEC 61850

STATION AUXILIARY TRANSFORMER:

i. Measurement of winding resistance
ii. Ratio, polarity and phase relationship
iii. Impedance voltage at normal, maximum and minimum tap for each winding
iv. Regulation at rated load and at unity, 0.8 lagging p.f.
v. Efficiencies at u.p.f. and 0.8 p.f. at 50%, 75% and 100% loading
vi. No load loss and no load current
vii. Load Losses and total losses
viii. Insulation resistance between windings and windings to earth
ix. Separate source voltage withstand test
x. Induced over-voltage withstand test
xi. Magnetic balance test
xii. Physical verification and dimension checking
xiii. Measurement of Tan Delta and capacitance of windings and bushing
xiv. Zero sequence impedance measurement

4.6.3. COMMISSIONING CHECKS / SITE TEST

After delivery and installation of All the switchgear panels and accessories at site, the afore-mentioned routine tests shall be carried out during trial run and commissioning.

All testing equipment including HV test kit, required for testing of the switchgear panels and accessories at site, shall be provided by the contractor free of charge on returnable basis. In the event of repeated testing becomes necessary, the entire expenditure on such repeat tests shall be borne by the contractor.

All testing equipment shall have the up-to-date calibration certificate. The contractor needs to furnish the same to the employer prior to starting of testing at site as well as at manufacturer's works, whatever the case may be.

4.7. DOCUMENTS TO BE SUBMITTED AFTER PLACEMENT OF LOA

- Name of manufacturer proposed by the contractor for each item / equipment as per **Cl. No. 4.9**.
- Performance certificates of proposed manufacturers as per **Cl. No. 4.10.**
- All Type test reports of each similar rated products of the proposed manufacturer.
- Routine Test Report / Shop Test Report of each similar rated products of the proposed manufacturer performed earlier.
- Test facilities at manufacturer's test house.
- General arrangement drawing of 11 kV Indoor Switchgear, LAVT cubicle, NGT cubicle, SAT etc. showing constructional features and space requirements for safe operation.

4.8. DOCUMENTS TO BE SUBMITTED DURING DETAILED ENGINEERING STAGE

Six (06) sets of data sheet, manual, leaflet, drawing and other documentation as mentioned below for 11 kV indoor switchgears and station auxiliary transformer shall be submitted to the Controlling Officer of the employer for according approval during detailed engineering stage.

- Guaranteed Technical Particulars (GTP) as per **Chapter – 20 (Cl. No. 20.3).**
- Detailed sectional view (front view, rear view, cross sectional view, side view) of complete switchgears as well as all the compartments / cubicles and SAT.
- Detailed drawings and characteristics for individual items viz. circuit breaker, NGT, LAVT, SAT, CT, PT, PT supply change over scheme etc.
- Schematic diagram, control philosophy & control circuit diagrams, wiring diagram etc.
- All construction drawings including equipment foundation details
- Detailed time schedule indicating submission of drawings, tentative date of inspection, delivery of items, installation, testing, trial run & commissioning.
- Detailed Bill of Material (BOM) which shall include the spare parts for five (05) years of trouble-free operation & maintenance of the above system as per **Cl. No. 19.4** and special tools, plants and equipment as per **Cl. No. 19.15.**
- Detailed Quality Assurance Plan (QAP) for routine test and field acceptance test
- Manual for installation, operation and maintenance procedure.
- Undertakings from Relay Manufacturer as mentioned in **Cl. No. 4.16.**
- Undertakings from Meter Manufacturer as mentioned in **Cl. No. 4.17.**

After approval, six (06) sets of approved drawings and documents along with soft copies for 11 kV indoor switchgears and station auxiliary transformer shall be submitted to the controlling officer of the employer.

Further, the contractor shall submit three (03) sets of successful shop / routine test reports to the controlling officer of the employer prior to dispatch of each item / equipment.

4.9. MAKE OF COMPONENTS

The contractor shall submit proposed make of 11 kV indoor switchgears and SAT including various bought out components such as relays, control switches, CTs, VTs, transformers etc. after placement of LOA. Final make shall be approved by the employer during detailed engineering stage based on the performance certificates submitted by the contractor. For approved makers list of WBSEDCL for various components, the bidders are requested to go through **Cl. No. 4.15** and **Chapter – 21** of this Technical Specifications.

4.10. CREDENTIAL AND PERFORMANCE CERTIFICATES

The contractor shall submit Performance Certificates issued to the proposed manufacturers by the respective employer for similar kind of job. The contractor shall also furnish documents in support of supply, delivery of similar equipment / system indicating thereon names of the organization, quantity ordered and quantity supplied along with their submission after placement of LOA. Non-submission of the same will be liable for rejection of the proposed manufacturers.

4.11. GUARANTEE

Guarantee of the total equipment including any integral part of the equipment should be up to Defect Liability Period of the project.

4.12. COMPLETENESS OF EQUIPMENT / SYSTEM

All items, equipment, fittings and accessories etc. for any specified equipment / system that may not be specifically mentioned in the specification but necessary for completeness of the system shall be deemed to be covered under the scope of this contract. No extra charges will be paid to the contractor for the same.

4.13. SYNCHRONIZATION

Auto-synchronization shall be done at the 11 kV voltage level by synchro-check relay (25) as mentioned in the **Plant SLD**. Necessary arrangements (separate synchronizing cubicle at the control room) of the same shall be provided for each incoming feeder (from generating unit) by the contractor.

4.14. SCHEDULE OF REQUIREMENT

Sl. No.	Description	Quantity
1	Complete 11 kV indoor switchgear panel comprising of 11 kV 1250 A bus bar, 3 nos. of 11 kV VCB, 2 nos. of 11 kV Load Break Switch, CTs, PTs, Terminal blocks, Indicating Meters, Relays and other accessories as detailed in this specification	One (01) Set
2	LAVT cubicle complete with all required equipment and accessories as detailed in this specification	As required
3	Neutral grounding cubicle complete with all required equipment and accessories as detailed in this specification	As required
4	Instrumentation, control and safety devices for turbine as per **Cl. No. 2.26**	As required
5	Integration with SCADA System as per **Cl. No. 4.4.14**	As required
6	11/0.415 kV, 250 kVA, dry type indoor Station Auxiliary Transformers as per **Cl. No. 4.5**	Two (02) sets
7	Special tools, plants and equipment as per **Cl. No. 19.15**	As required
8	Spare parts as per **Cl. No. 19.4**	As required
9	Completeness of equipment / system as per **Cl. No. 4.12**	As required

4.15. STANDARD MAKE

Item	Make
VCB	CGL / BEL / SCHNEIDER / SIEMENS / ABB

Item	Make
Vacuum Interrupter	CGL / BEL / SCHNEIDER / SIEMENS / ABB
Relays	ALSTOM / ABB / SIEMENS / SCHNEIDER
Current Transformer	PLASTOFAB / BMC / PRAGATI / ECS / KAPPA
Potential Transformer	PLASTOFAB / BMC / PRAGATI / AUDIO-VISION / ECS
Breaker Control Switch / Selector Switch	KAYCEE / ALSTOM / RECOM / SWITRON / L&T / SIEMENS / ABB
Voltmeter / PT Selector switch	KAYCEE / RECOM / SWITRON
Ammeter / Voltmeter	AE / RISHAV / SECURE / ACCORD / SCHNEIDER / MECO
Energy meter	SECURE METER LTD. / LARSEN & TOUBRO LTD. / LANDIS & GYR LTD. / GENUS POWER INFRASTRUCTURE LTD.
Push Buttons	ALSTOM / KAYCEE / VAISHNO / TEKNIC / LUMEN / STS / SIEMENS / L&T / SCHNEIDER
Indicating Lamps with lenses	ALSTOM / KAYCEE / VAISHNO / TEKNIC / LUMEN / STS / SWITRON
Panel wiring	ECKO / PHOENIX / FINOLEX / HAVELLS / KEI / RR KABLES / POLY CAB (with ISI mark)
Hooter / Buzzer / Bell	ANCHOR / KAYCEE/ VAISHNO / STS / JVS / BHARANI / ALAN
Annunciator	MINILEC / ALAN / INSTALARM / EAPL
MCB / MCCB	SIEMENS / L&T / SCHNEIDER / ABB / KAYCEE / LEGRAND / GE
Terminal Block	ELMEX / CONNECTWELL
TTB	DAV INDUSTRIES / CGL / JVS / UNITECH SALES / KEIZEN / PLASTOFAB

4.16. UNDERTAKINGS FROM RELAY MANUFACTURER

4.16.1. (TO BE SUBMITTED IN THE LETTER HEAD OF RELAY MANUFACTURER)

We hereby confirm that the protective relay(s) type _____

i.
ii.
iii.

offered by us against your tender No._____ through M/s._____ are in our current range of production. We also confirm that these relays will not be phased out by us in the next 10 years from the date of supply. Necessary repairs / replacements if necessary during this period will be made available by us.

Name & Designation:

Company Seal:

4.16.2. (TO BE SUBMITTED IN THE LETTER HEAD OF RELAY MANUFACTURER)

We have offered our relay(s) type _____

i.
ii.
iii.

to M/s. _____ against WBSEDCL's tender no._____.

In this connection we hereby confirm that we would be extending all the required technical support and back-up guarantee to M/s._____ for the above mentioned relay(s).

Name & Designation :

Company Seal :

4.17. UNDERTAKINGS FROM METER MANUFACTURER

4.17.1. (TO BE SUBMITTED IN THE LETTER HEAD OF METER MANUFACTURER)

We hereby confirm that the Meter(s) type _____

i.
ii.
iii.

offered by us against your tender No._____ through M/s._____ are in our range of production. We also confirm that these meters will not be phased out by us in the next 10 years from the date of supply. Necessary repairs / replacements if necessary during this period will be made available by us.

Name & Designation :

Company Seal :

4.17.2. (TO BE SUBMITTED IN THE LETTER HEAD OF METER MANUFACTURER)

We have offered our meter(s) type _____

i.
ii.
iii.

to M/s. _____ against WBSEDCL's tender no._____. In this connection we hereby confirm that we would be extending all the required technical support and back-up guarantee to M/s._____ for the above mentioned meter(s).

Name & Designation :

Company Seal:

5. MAIN TRANSFORMER

5.1. SCOPE

This section of the specification covers the design & engineering, material selection, manufacture, testing at works, supply, delivery at site, transit insurance, storage at site, erection, testing at site, trial run and commissioning of one (01) no. Main Transformer with associated auxiliary equipment and one (01) no. 1,000 LPH capacity Mobile Transformer Oil Treatment Plant for Lodhama-II Small Hydro-electric Power Project at power house elevation of 1066.55 m above MSL.

The transformer shall be located in the transformer yard near the power house. main tank body may be delivered in unpacked condition, but delicate parts like indicating meter, radiator, conservator, pressure relief valve (PRV), equalizer pipe, buchholz relay etc. shall be packed to avoid damage during transport.

The scope of supply shall also include spares, special tools and testing devices, which are essential for installation, operation and maintenance for five (05) years trouble free operation of the plant, even though these are not individually or specifically stated in this specification but recommended by the manufacturer. All the material & workmanship shall be of suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

The transformer and associated equipment shall be suitable for interfacing with SCADA system and all necessary transducers shall be included in the scope of supply.

5.2. STANDARDS

The equipment and materials covered by this specification shall conform to the latest edition of following IS / IEC except where specified otherwise in this specification:

Sl. No.	Standards	Description
1	IS: 2026 (Part I to IV) / IEC 76	Power transformer
2	IS: 5120	Fittings and accessories for power transformers
3	IS: 335	Transformer oil
4	IS: 325	Oil pumps
5	IS: 3637	Gas and oil operated relay
6	IS: 2099 / IEC 137	Transformers bushings
7	IS: 6088	Dimensions for porcelain transformer bushings
8	IS: 3347 / IEC: 354	Loading guide for oil-immersed transformers
9	IEC: 551	Transformer noise level
10	CBIP Manual	CBIP manual on transformers publication, Technical Report 1: Section : A.D. (Revised: 1987)
		CBIP technical report No. 72 (June: 1989)

Equipment complying with other internationally accepted standards such as A.S., B.S., V.D.E. etc. will also be considered if they ensure constructional features and performance equivalent or superior to standards listed above. In such a case the contractor shall clearly indicate the standards adopted and furnish a copy in English of the standards adopted along with copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

5.3. TECHNICAL REQUIREMENTS

The MVA rating of the Main Transformer shall be sufficient to evacuate power generated by the generators under full load condition as well as 10% overload condition at ambient temperature and voltage and frequency variations. The step up transformer shall have off circuit tap changer (OCTC) with tap ranging from –15% to +05% in steps of 1.25% at HV Side. The transformer shall operate without injurious heating at the rated MVA at any voltage within +/-10% of the rated voltage at particular tap. The transformer shall be designed to deliver rated MVA continuously even at the lowest tap without exceeding specified temperature rise.

In case of total failure of power supply to cooling fans, the transformer shall be able to operate at full load for at least ten (10) minutes without exceeding the calculated winding hot spot temperature on maximum yearly weighted avg. temperature (98°C as per IEC). Also stopping of one of the cooling fans should not affect the overall cooling system.

HV line terminals shall be brought out through 33 kV class porcelain / XLPE bushing. Terminal connector shall be suitable for connecting 33 kV XLPE Cable.

Ambient Air Temperature:

- Maximum ambient air temperature : 50^0 C
- Maximum daily average ambient air temperature : 40^0 C
- Maximum yearly weighted average ambient temperature : 32^0 C
- Minimum ambient air temperature : – 5^0 C

Maximum allowable Temperature rise:

Maximum allowable temperature rise over the above ambient temperature condition shall be as mentioned below:

- Maximum top oil temperature rise : 50^0 C
- Maximum winding temperature rise : 55^0 C
- Maximum winding temperature : 105^0 C
- Permissible limit of avg. temp. of winding after 2 sec of short circuit : 250^0 C

5.4. CORRECTION FOR HIGH ALTITUDE

All the transformers, being located at more than 1000 m above MSL (about 1066.55 m), necessary corrections for temperature rise and Insulation levels / electrical clearance shall be applied as per relevant standards while installing the transformer at site.

5.5. SYSTEM DETAILS

11 kV system will be non-effectively earthed through neutral grounding transformer at generator neutral point, whereas 33 kV system will be effectively earthed at neutral point of the star connected HV winding of the main transformer.

System voltage may be subjected to a fluctuation of ±10% of nominal voltage. Maximum system voltage for 33 kV and 11 kV system shall be taken as 36 kV & 12 kV respectively. The frequency shall be 50 Hz with a variation limit of +3% to –5%.

5.6. SHORT CIRCUIT WITHSTAND CAPABILITY

The main transformer shall be designed to withstand short circuit current of 25 kA for 3 sec. without damaging the thermal and dynamic capacities. This capability shall be demonstrated by type test report following relevant standard.

The transformer shall also be designed for operation at unbalanced loading conditions and shall be free of partial discharges over the range of operating voltages.

5.7. INTEGRATION WITH SCADA SYSTEM

The transformer and associated equipment shall be suitable for interfacing with SCADA system and all necessary transducers shall be included in the scope of supply.

5.8. TRANSFORMER TYPE AND RATING

Sl. No.	Standards	Description
1	Type	Core type, 3Φ, oil immersed, step-up, two winding copper wound transformer
2	No. of phases	Three (03)
3	Installation	Outdoor
4	Rated continuous MVA at max. ambient temperature of 40^0 C	12.5 MVA
5	% impedance at 75^0C refer to the normal / principal tapping at rated MVA and frequency	8.35 % (subject to a tolerance of ± 10 % as per the relevant standards)
6	Type of cooling	ONAF
7	Winding material	Copper
8	Type of conservator	Air bag type
9	Voltage ratio	11 / 33 kV
10	Rated frequency	50 Hz
11	Max. flux density at rated voltage and frequency at principal / normal tapping	The max. flux density in any part of the core and yokes shall not exceed 1.60 Tesla at normal voltage and 1.90 Tesla under over voltage condition.
12	Connection of Transformer	
	• HV winding	Star
	• HV neutral	The neutral point of HV winding shall be brought out to a separate insulated terminal and shall be solidly earthed

Sl. No.	Standards	Description	
	• LV winding	Delta	
	• Vector group	YNd11	
13	Terminals	Shall be provided with bushing insulators on both HV and LV sides. HV and LV Bushings shall be located on opposite side.	
14	Type of Bushing		
	• HV terminal	Weather proof, shaded porcelain / XLPE bushing, 36 kV class	
	• LV terminal	Porcelain / XLPE bushing, 12 kV Class	
	• HV neutral terminal	Neutral of HV winding shall be brought out through porcelain / XLPE bushing similar to HV bushing for connection with earth terminal in line with HV bushing.	
15	Rated voltage (Ur)		
	• HV winding	33 kV	
	• LV winding	11 kV	
16	Highest voltage (Um)		
	• HV winding	36 kV	
	• LV winding	12 kV	
17	Power frequency withstand voltage		
	• HV winding / bushing	70 / 70 kV (rms)	
	• LV winding / bushing	28 / 28 kV (rms)	
	• HV neutral / bushing (min.)	95 kV (rms)	
18	Lightning impulse withstand voltage		
	• HV winding / bushing	170 / 170 kV (peak)	
	• LV winding / bushing	75 / 75 kV (peak)	
	• HV neutral / bushing (min.)	170 kV (peak)	
19	Minimum creepage distance in air		
	• HV bushing	900 mm	
	• LV bushing	300 mm	
20	Tap changer	OCTC (+ 05 % to – 15 % @ 1.25 %)	
21	Minimum clearances	Phase to phase	Phase to earth
	33 kV	350 mm	320 mm
	11 kV	255 mm	140 mm
22	Short circuit capacity	25 kA for 3 sec.	

Sl. No.	Standards	Description
23	Insulation	
	• HV Winding	Class A (winding insulation shall be able to withstand 33 kV continuously)
	• LV Winding	Class A (uniformly insulated)
24	Voltage withstand capacity during sudden disconnection of load	1.4 times the rated voltage: 5 sec. 1.25 times the rated voltage: 1 min. 1.1 times the rated voltage: continuous
25	Noise level	as per NEMA TR- 1 standard
26	Cooling medium	Mineral oil as per IS 335
27	Body earthing	As per relevant standard
28	Installation	Outdoors on rails
29	HV Bushing CT:	In order to achieve restricted earth fault protection in star connected HV side of main transformer, CT shall be provided in HV bushings and neutral bushing of 12.5 MVA main transformer.
	CT ratio	300 /1 A
	No. of cores	Two (02)
	Accuracy class	PS
	Knee point voltage	≥ 250 V
	Max. sec. winding resistance	R_{CT} at 75^{0}C < 4 Ω at lower and higher ratio
	Max. excitation current (mA) at knee point voltage	30 mA at V_K/2 (at lower ratio)
30	No load loss	7 kW
31	Load loss at full load, principal / normal tapping and at 75°C	70 kW

5.9. LOSSES & PENALTY

i. Iron loss (no load loss) in kW at rated voltage and at rated frequency, and load losses (copper loss) in kW at rated full load capacity, rated voltage & frequency, principal / normal tapping and at 75°C shall be guaranteed by the contractor in the guaranteed technical particulars (GTP) to be submitted by him during detailed engineering stage.

ii. The contractor shall not specify any tolerance limit in respect of these losses.

iii. If any or all actual losses after test are found to exceed the guaranteed values, penalty shall be imposed on the excess loss over the corresponding guaranteed loss (any or all) in the following manner.

- @ Rs. 3,34,447.00 per kW for the excess of no load loss and
- @ Rs. 1,51,616.00 per kW for the excess of the load loss.

For fraction of a kW the penalty shall be applied as prorate basis.

iv. The guaranteed values for losses (no load loss and load loss) shall be within the values specified in **Sl. No. 31** and **Sl. No. 32** of **Cl. No. 5.8.**

v. The employer reserves the right to reject the product offered by the contractor if the tested values for no load loss and load loss exceed the corresponding specified values as mentioned in **Sl. No. 31** and **Sl. No. 32** of **Cl. No. 5.8.**

5.10. DESIGN AND CONSTRUCTION (GENEARATOR TRANSFORMERS)

5.10.1. GENERAL

The materials and workmanship shall be of suitable commercial quality as have proven successful in similar services and under similar conditions.

5.10.2. CORE

Core shall be constructed from high grade cold rolled non-aging grain oriented silicon steel laminations having magnate / carlite coating as insulation. The contractor shall offer inspection of the core for approval by the employer during manufacturing stage. Manufacturer's call notice for the purpose should be accompanied with the following documents as applicable as a proof towards use of prime core materials:

i. Invoice of the supplier
ii. Mill's test certificate
iii. Packing lists
iv. Bill of landing
v. Bill of entry certificate to customs, if applicable

Core materials shall be procured either from the core manufacturer or through their accredited marketing organization. Contractor/manufacturer shall preferably have in-house core cutting facility for proper monitoring and control on quality.

The design of the magnetic circuit shall be such as to avoid static discharge, development of short circuit paths within itself or to the earthed clamping structure and the production of flux components at right angles to the plane of the laminations, which may cause local heating. The materials used for insulation shall have high inter lamination resistance and rust inhibiting property. It shall not have any tendency to absorb moisture or to react with insulating oil.

The assembled core / top main core shall be securely clamped on the limbs and yoke with uniform pressure so as to minimize noise emission from it. The top main core clamping structure shall be connected to the tank body by a copper strap. The bottom clamping structure shall be earthed by one or more of the following methods:

- by connection through vertical tie rods to the top structure
- by direct metal to metal contact with the 3 tank base by the weight of the core and windings,
- by a connection to the top structure on the same side of core the main earth connection to the tank.

All parts of the cores shall be robust design capable of withstanding any shocks to which they may by subjected during lifting, transport, installation and service. Adequate lifting lugs shall be provided to enable the core and winding to be lifted. Adequate provision

shall be made to prevent movement of the core and winding relative to the tank during transport and installation or while in service.

The supporting frame work of the cores shall be so designed to avoid the presence of pockets which would prevent complete emptying of the tank through the drain valve or cause trapping of air during filling.

The insulation structure for the core to bolts and core to clamp plates shall be such as to withstand a voltage of 2 kV AC at 50 Hz for one (01) minute.

FLUX DENSITY OF CORE

The maximum flux density in any part of the core and yokes at principal / normal tapping and at rated voltage & frequency shall not exceed 1.60 Tesla and 1.90 Tesla under overvoltage condition.

5.10.3. WINDING

- The winding conductor shall be of copper material. The conductors shall be transposed at sufficient intervals in order to minimize eddy currents and equalize the distribution of currents and temperatures along the windings.
- Power transformer shall be designed to withstand the impulse and power frequency test voltages as specified in **Cl. No. 5.8 (Sl. No. 17** and **Sl. No. 18)**.
- The windings shall be designed to minimize the out-of-balance forces in the transformer at all voltage ratios.
- The insulation of transformer winding and connections shall be free from insulating material liable to soften, ooze out shrink or collapse and shall be non-catalytic and chemically inactive to transformer oil during service.
- The stacks of windings shall receive adequate shrinkage treatment before final assembly. Adjustable device shall be provided for taking up any possible shrinkage of coils in service.
- All windings shall be fully insulated. All the insulating materials to be used in the transformer shall preferably be of class 'A'.
- The coil clamping arrangement and the finished dimensions of any oil ducts shall be such that it will not impede free circulation of oil through the ducts.
- The windings and connection of transformer shall be braced to withstand shocks which may occur during transport or due to switching short circuit and other transient conditions during service. In any case crimping at joints is not allowed.
- Coil clamping rings, if provided shall be of steel or suitable insulating material. Axially laminated material other than bakelised paper shall not be used.

5.10.4. INTERNAL EARTHING ARRANGEMENTS

- **General:** All metal parts of the transformer with the exception of the individual core laminations, core bolts and associated individual clamping plates shall be maintained at fixed potential.
- **Earthing of Core Clamping Structure:** The top & bottom main core clamping structures shall be connected to the tank body by copper straps.
- **Earthing of Magnetic Circuit:** The magnetic circuit shall be earthed to the clamping structure at one point only, through a link placed in an accessible position beneath an inspection opening in the tank cover. The connection to the link shall be on the same side of the core as the main earth connection.

Where oil ducts or insulating barriers parallel to the plane of the lamination divide the magnetic circuit into two or more electrically separate parts, the ducts of barrage shall be bridged by tinned copper strip bridging pieces to maintain electrical continuity and the magnetic circuit shall not be regarded as being of sectional construction.

- **Earthing of Coil Clamping Rings:** Where coil clamping rings are of metal at earth potential, each ring shall be connected to the adjacent core clamping structure on the same side of transformer as the main earth connection.
- **Earthing Terminals:** Two (02) earthing terminals capable of carrying the full amount of lower voltage short circuit current of transformer continuously for a period of five (05) sec. shall be provided. Provision shall be made at positions close to each of the bottom two corners of the tank for bolting the earthing terminals to the tank structure to suit local condition.

5.10.5. TANK

CONSTRUCTION:

Conventional type tank shall be constructed. The transformer tank and cover shall be fabricated from good commercial grade low carbon steel suitable for welding and of adequate thickness. The tank shall be complete with all accessories and shall be designed so as to contain the complete transformer, be filled with oil, be lifted by crane or jacks, be transported without overstraining any joint and without causing subsequent leakage of oil. The main tank body shall be capable of withstanding vacuum gauge pressure 68.0 kN per m^2. (500 mm of Hg).

The under carriage of the tank shall be made of channel of suitable size and design. The base of each tank shall be so designed that it shall be possible to move the complete transformer unit by skidding in any direction without injury when using plate or rails. It shall be designed to prevent retention of water, where the base is of a channel construction. Tank stiffeners shall be properly designed to prevent retention of water.

Wherever possible, the tank and its accessories shall be designed without pockets where gas may accumulate. Where pockets cannot be avoided, pipes shall be provided to vent the gas into the main expansion pipe.

All joints other than those which may break shall be properly welded. All bolted joints to the tank shall be fitted with suitable oil tight gaskets which shall give satisfactory service under the operating and guaranteed temperature rise conditions. Special attention shall be given to the methods of making hot oil tight joints between the tank & the cover, the cover & bushing etc. to ensure that the joints can be remade at site.

TANK COVER:

Each tank cover shall be of adequate strength and shall not distort when lifted. Necessary inspection openings shall be provided to give easy access to bushings or tap changing or testing the earth connection. Each inspection opening shall be of ample size for the purpose for which it is provided with suitable lifting arrangement.

The tank cover shall be fitted with pockets for thermometer and bulbs of oil and winding temperature indicators. The thermometer pocket shall be fitted with a captive screwed top to prevent the ingress of water. Protection shall be provided, where necessary, for each capillary tube. The pocket shall be located in the position of maximum oil temperature and it shall be possible to remove the instrument bulbs without lowering the oil in the tank. Turrets should be provided on tank cover to house the bushings. The top

of turrets of both HV & LV bushings should be connected through pipes with main tank Buchholz Relay pipe or should have air release plug to drive out trapped air. Turret top of LV side should have bolted cover and turret pipe should have suitable sections to have access to the CTs as and when required, inside them.

Lifting eyes or lugs shall be provided on all parts of the transformer including tank, requiring independent handling during assembly or dismantling. The tank and the inspection covers shall also have suitable lifting arrangement.

5.10.6. CONSERVATOR VESSEL

CONSERVATOR VESSEL:

The conservator should be air cell / atmoseal type to prevent direct contact of transformer oil with atmospheric air for retarding oxidation contamination of oil. The air cell shall be made from suitable material with inner coating resistant to transformer oil & outer coating resistant to ozone & weathering.

The conservator shall be provided with necessary valves to drive out the air in the space between conservator wall & air cell during filling of oil, drain valves for complete draining of oil and cut off valves etc.

The conservator complete with necessary valves shall be provided in such a position as not to obstruct the electrical connections to the transformer from HV & LV side.

The conservator shall be of capacity to meet the requirement of expansion of the total cold oil volume in the transformer & cooling equipment and it should be such that the oil level will always be visible through the plain Oil Level Gauge.

The conservator shall be designed so that it can drain oil completely by means of the drain valve provided when mounted. One end of the conservator shall be bolted into position so that it can be removed for cleaning purpose.

OIL GUAGES:

One magnetic type oil gauge shall be provided. The oil level at 30^0C shall be marked on the gauge. A plain oil level gauge shall also be provided on the opposite side of the conservator, on which MOG is provided with marking as per IS.

CONNECTION:

The oil connection from the transformer tank to the conservator vessel shall be arranged at a raising angle of 3^0 to 9^0 to the horizontal up to the Buchholz Relay and shall consist of suitably sized pipe as per IS: 3639. Two valves shall be provided between the conservator & transformer main tank to cut off the oil supply to the transformer after providing a straight run of pipe for at least a length of five times the internal diameter of the pipe on the tank side of the gas and oil actuated relay and at least three times the internal diameter of the pipe on the conservator side of the gas and oil actuated relay. The valves should be fitted on both side of the gas and oil actuated relay.

BREATHER:

The conservator vessel shall be fitted with a glass container type breather with silica gel dehydrating agent. All breathers shall be mounted at approximately 1400 mm above ground level and shall be connected to the air cell of the conservator through pipe for the purpose of breathing during contraction or expansion of the air cell. The breather shall be so designed that

i. The external atmosphere is not continuously in contact with the Silica gel.

ii. The moisture absorption indicated by a change in colour of the tinted crystals can be easily observed from the distance.

5.10.7. BUSHINGS & TERMINATION ARRANGEMENT

Pollution free, weather proof insulator should be used for the bushings. The bushing should be located on suitable turrets. Adjustable arcing horns should be provided on the bushings. Bushings of Identical voltage rating shall be interchangeable. All bushings shall be equipped with suitable terminals of approved type size and shall be suitable for bimetallic connection.

The bushing shall have high factor of safety against leakage to ground and so located as to provide adequate electrical clearance between bushings & grounded parts.

HV bushings shall be suitable for connection of 33 V XLPE Cables whereas LV bushings shall be suitable for connection of 11 kV XLPE Cables coming from 11 kV indoor switchgear.

The electrical characteristics of bushings / bushing insulators shall be in accordance with relevant IEC standards / IS: 3347 / IS: 2099. Any stress shield shall be considered as an integral part of bushing assembly.

5.10.8. FILTER AND DRAIN VALVES, SAMPLING DEVICES AND AIR RELEASE PLUGS

Each Transformer shall be fitted with the following :

i. The filter and drain valves. as required.
   A drain valve as specified below shall be fitted to each conservator.
   For diameter up to 650 mm : Size of the valve 15 mm
   For diameter above 650 mm : Size of the valve 25 mm.
ii. Suitable oil sampling device shall be provided at the top and bottom of the main tank. The sampling device shall not be fitted on the filter valves.
iii. One 15 mm air release plug on the main tank of the transformer.
iv. All other valves opening to atmosphere shall be fitted with blank flanges.
v. The drain valve and bottom filter valve should be provided with a protective cover with nuts and bolts arrangement

5.10.9. TRANSFORMER COOLING SYSTEM

General: The transformer shall be ONAF cooled. All cooling equipment shall be mounted on the transformer and supported in such a manner that no additional foundations are required. All cooling equipment shall include supports, mountings, automatic control equipment, conduits and wiring. Alarm relays shall be provided to indicate loss of AC power.

Radiator: Radiators shall be so designed as to avoid pockets in which moisture may collect and shall withstand the pressure tests.

The radiator tubes / fins shall be seamless, made of mild steel having a minimum wall thickness of approx. 1.2 mm and a clean bright internal surface free from dust and scale. They shall be suitably braced to protect them from mechanical shocks, normally met in transportation and to damp the modes of vibration transmitted by the active part of the transformer in service. Each cooler unit shall have a lifting eye.

Radiator valves: Metal valves shall be provided for isolating detachable radiator assembly. One cock at the bottom of radiator stack shall be provided for draining oil. Air release plug at the top of radiator stack shall be provided for release of locked air. Removable blanking plates shall be provided to permit the blanking off the main oil connection of cooler.

Radiator fixing bands in top & bottom of radiators shall be provided to minimize the vibration of the same.

5.10.10. LIFTING AND HAULAGE FACILITIES

Each tank shall be provided with

i. Lifting lugs suitable for lifting of transformer complete with oil.
ii. Jacking lugs, in accessible positions to enable the oil filled transformer to be raised or lowered using hydraulic or screw jacks. The minimum height of the lugs above the base shall be
    a. Transformers up to and including 10 tones weight : 300 mm
    b. Transformers above 10 tones weight : 500 mm
iii. Suitable haulage holes.

5.10.11. PRESSURE RELIEF DEVICE

Pressure relief device (PRD) of sufficient sizes shall be provided for release of any pressure that may be generated within the tank, and which might result in damage to the equipment. The device shall operate at a static pressure of less than the hydraulic test pressure for transformer tank. Provisions shall be made to prevent ingress of rain. It shall be mounted on the cover of the main tank and shall be designed to prevent gas accumulation. Spring loaded setting type PRV having suitable opening port hole according to the capacity of the transformers should be provided. The PRV shall have provision of visual indication for opening of the valve and also contract/micro switch arrangement for alarm/tripping function.

5.10.12. GAS AND OIL ACTUATED RELAY

Transformer shall be provided with double float type gas and oil actuated relay (Buchholz Relay) conforming to IS: 3637 with one set of alarm contacts, one set of trip contacts and a testing pet cock. The contacts shall be wired with a PVC armoured cable. A machined surface shall be provided on the top of relay to facilitate the setting of relay and to check the mounting angle in the pipe and cross level of the relay.

The pipe work shall be so arranged that all gas arising from the transformer shall pass into the gas and oil actuated relay. The oil circuit through the relay shall not form a delivery path in parallel with any circulating oil pipe.

5.10.13. TAP CHANGING EQUIPMENT

The transformer shall be provided with Off Circuit Tap Changer (OCTC) mechanism. It shall be suitable to vary the voltage on HV side between +05% to -15% in steps of 1.25 %.

The OCTC shall include the following:

a) An oil immersed tap selector and arcing switch or arc suppressing tap selector, provided with reactor or resistor for reduction of make and break arcing voltages and short circuits.
b) Control and protection devices
d) Local tap changer position indicator
e) Manual / electrical operating device.

The OCTC shall be designed so that the contacts do not interrupt arc within the main tank of the transformer. The tap selector and arcing switch or arc suppressing tap selector switch shall be located in one or more oil filled compartments. The compartment shall be provided with oil surge relay with trip float arrangement. Those compartments shall be designed so as to prevent the oil in tap selector compartment from mixing with the oil in the transformer main tank.

The tap changer shall be capable of permitting parallel operation with any other future transformers of the same type as master or follower. Necessary interlocks, blocking independent control when the units are in parallel, shall be provided. Under parallel operation, if the controlling one tap changer sticks, the arrangement must be such as to switch off supply to the motor so that an out of step condition is limited to only one tap difference between the units. Details of out of step protection provided for the taps should be furnished by the contractor during detailed engineering stage.

The manual operating device shall be located on the transformer so that it can be operated by a man standing at the level of the transformer track. It shall be strong and robust in construction.

Complete particulars of the tap changing gear shall be stated in Guaranteed Technical Particulars (GTP) to be submitted by the contractor during detailed engineering stage. The OCTC should be type tested.

5.10.14. WHEELS

The Transformer shall be provided with flanged wheel suitable for use on gauge track. The wheels shall be suitable for being turned through an angle of 90^0 and locked in that position when the tank is jacked up. All wheel shall be detachable and shall be made of cast iron or steel. Suitable locking arrangement shall be provided to prevent the accidental movement of the transformer.

5.10.15. CLEANING & PAINTING

Before painting or filling with oil, all galvanized parts, interior of all transformer tanks, other oil filled chambers and internal structural steel work shall be completely cleaned and free from rust, scale and grease and all external surface cavities on castings shall be filled by metal deposition. These surfaces shall be painted with hot oil resisting varnish or paint. Unexposed welds need not be painted.

Except for nuts, bolts and washers, which may have to be removed for maintenance purposes, all external surfaces, shall receive a minimum of three coats of paint. The primary coat shall be applied immediately after cleaning. The second coat shall be of oil paint of weather resisting nature and preferably of a shade or colour easily distinguishable from the primary and final coasts shall be applied after the primary coats have been touched up where necessary. The final coat shall be of glossy oil and weather resisting non fading paint of Dark Admiralty Grey shade no. 632 of IS:5. Primer

paint shall be ready made zinc chrome as per IS: 104: Intermediate and final costs of paint shall be as per IS: 2932.

All interior surfaces of mechanism chambers and kiosks except those which have received anti-corrosion treatment shall receive three coats of paint applied to the thoroughly cleaned metal surface as per procedure mentioned above. The final coat shall be of a light coloured anti-condensation mixture.

Any damage to paint work incurred during delivery shall be made good by the manufacturer / contractor by thoroughly cleaning the damage portion and applying the full number of coats of paint that had been applied before the damage was caused.

5.11. TRANSFORMER OIL

Oil for first filling together with 10% extra oil shall be supplied with each transformer. The oil shall comply to the latest edition IS: 335. Particular attention shall be taken to deliver the oil free from moisture having uniform quality throughout in non-returnable steel drums. The quantity of oil for first filling of each transformer shall be stated in the offer. The oil should have the following characteristics:

Sl. No.	Characteristics	Requirement
1	Interfacial tension at 27^0C (min)	0.04 N/m
2	Electrical strength (Breakdown voltage)	60 kV (rms) after treatment at 2.5 mm gap
3	Resistivity at 90^0C / 27^0C	35 x 10^{12} / 1500 x 10^{12} Ohm-cm
4	Dielectric dissipation factor (tan delta at 90^0C max.)	0.002

After site processing through filtration and before commissioning, the moisture content shall be less than 10 ppm.

5.12. CURRENT TRANSFORMER

The outdoor type current transformers (CT) to be used at the HV bushing and HV neutral bushing of the main transformer shall comply with the requirements of latest issue of IS: 2705. The rating of CTs are as mentioned in **Sl. No. 30** of **Cl. No. 5.8**.

5.13. TEMPERATURE INDICATING DEVICES

The oil and winding temperature indicator each with two (02) electrical contacts for alarm and trip purposes and with repeater for remote indication, shall be provided with anti vibration mounting. The temperature indicators shall be housed in the marshalling box of the transformer. Remote indication of oil and winding temperature shall be provided in RTCC panel and as such the temperature indicators shall be compatible for the same. Special care shall be taken for packing and transportation of WTI and OTI.

The oil and winding temperature indicator should be of renowned make. The scale on the dial of the thermometer should be 0^0C to 150^0C. The signaling contacts of the oil and winding temperature indicator shall be set to operate at the following temperature:

Oil temperature indicator	**:**	**Alarm** - 80^0 C	**Trip** – 90^0 C
Winding temperature indicator	**:**	**Alarm** - 85^0 C	**Trip** – 95^0 C

The tripping contacts of indicators shall be adjustable between 60^0 C and 120^0 C whereas the alarm contacts of indicators shall be adjustable between 50^0 C & 100^0 C.

All contacts shall be adjustable on a scale and shall be accessible on removal of the cover. The temperature indicators shall be so designed that it shall be possible to check the operation of contacts and associated equipment.

For measuring winding temperature a heater coil fed from a CT has to be provided on the pocket for winding temperature indicator bulb. The connection from CT to heater should be through a link arrangement on the tank cover suitably housed in a weather proof box so that CT current and heater coil resistance can be checked.

5.14. MARSHALLING BOX

A sheet steel, vermin proof, well ventilated and weather proof marshalling box of a suitable construction shall be provided for the transformer ancillary apparatus. The box shall have domed or sloping roofs and the interior & exterior painting shall be in accordance with **Cl. No. 5.10.15.** The degree of protection shall be IP 54.

The marshalling box shall accommodate.

i. Oil and winding temperature indicator.
ii. Terminal blocks and removable cable gland plates for cables.
iii. Protection and control equipment for the cooling equipment
iv. One (01) space heater operated by 230 V AC auxiliary supply,
v. Cubicle illuminating lamp with door switch.
vi. 5 A, 240 V, 3 pin socket with switch

All the above equipment shall be mounted on panels and back of panel wiring shall be used for Interconnection. The temperature indicators shall be so mounted that the dials are visible by standing at ground level. Door of the compartment shall be provided with non glass transparent type acrylic window of adequate size. Ventilation louvers shall be provided. Cable box shall be suitable for 11 kV, 2R, 300 mm^2, Aluminium XLPE Cables. Suitable removable cable gland plates shall be provided at the bottom of kiosk for passage cables.

5.15. RATING DIAGRAM AND PROPERTY PLATES

The following plates shall be fixed to the transformer tank at a suitable height so that the particulars could be read by standing at ground level.

i. A rating plate bearing the date specified in the relevant clauses of IS: 2026 including figures of temperature rise of oil and winding and high voltage test values.
ii. A diagram plate showing the internal numbering of taps, tapping switch connection of windings and also the voltages vector relationship in accordance with IS: 2026 and in addition a plan view of the transformer giving the correct physical relationship of the terminals. No load voltage shall be indicated for each tap. Details of CT particulars i.r.o. phase, neutral & WTI CT shall be mentioned.
iii. A property plate showing that the equipment belongs to WBSEDCL with reference of purchase order.

5.16. CENTRE OF GRAVITY

The centre of gravity of the assembled transformer shall be low and as near the vertical centre line as possible. The transformer shall be stable with or without oil. If the centre of gravity is eccentric relative to track either with or without oil, its location shall be shown on the outline drawing.

5.17. OPERATION

The transformer shall be suitable for operating in transformer yard beside the power house of Lodhama II Small Hydro-electric Power Plant. This shall operate Independently with provision of parallel operation.

5.18. DUTY UNDER FAULT CONDITION

It is to be assumed that normal voltage will be maintained on one side of the transformer when there is a short circuit between phases or to earth on the other side. The thermal ability to withstand short circuit shall be two (02) Sec. without injury for 3φ dead short circuit at the terminals.

The transformer may be directly connected to an underground or overhead line and may be switched in and out of service together with or without its associated incoming / outgoing line.

5.19. RATED VOLTAGE OF OPERATING DEVICE

Rated voltage for indicating & operative device shall be 110V DC / 230V AC with variation as specified in the relevant Indian Standard.

5.20. CONTROL AND ANNUNCIATION SCHEME

The transformer shall be provided with sufficient number of contacts for the following annunciation and alarms / trips on the initiating relay / device with a provision of local as well as remote control and operation:

- Oil temperature high alarm and trip
- Winding temperature high alarm and trip
- Oil and gas relay alarm and trip
- Low and high oil level alarm (for both conservator & tap changer tank)
- AC supply fail
- Pressure relief device (PRD) operated
- Loss of fans (single or total)
- Earth fault protection
- Instantaneous and time delayed over current
- Over Voltage and under voltage

5.21. TRANSFORMER OIL TREATMENT PLANT

The transformer oil treatment plant shall be mobile type, high vacuum, 1000 LPH capacity with all accessories, mounting and spares conforming to IS: 6034 or equivalent international standard.

The oil treatment plant shall be capable of delivering the following results for transformer oil conforming to latest edition of IS 335 or any other international standard in single pass.

Sl. No.	Parameters	Pre-Processing Values	Post Processing Values
1	Breakdown voltage	20 kV	>60 kV
2	Water content	60 PPM	Less than 10 PPM
3	Particle size	Many particles	One micron
4	Gas content	10% by volume	0.1% by volume

5.22. TESTS

5.22.1. TYPE TESTS

The transformer and accessories including transformer oil treatment plant shall be subjected to all kind of type test in accordance with the latest version of relevant standards. The contractor shall submit type test report from CPRI / NABL / Govt. approved Laboratories having identical type, rating and voltage ratio similar to the tendered item during detailed engineering stage, carried out within ten (10) years from the date of this NIT Publication. The contractor may be required to furnish the original type test reports with test results, if desired by the employer.

TYPE TEST AFTER ROUTINE TESTS

The employer shall have the right to ask the contractor to perform the type tests again, after routine test, on the transformer following relevant Indian Standard from CPRI / NABL accredited / Government recognized test house or laboratory in presence of the employer's representative. The contractor shall be liable to arrange the same.

The amount charged by the test house / laboratory for carrying out such type tests only will be reimbursed to the contractor on production of necessary supporting documents.

5.22.2. ROUTINE / ACCEPTANCE TESTS

The transformer and accessories including transformer oil treatment plant shall be subjected to following minimum routine tests as per relevant standards.

a) Measurement of winding resistance and magnetizing current
b) Measurement of voltage ratio, polarity and check of voltage vector relationship
c) Measurement of no load loss and load loss
d) Measurement of short circuit impedance and excitation current
e) Measurement of Insulation resistance before and after dielectric test
f) Dielectric tests
   - Separate source withstand voltage test
   - Induced AC overvoltage withstand test
g) Magnetic balance test
h) Testing of phase & neutral bushing CTs
i) Oil leakage test of transformer tanks at a pressure equals to the normal pressure plus 35 kN / m^2. measured at the base of tank.

j) Tests on 'off circuit tap changer' (OCTC)
k) Operation of tap changer from RTCC as well as from OCTC
l) Tests on gas and oil actuated relay / Buchholz relay
m) Tests on RTCC Panel and marshalling box
n) Short circuit test
o) Measurement of zero sequence impedance
p) Measurement of acoustic sound level
q) Tests on oil filled in transformer
r) Oil pressure test on completely assembled transformer
s) Any other routine tests as per relevant standards

All acceptance tests shall be carried out at manufacturer's works following relevant IS & IEC in presence of the employer's representatives. Employer shall have the right for retesting rejection of the item(s) if the test results found unsatisfactory. The entire cost of acceptance and routine tests shall be deemed to be included in the quoted price by the contractor.

5.22.3. COMMISSIONING CHECKS / SITE TESTS

After delivery and installation of the transformer and accessories at site, the afore-mentioned routine tests shall be carried out during trial run and commissioning.

All testing equipment including HV test kit, required for testing of the transformer and accessories at site, shall be provided by the contractor free of charge on returnable basis. In the event of repeated testing becomes necessary, the entire expenditure on such repeat tests shall be borne by the contractor.

All testing equipment shall have the up-to-date calibration certificate. The contractor needs to furnish the same to the employer prior to starting of testing at site as well as at manufacturer's works, whatever the case may be.

5.23. DOCUMENTS TO BE SUBMITTED AFTER PLACEMENT OF LOA

- Name of manufacturer proposed by the contractor for each item / equipment as per **Cl. No. 5.25**.
- Performance certificates of proposed manufacturers as per **Cl. No. 5.26.**
- All Type test reports of each similar rated products of the proposed manufacturer.
- Routine Test Report / Shop Test Report of each similar rated products of the proposed manufacturer performed earlier.
- Test facilities at manufacturer's test house.

5.24. DOCUMENTS TO BE SUBMITTED DURING DETAILED ENGINEERING STAGE

Six (06) sets of data sheet, manual, leaflet, drawing and other documentation as mentioned below for the main transformer and accessories including transformer oil treatment plant shall be submitted to the Controlling Officer of the employer for according approval during detailed engineering stage.

a) Guaranteed Technical Particulars (GTP) as per **Chapter – 20 (Cl. No. 20.4)**
b) General outline drawing showing general arrangement of accessories and overall dimensions, net and shipping weights etc.

c) Outline dimension drawings of transformers and fittings / accessories
d) Assembly drawings and weight of main components
e) Transport drawings, showing main dimensions and weight of each package
f) All construction drawings including equipment foundation details
g) Detailed drawings of transformer fittings / accessories viz. bushing (both HV & LV), off circuit tap changer (OCTC), marshalling box
h) Large scale drawings of HV and LV winding of the transformers, showing the nature and the arrangement of insulation and terminal connection
i) Excitation characteristics curves (Flux density vs core loss, flux density vs excitation)
j) Requirement of Transformer Oil
k) General Arrangement & scheme drawing, wiring diagram and explanatory note for RTCC Panel
l) Calculations in support of the ability to withstand short circuit on consideration of highest value that may attain
m) Detailed time schedule indicating submission of drawings, tentative date of inspection, delivery of items, installation, testing, trial run & commissioning.
n) Detailed Bill of Material (BOM) which shall include the spare parts for five (05) years of trouble-free operation & maintenance of the above system as per **Cl. No. 19.5** and special tools, plants and equipment as per **Cl. No. 19.15.**
o) Detailed Quality Assurance Plan (QAP) for routine test and field acceptance test
p) Manual for installation, operation and maintenance procedure.
q) Name-plate diagrams etc.

After approval, six (06) sets of approved drawings and documents along with soft copies for 11 kV indoor switchgears and station auxiliary transformer shall be submitted to the controlling officer of the employer. In addition one set of approved drawing, manual for transformer shall also be send to the Project Site in water proof folder at the time of delivery of the transformer.

Further, the contractor shall submit three (03) sets of successful shop / routine test reports to the controlling officer of the employer prior to dispatch of each item / equipment.

5.25. MAKE OF COMPONENTS

The contractor shall submit proposed make of main transformer and accessories including transformer oil treatment plant after placement of LOA. Final make shall be approved by the employer during detailed engineering stage based on the performance certificates submitted by the contractor. For approved makers list of WBSEDCL for various components, the bidders are requested to go through **Chapter – 21** of this Technical Specifications.

5.26. CREDENTIALS AND PERFORMANCE CERTIFICATES

The contractor shall submit Performance Certificates issued to the proposed manufacturers by the respective employer for similar kind of job. The contractor shall also furnish documents in support of supply, delivery of similar equipment / system indicating thereon names of the organization, quantity ordered and quantity supplied along with their submission after placement of LOA. Non-submission of the same will be liable for rejection of the proposed manufacturers.

5.27. GUARANTEE

Guarantee of the total equipment including any integral part of the equipment should be up to Defect Liability Period of the project.

5.28. COMPLETENESS OF EQUIPMENT / SYSTEM

All items, equipment, fittings and accessories etc. for any specified equipment / system that may not be specifically mentioned in the specification but necessary for completeness of the system shall be deemed to be covered under the scope of this contract. No extra charges will be paid to the contractor for the same.

5.29. SCHEDULE OF REQUIREMENTS

Sl. No.	Description	Quantity
1	12.5 MVA, outdoor type 11/33 kV, 3 φ, 50 Hz., oil filled, ONAF step up transformers with OCTC (+05 % to –15 % @ 1.25 %) complete with all fittings and accessories	One (01) set
2	Transformer oil treatment plant, 1000 LPH capacity with all accessories as per **Cl. No. 5.21**	One (01) set
3	Co-ordination and provision of necessary contacts and/or ports for integration with plant SCADA system	As required
4	Lot-Oil for first filling plus 10% extra	As required
5	Special tools, plants & equipment as per **Cl. No. 19.15**	As required
6	Spare parts as per **Cl. No. 19.5**	As required
7	Completeness of the equipment / system as per **Cl. No. 5.28**	As required

6. 33 KV POWER EVACUATION SYSTEM

6.1. SCOPE

This specification covers the design, manufacture, shop testing at manufacturer's works, supply, delivery at site, transit insurance, storage at site, erection, testing & commissioning of complete 33 kV power evacuation system for Lodhama II Small Hydro-electric Project, as specified hereunder and as given in schedule of requirements. The transmission line shall be constructed as per WBSEDCL's standard practice in hilly region.

The scope of supply shall also include spares, special tools and testing devices, which are essential for installation, operation and maintenance for five (05) years trouble free operation of the plant, even though these are not individually or specifically stated in this specification but recommended by the respective manufacturers. All the material & workmanship shall be of suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

6.2. STANDARDS

The equipment covered under this specification shall comply with the requirement of latest edition of following IS/BS/IEC specifications except where specified otherwise.

Sl. No.	Standards	Description
1	IEC: 60694, IEC: 60298, IEC: 62271-200, IEC: 60529. IS: 3427, IS: 12729, IS 12063, IS:13947, IS: 9046	AC metal enclosed switchgear & control gear for rated voltages above 1 kV & up to & including 52 kV
2	IS: 13947	Degree of Protection provided by enclosures for switchgear.
3	IS: 1901	Specification for visual indication lamps
4	IS: 5	Colors for ready mixed paints & enamels
5	IEC 60056	Vacuum Interrupter
6	IEC: 62271-100, IS: 13118, IS: 2516	High Voltage AC circuit breakers
7	IEC: 60185, IS: 2705	Current Transformers.
8	IEC: 60185, IS: 3156	Voltage Transformers.
9	IEC: 60694	Common clauses for high voltage switchgear & control gear
10	IS: 1248	Indicating electrical measuring instruments
11	IS: 8686, IS: 3231, IS: 3842	Electrical relays for power systems
12	IS: 8084	Inter connecting bus bars for AC voltage between above 1kV up to and including 36kV
13	IEC: 99-4	Metal Oxide Surge Arresters without gates for AC systems

Sl. No.	Standards	Description
14	IS: 1818 / IS:9921 / IEC: 129 / IEC: 62271-102	Alternating current isolators and earthing switches
15	IS: 398 (Part I & II)	Aluminium conductors for overhead transmission purposes - specification
16	IS: 6875	Control switches and push buttons
17	IEC: 61000	Electromagnetic compatibility
18	IS: 375	Arrangement of switchgear bus bars, main connection and auxiliary wiring
19	IS: 6005	Code of practice for phosphating iron & steel
20	Indian Electricity Rules 1956	
21	Indian electricity act 2003	
22	Any other standards applicable (with latest amendments	

6.3. UNIT OF MEASUREMENT AND LANGUAGE

In all correspondence, technical schedules and drawings prepared by the manufacturer, the metric units of measurement shall be used. On drawings or printed pamphlets where other units have been used, the equivalent metric measurements shall be added. All documents, correspondence, drawings, reports, operating and maintenance instructions / manuals and nameplate details of the equipment shall be in English language.

SPECIFIC TECHNICAL REQUIREMENTS / PARAMETERS

6.4. 33 KV INDOOR SWITCHGEAR

PANEL CONSTRUCTION:

Sl. No.	Item	Details
1	Nominal system voltage	33 kV
2	Highest system voltage	36 kV
3	Make	Authorized System Integrator of VCB Manufacturer will be allowed subject to compliance of Cl No. 6.21, 6.22 & 4.15 (except First row) of Vol-6: Part III
4	Type of installation	Indoor
5	Enclosure type	Dead front, floor- standing, rigid welded steel frames fully compartmentalized, metal clad, vermin proof, suitable for indoor installation and provision for bolting to the floor.
6	Degree of protection (min.)	IP 42
7	Enclosure material	CRCA steel / Alu-zinc

Sl. No.	Item	Details
8	Metal sheet thickness	2.0 mm (min.)
9	Gland plate (detachable type)	3.0 mm MS, detachable type for 3 core cable and 5.0 mm, Aluminium for single core cables. Cable compartment shall have an anti vermin guard plate for protection against entry by rats, rodents etc.
10	Compartment	Switchgear design shall comprise of one (01) vertical compartment for 33 kV feeder. The system shall comprise of CTs, PTs, cables, meters, relays etc.
11	Breaker to bus bar compartment	Through seal off bushing
12	Breaker to cable compartment	Through seal off bushing
13	Breaker compartment door	Separate with lockable handle
14	Pressure relief devices	To be provided
15	Bus support insulator	Non hygroscopic, track-resistant, high strength, epoxy insulators (calculation for validating dynamic force withstand capability to be submitted by the contractor during detailed engineering stage)
16	Fixing arrangement i. Doors ii. Covers iii. Gasket	Concealed hinged bolted with SS bolts and neoprene rubber gasket, washer
17	Required HV cable termination height in the cable	550 mm
18	Panel base frame	Steel base frame as per maker's standard
19	Handle	Removable bolted covers for cable chamber and bus bar chamber shall be provided with C type handle
20	Prevention of internal arc	Shall be type tested against internal arc as per provision in IEC: 62271-200. The circuit breaker, bus bars and cable compartments shall be provided with arc venting outlet. The doors for the compartments shall be capable of withstanding the effects of maximum internal arcing fault without being blown off and causing danger to personnel and other equipment This should be proven by successful testing as per relevant IEC standard.
21	Space heater	Thermostat control space heater with switch

Sl. No.	Item	Details
		for isolation to be provided in breaker, HT cable & instrument compartments.
22	Cable tray	Netted metal cable tray of suitable size at the rear side of switchgear, preferably running at the top along the panel for carrying the signal cables for SCADA interface to be provided.
23	Multi-way terminal Block and low voltage wiring	Delinking type, rail/channel mounted, terminal connector to be used in CT circuit & screw type for other circuits. The Terminal Blocks should be suitable for respective wire sizes and covered with insulated transparent cover. Pitch should be minimum 8mm & 10mm for screw type & delinking type connectors respectively. The LV cable shall be enclosed in grounded metal conduit when routed through a HV compartment. Control wiring shall be neatly bundled and tie wrapped where applicable. Wiring shall be protected from rubbing against door flanges or other parts of the enclosure. Min. 100 mm clearance to be maintained between two rows of Terminal Block. 25% spare terminal blocks shall be provided.
24	Ferrules	a) Plastic ferrules conforming to IS to be used. Same marking is to be used at both ends of wires. b) Ferrule markings will be as follows : AC Circuit: H1, H2, H3 - - - - - Metering circuit: D11, D31, D51 - - Protection Circuit: C11, C31, C51 - - REF / Differential protection CT Circuit: A11, A31, A51 - - Main DC Circuit: J1, J2, J3 - - - - - - DC Control Circuit: K1, K2, K3 - - - - Indication Circuit: L1, L2, L3 - - - - - Motor Circuit: M1, M2, M3 - - - - PT Circuit: E11, E31, E51 - - - Spare circuit: U1, U2, U3 - - - - - c) Plastic channels, inter panel wiring through PVC sleeves / suitable grommets
25	Earth bus	A ground bus rated to carry maximum fault current shall be furnished along the full length of the panel board. Each stationary unit shall be grounded directly to ground bus. All bolted joints in the bus will be made

Sl. No.	Item	Details
		by connection of two bolts. The earth bus shall be of electrolytic copper, rectangular shape with adequate cross sectional area (50 x 6 mm min.) and shall be capable of 25 kA for 3 Sec fault level. Earthing conductors shall be of annealed high conductivity stranded copper.
26	Internal wiring	a) 1.1 kV grade PVC insulated stranded flexible copper wire to be used. b) Size of wire will be as follows: CT circuit : 4.0 sq. mm. PT circuit : 2.5 sq. mm. Main AC & DC circuit : 4.0 sq. mm. Other circuit : 1.5 sq. mm. c) A suitable wiring duct system with covers, firmly fixed on the panel shall be installed for front to rear and inter panel wiring to offer ease in inspection and maintenance. d) Wiring between terminals of the various devices shall be point to point. Splices or tee connection will not be acceptable. e) Wires shall be suitably bunched adequately supported to prevent sagging and it shall have sufficient clearance from High voltage system. f) Colour of wires will be as follows: For CT & PT circuit: R Phase: Red, Y Phase: Yellow, B Phase: Blue, Neutral: Black For DC circuit: Grey For Earth circuit: Green.
27	Power switch & socket	5 Amp rated power socket & switch to be provided in instrument compartment
28	Illuminating lamp	9 Watt, LED type
29	Surface cleaning	Seven tank process or sand blasting
30	Painting	Powder coating with texture finish, minimum thickness of 50 microns
31	Paint shed	RAL 7032
32	Elevation at which installed	EL 1071.55 m
33	Rated current at 33 kV Bus @ 50^0C ambient	630 A
34	Auxiliary DC supply	110 V DC, shall be controlled by suitably rated MCB / MCCB.

Sl. No.	Item	Details
35	Auxiliary AC supply	240 V, 50 Hz, shall be controlled by suitably rated MCB / MCCB.
36	Cable Entry	From bottom for power cable, through remote terminal box installed at the backside of the panel for control cables.
37	SCADA compatibility	Yes

6.5. CIRCUIT BREAKER

The 33 kV circuit breaker shall be triple pole horizontal drawing out type suitable for installation in the switchgear cubicle. The breakers shall comply with IEC: 62271-100 / IS: 13118 / IS: 2516 conforms to latest amendment thereof.

The circuit breaker shall be spring operated, motor charged, manually released spring closing mechanism with three pole simultaneous operation. The indicating device shall show the OPEN and CLOSE position of breaker visible from front of the cubicle. The spring charging time of the motor shall not exceed 15 sec. The "TRIP" and "CLOSE" coils shall be of reliable design and low consumption preferably less than 300 W. It shall be possible to manually charge the circuit breaker operating spring in case of auxiliary supply failure.

The circuit breaker shall be isolated by horizontal racking and positively fixing the unit into any one of the following positions:

- **Service Position:** Main and auxiliary circuits connected
- **Test Position:** Main circuits disconnected, auxiliary circuits connected. Circuit breaker in its isolated position shall be completely contained in the apparatus compartment with shutters on main circuit and compartment front door closed.
- **Withdrawn Position:** Main circuits and auxiliary circuits disconnected. Circuit breaker is removed out of the cubicle

Locking of circuit breaker in the test position shall be made possible by means of key lock on the earth switch maneuver. A position indicator switch or viewing window must be provided for visual indication of the circuit breaker position.

Each circuit breaker shall be provided with following accessories.

- ON-OFF Indicator for indicating circuit breaker position.
- Trip push button
- Shunt trip coil, operating between 70 % – 110 % of rated control voltage.
- Close coil, operating between 85 % – 110 % of rated control voltage.
- Spring charging motor, operating between 90 % – 110 % of rated control voltage.
- Two trip coils and one closing coils shall be provided in all the breakers.

The switchgear shall be provided with facilities for full operation from a remote point. For local operation of circuit breakers, control switch of circuit breaker shall be located at such a height so that a man can operate standing on ground / floor. It shall be possible to trip the circuit breaker locally by mechanical means.

The circuit breaker truck shall ensure earth in both connected and disconnected positions.

An electro-mechanical device shall be provided to ensure the auxiliary circuits have been securely connected between the fixed and moving portions of the switchgear, before

allowing closing operation of the circuit breaker. The voltage rating of the device shall be the same as the voltage used for the closing circuit.

Tripping and/or release coils shall be continuous rated to ensure longer life but rating should not exceed 300 W each. The electrical tripping device shall be of a type which acts directly on the circuit breaker mechanism and shall give positive operation for a supply voltage of 70 % of nominal at DC and 85 % of nominal at AC control voltage.

Comprehensive interlocking system to prevent any dangerous or inadvertent operation shall be provided. Each circuit breaker shall be interlocked to prevent:

- the breaker being inserted into service position unless it is open
- the breaker being withdrawn from the service position unless it is open
- the breaker being closed unless it is fully in the service or test position
- remote operation whilst in the withdrawn / test position

Circuit breakers shall be mechanical latching and electrical and mechanical tripping. The operating mechanism shall be trip-free and shall include an anti-pumping device.

Circuit Breaker compartment should have automatic shutters, which shall be opened and closed by the mechanical drive of the circuit breaker. The bus bar and circuit spout covers shall be operated independently of each other. Padlock facilities can be provided on the metal shutters.

The Circuit Breakers shall have the following ratings:

Sl. No.	Item	Details
1	Type	Vacuum Circuit Breaker (VCB)
2	No of Poles	Three (03)
3	Nominal System Voltage	33kV
4	Highest System Voltage	36 kV
5	Installation	Indoor
6	Altitude above mean sea level (meter)	1071.55
7	System neutral earthing	Earthing transformer
8	Insulating level 1.2/50 micro- Sec impulse withstand volt. (between line & earth)	+/- 170 kVp
9	1 min power frequency withstand voltage between line & earth (dry & wet)	70 kV rms
10	Rated continuous current	630 Amps: 1 no.
11	Short time withstand current	25 kA for 3 sec.
12	Short circuit making current	62.5 kA
13	Min. creepage distance between phase to ground and between CB terminals	900 mm
14	Break time	Less than 60 ms
15	Make time	Less than 120 ms
16	Operating cycle	Min. 10000 operating cycles

Sl. No.	Item	Details
17	Operation counter	Mechanical operation counter to be provided in the breaker trolley with count range 0 to 9999.
18	Operating mechanism	Duty cycle O- 0.3 sec-CO-3 min-CO
19	Control voltage	110 V DC (+ 10 % to – 15 %)
20	Range of auxiliary voltage	
	Closing	85 % - 110 %
	Tripping	70 % - 110 %
	Spring charging	85 % - 110 %
21	Total opening time	Not more than 4 cycles
22	Total closing time	Not more than 5 cycles
23	Method of isolation from switchgear	Trolley mounted draw out type
24	Electrical indication	CB ON, CB OFF, Spring Charged, CB in test / service position, flush mounted type high intensity, clustered LED lamps to be used. Colour of the lamps will be as follows: a) Breaker ON : Red b) Breaker OFF : Green c) Spring charged : Blue d) Auto trip : Amber e) Test / Service position : White
25	Anti pumping	Anti Pumping Relay (94) to be provided in the breaker panel. PLA type relay / contactor is not acceptable.
26	Local remote selector switch	Switch should be 4 pole 2 ways lockable and stay put type
27	Operating mechanism	Spring / Spring
28	Mode of operation	Gang operated
29	Minimum number of spare contacts	6 NO + 6 NC
	No. of spare contacts of service and test position limit switch contact	2 NO + 2 NC
	No. of spare contacts of spring charge limit switch	2 NO + 2 NC
30	Spring charge limit switch	The circuit breaker shall be provided with motor operated spring charged closing. Spring charging by motor should be smooth and hassle free

Sl. No.	Item	Details
		and there should be nominal sound during spring charging. Motor should be 230 Volt AC operated. Tripping of the circuit breakers shall be through "shunt trip" coils rated for 110 V DC auxiliary supply. It shall be possible to trip the breaker manually in case of necessity. 2 NC : For motor circuit 1 NO : For breaker closing circuit 1 NO : For breaker closing permissive to be used in relay 1 NO : For panel spring charged indication AC operated contactor may be used for contact multiplication of limit switch, if required, for indication and spare contacts.
31	Breaker electrical operation features	
	Trip coil supervision	To be given for breaker close and open condition
	Trip coil supervision relay contact	For indication and alarm
	Master trip relay (NO) contact	Wired directly to trip coil
	Master trip relay (NC) contact	Wired to inhibit closing of breaker
	DC control supply and AC supply bus in all panels	Single DC and AC Incoming source shall be fed. Isolating fuse units shall be provided for incoming supplies.
	Emergency trip push button contact	Wired directly to trip coil of breaker
	PT supply in all panels	Fed by 33 kV line PT
32	Functional requirements (interlock and safety devices)	
	Breaker compartment door opening	Can't be opened unless breaker is OFF and racked out to test position
	Breaker compartment door closing	Shall be possible even when breaker in isolated position
	Racking mechanism safety interlock	Mechanical type
	Racking in or out of breaker inhibited	When the breaker is closed
	Racking in the circuit breaker inhibited	Unless the control plug is fully engaged
	Disconnection of control plug inhibited	As long as the breaker is in service position

Sl. No.	Item	Details
33	Additional Requirement	
	Exposure to live parts	In case the breaker panel door is required to be opened during a contingency, the personnel should not be exposed to any live parts. Suitable shrouds / barriers / insulating sleeves shall be provided as required.
	Operation of breaker in local	In either service or test position
	Operation of breaker in remote	Only in service position
	Protection trip	Both in local and remote position of LR switch
	Closing from local	Only when local/remote selector switch is in local position
	Closing from remote	Only when local / remote selector switch is in remote position
	Tripping from local	Selector switch in local
	Tripping from remote	Selector switch in remote position
	Testing of breaker	In test or isolated position keeping control plug connected
34	First pole to clear factor	1.5
35	Rated line charging breaking current	10 A
36	Rated cable charging breaking current	50 A
37	Rated transient recovery voltage (TRV) (TRV peak valve-KV)	62

MANDATORY PARTICULARS FOR VACUUM BOTTLE:

Vacuum Interrupter bottle shall be VCB manufacturer's own make and suitable to full short circuit breaking of 100 operations.

The vacuum interrupter, consisting of fixed contact and moving contact, shall be interchangeable among the same type interrupter. Short circuit capacity of vacuum bottle shall be 25kA and design life should be 100 nos. operation at rated short circuit level.

Constructional features of the vacuum chamber along with its functional arrangements shall be shown in a drawing and submitted during detailed engineering stage.

The gap between contacts of the Circuit Breaker inside interrupter should be capable of withstanding 1.5 times voltage to neutral at one atmospheric pressure at normal ambient condition within Breaker in the event of vacuum pressure drop due to leakage.

The circuit breakers and their components shall be capable of withstanding the mechanical forces and thermal stresses of the short circuit current of the system without any damage or deterioration of material.

Sl. No.	Item	Description
1	Make	CGL / BEL / SCHNEIDER / ABB / SIEMENS
2	Rated voltage	33 kV
3	Highest system voltage	36 kV
4	Rated current	630 A
5	Short time withstand current	25 kA for 3 sec.
6	Insulating level 1.2/50 micro- Sec impulse withstand volt.(between line terminals and ground)	+/- 170 kVp
7	1 min power frequency withstand voltage between line terminals and ground (dry & wet)	70 kV rms
8	Frequency	50 Hz.
9	Short circuit making current	62.5 kA
10	Mechanical endurance capacity	30000 operation
11	Electrical endurance capacity	10,000 operation in line with IEC
12	Minimum electrical life	100 nos. at rated short circuit current

6.6. ISOLATOR / DISCONNECTING SWITCH

The 33 kV isolator shall be outdoor type, motorized, three phase, single break, suitable for manual operation and upright mounting on steel structure. Each pole unit of the multi-pole Isolators shall be of identical construction and mechanically linked for gang operation.

The design shall be such that the operating mechanism with the linkages shall be suitable for mounting on any of the outer pole ends without much difficulty and with minimum shifting of parts. The isolators are required to be used in electrically exposed installations and this should be taken into account while fixing the clearance between phases and between phase and earth.

Moving contacts of all isolators shall rotate for sufficient angular displacement from their "Fully Closed Position" to "fully open position" so that the break is distinct and clearly visible from ground level.

The isolators shall be suitable to carry the rated current continuously and full short circuit current for three (03) sec. at site condition without any appreciable rise in temperature. These shall also be suitable for operation at 110 % rated (normal) voltage. The Isolators shall be suitable for isolating low capacitive / inductive current. The limits of magnitudes of the same shall be furnished by the contractor in the Guaranteed Technical Particulars (GTP).

RATING:

Sl. No.	Item	Details
1	Type	Porcelain type
2	No. of poles	Three (03)

Sl. No.	Item	Details
3	No. of phase	Three (03)
4	Nominal system voltage	33 kV
5	Highest system voltage	36 kV
6	System frequency	50 Hz.
7	Material of contact	Electrolytic copper
8	Maximum continuous current rating	400 A
9	Quantity	1 no.
10	Rated short time withstand current	25 kA (rms) for 3 sec.
11	Rated peak withstand current	62.5 kA (peak)
12	Phase center for Isolator	1220 mm
13	Min. clearance between fixed and moving contacts of Isolator in fully open position	520 mm
14	Height of the post insulators	508 mm
15	System neutral earthing	Non-effectively earthed
16	Impulse withstand voltage (to earth and between poles)	170 kV (peak)
	Impulse withstand voltage (across the isolating distance)	195 kV (peak)
17	Power frequency withstand voltage (to earth and between poles)	70 kV (rms)
	Power frequency withstand voltage (across the isolating distance)	80 kV (rms)
18	Earth switch	Shall be provided
19	Operating mechanism	Motorized with provision of manual operation
20	Maximum temperature rise	As per relevant IS

MAIN CONTACTS:

The isolator shall have heavy duty, self aligning and high pressure, line type contacts made of high conductivity, corrosion resistant, hard-drawn electrolytic copper strips 50mm x 3mm jaw type. Fixed contacts should be suitable for 400 A rating. The hard-drawn electrolytic copper strip should be silver plated of 20 micron thickness and fixed contacts should be backed by powerful phosphor bronze / stainless steel springs of suitable numbers.

The isolator blades forming the moving contacts shall be made from rod of high conductivity hard-drawn electrolytic copper having 20 mm. diameter and wall thickness should be sufficient for 400 A rating. Current density for other current carrying copper parts should not exceed 1.75 A/mm^2.

These fixed and moving contacts shall be able to carry the rated current continuously and the maximum fault current of 25 kA for 3 sec. without any appreciable rise in temperature.

The isolator blades shall retain form and straightness under all conditions of operation including all mechanical stresses arising out of operation and rated short circuit condition.

Fixed guides shall be provided so that even when the blades are out of alignment by one (01) inch (max.) at the time of closing of switches, proper seating of the blades in between the contacts and adequate pressure to give enough contact surface shall be ensured. Whenever possible, the blades shall be counter balanced by weights & springs at the end of the travel both on opening and closing of the isolator. The springs shall be made of durable and non-rusting type alloy.

The contacts shall be self cleaning type by the wiping action created by the movements of the blades. The surface of the contacts shall be rendered smooth and silver-plated.

Isolator main switch shall be required to make or break the line charging current with no significant change in voltage occurs across the isolating distance.

CONNECTOR:

The isolator shall be supplied complete with high conductivity bimetallic single grooved bolted type of terminal connectors made from Aluminium Alloy (LM - 6 grade) suitable for connecting 'ACSR DOG' (100 mm^2) conductor. The support plate shall be universal type i.e. rigid type connector for conductors shall have to be fitted on support plate without altering or modifying the support plate. The other connector shall be fitted at the free end of the "Flexible Jumper". Current density for terminal connector (Aluminium) shall be 1 A/mm^2 max. The entry of conductors to the isolators along with the phase centres of the isolators i.e. the centre line of the conductors and bushings of the isolators in a phase shall be in a straight line. Suitable precautions shall be taken to inhabit bimetallic action with the aluminium conductors.

OPERATING MECHANISM:

The operating mechanism shall be simple & ensure quick and effective operation for motorized as well as manual operation. Manual operating mechanism for main isolator shall be through lever / hand on the operating shaft. The design shall be such as to enable one man to operate it with nominal effort. The operating mechanism shall be suitable to hold the main switch in closed or open position to prevent operation by gravity, wind, short circuit, seismic acceleration, vibration, shock, accidental touching.

The isolator blade shall be in positive continuous control throughout the entire cycles of operation. The operating rods and pipes shall be rigid enough to maintain positive control under most adverse conditions and to withstand all torsion and bending stresses arising from operation. Operation of the switches at any speed should not result in improper functioning, in displacement of parts / mechanism after final adjustment has been made. All holes in cranks, linkages etc. having moving pins shall be drilled and fitted accurately so as to prevent slackness and least motion.

EARTHING:

The 33 kV system neutral is solidly earthed. The Isolators to be installed in the 33 kV outgoing feeder shall be provided with earth switches as mentioned in the **Plant SLD**, fixed with nuts and bolts, the diameter of the bolts being 12 mm in at least one of the three base channels provided in each set of Isolator. Besides that, each operating handle shall be provided with earthing terminal along with bolt and nut of above mentioned sizes.

MARKING:

Name Plate shall have to be provided in each channel of Isolator with the information as specified in Cl. No. 10.1 of IS: 1818-1972. The Name Plate should be weather proof &

corrosion proof. Manufacture's serial number, employer's name and employer's order reference shall be indicated in the Name Plate.

6.7. CURRENT TRANSFORMER

Current Transformers conforming to latest edition of IS: 2705 (Part I, II, III & IV) / IEC: 60044 shall be mounted inside the 33 kV switchgear. CTs shall have insulation Class 'B' or better. Contact tips on primary side shall be silver plated. Correct polarity shall be invariably marked on each primary and secondary terminal. Secondary stud shall be of good quality brass material.

Primary shall be wound or bar type, rigid, high conductivity grade copper conductor. Unavoidable joints on the primary conductor shall be welded type, preferably lap type. Current density at any point shall not exceed 1.60 Amp./sq.mm. Suitable insulated copper wire of electrolytic grade shall be used for CT secondary winding. Multi ratio in CT shall be achieved by reconnection of secondary winding tapping. The secondary terminals shall have screw type terminals. The screw should have sufficient length for connection of at least two (02) nos. wires with plain and spring washers and minimum 10 mm clearance between the adjacent screws.

The exciting current shall be as low as possible and the CTs shall be capable of maintaining its rated accuracy at different burdens and saturation limits. The supplier shall ensure that the current transformers have adequate burden (VA output) for the type of protection & metering offered. CT characteristics shall be such as to provide satisfactory performance for burdens ranging from at least 25% to 100% of rated burden, in case of metering CT cores and knee point voltage, in case of protection CT core. PS class CTs shall have low secondary resistance and high knee point voltage so as to avoid any possibility of CT saturation under through fault conditions. The contractor shall furnish calculations in support of selection of above parameters for the offered CTs.

The design and construction of CTs shall be sufficient to withstand the thermal and mechanical stresses resulting from the specified short circuit currents. Maximum permissible temperature rise of the CT winding with rated continuous primary current at rated frequency and burden over an ambient temperature should be as per IS: 2705 (Part-I): 1992, considering ambient temperature 40°C for design purpose.

The core of the CTs shall be high grade non-ageing, silicon laminated steel of low hysteresis loss and high permeability to ensure high accuracy confirming to IS: 3024. Primary & secondary windings shall be of copper. Size, no. of turns etc are to be mentioned in GA drawing in line with short circuit test report.

One (01) set of CT for the 33 kV outgoing feeder as per **Plant SLD**. The CT shall be installed inside the 33 kV Indoor Switchgear. CT secondary connection terminals should be clearly visible and accessible from the back side of the breaker assembly after opening the rear cover plate. Necessary protections shall be provided for the personnel.

RATING:

Sl. No.	Item	Details
1	Type	Outdoor type
2	Nominal system voltage	33 kV
3	Highest system voltage	36 kV
4	Installation	Indoor

Sl. No.	Item	Details		
5	No of phases	Single		
6	Insulation class	Class 'B' or better		
7	Short time withstand current	25 kA for 3 sec		
8	Rated dynamic current	62.5 kA (peak)		
9	Ratio	300 / 1 – 1 – 1 Amp		
10	No. of Secondary winding	Two (03)		
11	Accuracy Class	0.2S	5P20	PS
12	Output burden (VA)	As required	As required	–
13	Instrument Security factor	≤ 5	-	–
14	Accuracy Limit factor	-	20	–
15	Minimum Knee Point Voltage	-	–	250 V
16	Max. Excitation Current (mA) at Knee point Voltage	-	–	30 mA at $V_k/2$ (at lower ratio)
17	Max. CT Sec. Winding Resistance	-	–	R_{CT} at 75^0C = 4Ω
18	System frequency	50 Hz.		
19	Continuous over load capacity	120 % of rated primary current		
20	PF withstand voltage – Primary / Sec.	70 kV / 3 kV (rms)		
21	Rated lightning impulse withstand voltage	170 kV (peak)		
22	Limit of temperature rise of windings at rated current	55^0C		
23	Minimum creepage distance	900 mm		

GROUNDING TERMINALS:

Two (02) grounding terminals on diagonally opposite sides of adequate size suitable for connecting MS Flat of size of 50 mm. x 6 mm.

NAME PLATE OF CT:

Name plate for the current transformer shall be provided with all the required details as per IEC: 60044-1 / IS: 2705, including:

i. The manufacturer's name
ii. Serial number and a type designation
iii. Rated and highest voltage of the equipment
iv. Rated frequency
v. Rated primary and secondary current
vi. Rated continuous thermal current
vii. Rated output and corresponding accuracy class for each secondary winding, including the rated accuracy limit factor and instrument security factor for protection and metering secondary windings respectively.

viii. Class of Insulation
ix. Rated short-time thermal current and the rated dynamic current
x. Property Label – — "Property of WBSEDCL"
xi. Guaranteed for five (05) Years

6.8. POTENTIAL TRANSFORMERS

Potential Transformers (PT) shall be three (03) nos. single phase PT housed in a withdraw-able carriage, shall have insulation Class 'B' or better. Service position locking mechanism shall be provided and rigidity of primary stud point with earth bus in service position shall be confirmed by the contractor. Secondary stud shall be of good quality brass material.

Contact tips of primary / secondary contacts shall be silver plated. Correct polarity shall be distinctly marked on primary and secondary terminal. Secondary terminal studs shall be provided with at least three nuts, two plain and two spring washers for fixing leads. The stud, nuts and washers shall be of brass, duly nickel plated. The minimum outside diameter of the studs shall be 6 mm. the length of at least 15 mm shall be available on the studs for inserting the leads. The space clearance between nuts on adjacent studs when fitted shall be at least 10 mm.

The core of the PTs shall be high grade non-aging, silicon laminated steel of low hysteresis loss and high permeability to ensure high accuracy at both normal and over voltages conforming to IS: 3024. PT Characteristics shall be such as to provide satisfactory performance for burdens ranging from at least 25 % to 100 % of rated burden over a range of at least 05% to 100% & 190% rated voltage in case of protective cores and a voltage range of 80% to 120 % (0.8 pf lagging) in case of measuring cores. The supplier shall ensure that the PTs have adequate VA rating for required protection & metering offered.

The maximum temperature rise at 1.1 times rated primary voltages, rated frequency and rated burden shall be within the limits of relevant IS/IEC, considering ambient temperature 40° C for design purpose. The PT shall be capable to withstand line discharge effect and also the ferro-resonance effect.

REQUIREMENT:

One (01) set of PT shall be provided in the 33 kV outgoing feeder as per **Plant SLD.** PTs shall be rail mounted on top of the unit and connected on bus side. It can be plugged into and withdraw from service by pulling or pushing the PT by the handle provided on the PT. This action traverses the PT along the rails and shall automatically operate the spout shutters. The shutter drive also forms a latch which holds the PT in the service position and this latch shall be required to be released before PT can be isolated. Access to the PT and the reinforcement in the panel for allowing a person to stand on the top should be provided. Sealing arrangement of the PT with the carriage and secondary fuses are to be provided. PTs shall be mounted in a separate cubicle.

RATING:

Sl. No.	Item	Details
1	Type	Outdoor Type
2	Nominal System Voltage	33 kV
3	Highest System Voltage	36 kV
4	No of phases	Single

Sl. No.	Item	Details	
5	Installation	Indoor	
6	Rated Voltage Ratio	$33/\sqrt{3}$ kV / $110/\sqrt{3}$ V / $110/\sqrt{3}$ V	
7	Insulation Class	Class B or better	
8	Frequency	50 Hz.	
9	No of Secondary Windings	Two (02)	
10	Accuracy Class	0.2	3 P
11	Rated Burden	As required	
12	Rated voltage Factor	1.2 Continuous, 1.9 times for 30 sec.	
13	PF withstand voltage – Primary / Sec.	70 kV / 3 kV (rms)	
14	Rated Lightning Impulse Withstand Voltage	170 kV (peak)	
15	Minimum Creepage Distance	900 mm	

GROUNDING TERMINALS:

Two (02) grounding terminals on diagonally opposite sides of adequate size suitable for Connecting MS Flat of size 50 mm. x 6 mm. shall be provided.

NAME PLATE OF PT:

Name plate for the voltage transformer shall be provided with all the required details as per IEC: 60044-2 / IS: 3156 Standards, including:

i. The manufacturer's name
ii. Serial number and a type designation
iii. Rated primary and secondary voltage
iv. Rated frequency
v. Rated output and corresponding accuracy class for each secondary winding
vi. The highest voltage of the equipment
vii. Rated Insulation Level
viii. Class of Insulation for the equipment
ix. Rated voltage factor and corresponding rated time
x. The use of each secondary winding and it's corresponding terminals
xi. Property Label – "Property of WBSEDCL"
xii. Guaranteed for five (05) Years

6.9. LIGHTNING ARRESTOR

The 9 kV and 42 kV Lightning Arrestors (LA) shall be of heavy duty, station class / distribution class and gapless zinc oxide type. arrestors shall be hermetically sealed units suitable for outdoor installation on self-supporting base or structures.

DUTY REQUIREMENT:

The LAs shall be capable of discharging Lightning and switching surges and temporary power frequency over voltages. The LA shall be capable of discharging over voltages occurring during switching of unloaded transformers. The arrestors shall be capable of

withstanding Maximum Continuous Operating Voltages (MCOV). The reference current of the arrestors shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltages.

The LAs are to be provided to protect the following equipment whose insulation levels are indicated in the table given below:

Equipment to be protected	Lightning Impulse Voltage (kVp)
Power transformer	± 170 / ± 75 (HV / LV)
Instrument transformer	± 170
Circuit breaker / isolator phase to ground	± 170
Across open poles	± 195

RATING (42 kV LA):

Sl. No.	Item	Details
1	Type	Metal oxide gapless
2	Installation	Outdoor
3	System voltage	33 kV
4	Highest system voltage	36 kV
5	Rated voltage of LA	42 kV
6	Rated Frequency (Hz.)	50
7	Number as per Plant SLD	2 sets
8	Maximum continuous operating voltage (kV_{RMS})	10
9	Nominal discharge current (kA_P)	10
10	Minimum energy discharge capability (kJ/kV)	5
11	Temporary over voltage withstand capability (kV_{RMS}) for 10 sec.	42
12	Insulation housing withstand voltages i) Lightning impulse(dry) ii) Power frequency(wet) • for 10 kA • for 5 kA	Minimum values as per IEC
13	Minimum creepage distance acceptable (mm)	1100
14	(Min.) High current impulse withstand (4/10) (kV_{Peak})	100
15	Maximum Lightning Impulse (8/20 microsecond impulse) residual voltage (kVp): • 5 kA • 10 kA	 112 –
16	Maximum switching surge (30/60 microsecond	98

Sl. No.	Item	Details
	wave) protective level (kVp) • 500 A	
17	Maximum steep impulse (1/20 micro-seconds impulse) residual voltage at 10 kA (kVp)	130
18	RIV / partial discharge (micro-volt / pico-coulomb) when energized at 1.05 times its continuous operating voltage shall not exceed	250 microvolt / less than 50 pico-coulomb
19	Terminal connection	ACSR DOG

RATING (9 kV LA):

Sl. No.	Item	Details
1	Type	Metal oxide gapless
2	Installation	Outdoor
3	System voltage	11 kV
4	Highest system voltage	12 kV
5	Rated voltage	9 kV
6	Rated Frequency (Hz.)	50
7	Number as per Plant SLD	1 set
8	Maximum continuous operating voltage (kV_{RMS})	10
9	Nominal discharge current (kA_P)	10
10	Temporary over voltage withstand capability (kV_{RMS}) for 10 sec.	12
11	Insulation Housing withstand voltages i) Lightning Impulse(Dry) ii) Power frequency(wet) • for 10 kA • for 5 kA	Minimum values as per IEC
12	Min. creepage distance acceptable (mm)	300
13	(Min.) High current impulse withstand (4/10) (kV_{Peak})	65
14	Max. lightning impulse (8/20 microsecond impulse) residual voltage (kVp) : • 5 kA • 10 kA	 34 –
15	Maximum steep impulse (1/20 micro-seconds impulse) residual voltage at 10 kA (kVp)	28
16	Maximum switching surge (30/60 microsecond wave) protective level (kVp)	21

Sl. No.	Item	Details
	• 500 A	
17	RIV / Partial Discharge (micro-volt / pico-coulomb) when energized at 1.05 times its continuous operating voltage shall not exceed	1000 microvolt / less than 500 pico-coulomb
18	Terminal connection	ACSR DOG

NAME PLATE OF LA:

Arrestor rating upto 42 kV shall be directly mounted on structure as there is no surge counter. Each single pole arrestor shall be provided with suitable name plate, at the base with the following data:

i. Serial number
ii. Manufacturer's name and trade mark, type and identification
iii. Year of manufacture
iv. Voltage & frequency rating
v. Nominal discharge current
vi. MCOV (Maximum Continuous Operating Voltage in kV)
vii. Discharge class
viii. Energy discharge capability (kJ/kV rating)
ix. Purchase order reference
x. Applicable standards
xi. Pressure relief rated current in kA rms (for arrestors fitted with Pressure Relief device)
xii. Property Label – "Property of WBSEDCL"
xiii. Guarantee for five (05) years

CONSTRUCTIONAL FEATURES:

The arrestor elements shall be designed in such a way as to obtain robust construction with excellent mechanical and electrical properties even after repeated operation. The lightning arrestors should be adequately designed to operate satisfactorily under temporary power frequency over voltage, after discharging two shots of respective long duration surges. Uniform density of zinc oxide element shall be maintained to provide uniform current distribution.

The LAs shall be of adequate pressure relief class as per IEC-99-4, fitted with pressure relief devices and arc diverting ports to minimize possibilities of shattering of porcelain housing. Sufficient creepage distance shall be provided to reduce excessive uneven voltages over the porcelain due to contamination, for which the arrestor shall not fail. Seals shall be provided in such a way that these are always effectively maintained even when discharging the maximum rated lightning current.

Housing of Insulators shall be of Porcelain, glazed and completely vitrified and free from blow holes, micro-cracks or void. Porcelain, housing shall be so coordinated that external flashover will not occur due to application of any impulse or switching surge voltage up to the maximum design value for the arrestor.

Arrestors shall be suitable for mounting on a support structure. Clamp type terminal connector shall be suitable for 'ACSR DOG' Conductor for 42 kV voltage class LA having horizontal / vertical take-off. Two (02) ground terminal connectors suitable for GI strip of required size shall be provided on diagonally opposite sides. Necessary hardware such as nuts, bolts, spring washers, etc. shall be supplied. The end fittings shall be made of non-

magnetic and corrosion proof material. It is preferable that the LAs shall be hermetically sealed with inert gas (Nitrogen).

APPLICATION:

The lightning Arrestors shall be provided for protection of 33 kV outgoing feeder from lightning surge as well as from power frequency over voltage as mentioned in **Plant SLD**.

6.10. INDICATING METERS

Flush mounted, back connected, dust proof with Industrial Grade "A" classification meters conforming to latest edition of relevant Indian Standard shall be provided with 33 kV indoor switchgear. The requirements of various meters are mentioned in the **Plant SLD.**

CT OPERATED AMMETER:

Analog ammeters for measuring load current of each phases shall be provided for 33 kV outgoing feeder.

Aux. AC Power	:	230 V AC
Aux. DC Power	:	110 V DC
CT Ratio	:	300 / 1A
Accuracy Class	:	0.5 or better

DIRECT AMMETER:

One (01) no. separate digital ammeter to be provided for measuring heater current consumption in all the panels.

Display	:	3 ½ -Digit Display,
Aux. AC Power	:	230 V AC
Aux. DC Power	:	110 V DC
Accuracy Class	:	0.5 or better

DC AMMETER:

One (01) no. analog DC ammeter to be provided in the DC control circuit for measurement of DC current.

PT OPERATED VOLTMETER:

Analog voltmeter for measuring phase to phase system voltage shall be provided for 33 kV outgoing feeder.

Aux. AC Power	:	230 V AC
Aux. DC Power	:	110 V DC
PT Ratio	:	33000/√3 / 110/√3 V
Accuracy Class	:	0.5 or better

DC VOLTMETER:

One (01) no. analog DC voltmeter to be provided in the DC control circuit for measurement of DC voltage.

MULTI-FUNCTION METER (MFM):

One (01) no. 3φ, four wire CT / PT operated, fully static AMR (Automatic Meter Reading) compatible MFM along with TTB to be provided for 33 kV indoor switchgear panel in a

separate metering chamber. Necessary wiring to be provided with separate terminal block (suitable for CT / PT connection) for MFM connection.

The data stored in the meters shall not be lost in the event of power failure. The meter shall have Non Volatile Memory (NVM), which does not need any battery backup. The NVM shall have a minimum retention period of ten (10) years.

Meter shall have scroll lock facility to display any one desired parameter continuously from display parameters. Auto display cycling of each parameter should be minimum 10-12 Seconds. The time between two auto display cycles shall be 100-120 sec. OBIS code in display is not required.

Type:	3φ, four wire CT / PT operated, fully static AMR compatible along with TTB
Display of measured values:	The meter display shall have seven (07) digits (complete) for energy counter with alphanumeric digits for parameter identifier and tamper indication with backlit LCD of min. 10 mm height, wide viewing angle suitable for temperature withstand of 70°C. LCD shall be of Super Twisted Nematic (STN) type.
Frequency:	50 Hz ± 5%
Accuracy Class:	0.2S
Secondary Voltage Rating:	Suitable for operation 110 V Ph-Ph, (3P, 4W); 63.5 V Ph–N.
Voltage Variation:	- 30 % to + 20 %
Current Rating:	I_{BASIC} = 1 A; I_{MAX} = 2 A
Max. Continuous Current:	As per IS 14697:1999 (2004)
Starting Current:	0.1% of I_{BASIC} at unity power factor
Power Consumption:	The active & apparent power consumption, in each voltage circuit, at reference voltage, temperature and frequency shall not exceed 1.5 W and 8 VA. The apparent power taken by each current circuit, at basic current, reference frequency and temperature shall not exceed 1.0 VA.
Power Factor:	0 Lag – Unity – 0 Lead
DLMS Test Certificate:	Manufacturer must have test certificate for conformance to DLMS from CPRI of Category – 'C'.

The MFM shall have the features to display the following minimum parameters.

- Meter serial number
- Real time & date (DD/MM/YYYY)
- Cumulative power off hours
- Cumulative active energy (cumulative sign / legend must be given)
- Cumulative reactive energy lag (do)
- Cumulative reactive energy lead (do)
- Cumulative apparent forward energy – lag only (do)
- Phase sequence & phase correspondences of voltage & current
- Instantaneous secondary voltages and currents –phase wise (P-N)
- Signed instantaneous power factor – phase wise
- Instantaneous net power factor

- Signed instantaneous active power
- Instantaneous apparent power
- Instantaneous frequency
- Front cover open count
- Connection check
- Self diagnosis including LCD Test etc.

6.11. RELAYS FOR PROTECTION AND CONTROL

Relay Type:	Numerical with self monitoring features
Mounting:	Flush mounted IP 5X with key pad on front
Relay characteristics:	Numerical IED with multiple characteristics like IDMT, DMT, instantaneous with compatible choices of time delays and multiple settings for multiple functions like over current, earth fault etc. along with control of breaker, measurement and status etc.
Relay communication:	As per IEC 61850
Relay input signal:	From CT & PT, with auxiliary DC supply
Relay terminals:	Shall be screw type terminals large enough to accommodate 4.0 mm^2 cables and shall be located at the back of the relay.
Relay contacts:	Shall make firmly without bounce and the relay mechanism shall not be affected by panel vibration or external magnetic field.
Electromagnetic compatibility:	Relay thermal rating shall be such that the fault clearance times on any combination of current and time multiplier settings shall not exceed the thermal withstand capability of the relay. Compliant to EMC directives as per IEC.
Relays for auxiliary, supervision, trip & timer:	Static or attracted armature type with short pickup time of less than 30 ms.
Relay reset:	Self reset contacts except for master trip relays
Operation indicators:	With hand reset operation indicators (flags) or LEDs with push buttons for resetting, for analyzing the cause of operation
Test facility:	In built. Necessary test plugs shall be provided.
Auxiliary supply:	Operate on available 110 V DC supply. To reduce the effect of electrolysis, relay coil shall be so connected such that they are not continuously connected from the positive pole of the station battery.
Master trip relay:	High impedance and high speed relay flush mounted having coil cut-off contact with at least 4NO and 4NC contact and electrical reset facility capable to make, carry and break trip coil current of circuit breaker and

	capable for future integration with SCADA. It should be immune to capacitance discharge currents and leakage current. Operating time should be less than 20 ms. Terminals shall be screw type to accommodate 4.0 mm^2 cable and located at the back of the relay. Terminals shall be clearly marked. Contact configuration shall be drawn on the relay casing.
Fault recording:	Relay shall have the facility for recording of various parameters during a fault. It should be possible to set the duration of record through settable pre fault and post fault time. It should be possible to down load the data locally or from SCADA remotely.
Performance:	As per Plant SLD

6.12. ACSR DOG CONDUCTOR

The material offered shall be of best quality and workmanship. The stranded steel reinforced conductors shall be manufactured from hard-drawn aluminium wires and galvanized steel wires. The coating of the galvanized steel wires shall be applied by the hot process or electrolysis process in accordance with IS: 4826 –1968 (latest edition). The wires shall be smooth and free from all imperfections such as soils and splits. No two joints shall occur in the conductor closer than 15 meters.

The conductor shall be wound on non-returnable drum strong enough and provide within lagging of adequate strength, constructed to protect the conductor against all displacement during transit, storage and subsequent handling and stringing operation in the field. The drum shall conform to IS: 1778-1980 as amended upto date and the dimensions shall be as per drum under column 9 of table 2 of the IS. The drum shall be suitable for wheel mounting.

SIZE AND PROPERTIES:

Sl. No.	Item	Value
A	Sizes & properties of aluminium conductor galvanized steel reinforced	
A. 1	Nominal aluminium area (mm^2)	100.00
A.2	Stranding and wire diameter (mm)	
	Aluminium	6 / 4.72
	Steel	7 / 1.57
A.3	Sectional area of aluminium (mm^2)	105.00
A.4	Total sectional area (mm^2)	118.50
A.5	Approximate overall diameter (mm)	14.15
A.6	Approximate mass (kg/km)	394.00
A.7	Calculated Resistance at 20^0C max. (ohm/km)	0.2792
A.8	Approximate calculated breaking load (kN)	32.41
B	Properties of aluminium wires used in the construction of aluminium conductors	

Sl. No.	Item	Value
	galvanized steel reinforced	
B.1	Diameter (mm)	
	Nominal	4.72
	Minimum	4.67
	Maximum	4.77
B.2	Cross sectional area of nominal diameter (mm^2)	17.50
B.3	Mass (kg/km)	47.30
B.4	Resistance at 20^0C (max) (ohm/km)	1.650
B.5	Breaking load (min) (kN)	2.78
B.6	Breaking load after stranding (kN)	2.64
C	Properties of steel wires used in the construction of aluminium conductor steel reinforced	
C.1	Diameter (mm)	
	Nominal	1.57
	Minimum	1.54
	Maximum	1.60
C.2	Cross sectional area of nominal diameter (mm^2)	1.936
C.4	Mass (kg / km)	15.10
C.5	Breaking load (min) (in kN)	
	Before stranding	2.70
	After stranding	2.57

TOLERANCES:

The following tolerances shall be permitted:

- Tolerance on nominal diameter of aluminium wires: ± 01 (one) percent.
- Tolerance on nominal diameter of galvanized steel wires: ± 02 (two) percent.

STRANDING:

The wires used in manufacturing of a stranded conductors shall satisfy all requirements of IS: 398/ 1996 (Part-I & II) before stranding.

In all constructions, the successive layers shall have opposite directions of lay and the outer most layers being right handed. The wires in each layer shall be evenly and closely stranded. In conductor having multiple layers of aluminium wires, the lay ratio of any aluminium layers shall be not greater than the lay ratio of the aluminium layer immediately beneath it.

MODULUS OF ELASTICITY & CO-EFFICIENT OF LINEAR EXPANSION:

The values of the final modulus of elasticity and co-efficient of linear expansion for ACSR shall be as given hereunder.

- Final modulus of elasticity GN / m^2 (practical) : 75
- Co-efficient of linear expansion /^{0}C : 19.8 x 10^{-6}

LAY RATIO:

The lay ratio (ratio of the aerial length of a complete turn of the helix formed by an individual wire in a stranded conductor to the external diameter of the helix) shall be within the limits given below:

No. of wires		Lay Ratio for Steel Core		Lay Ratio for outside layer	
Aluminium	Steel	Max.	Min.	Max.	Min.
6	10	28	13	14	10

WEIGHT:

Description of Materials	Aluminium	Steel	Total
ACSR:100 mm^2 (DOG)	287.46 kg / km	105.71 kg / km	393.17 kg / km

GROSS WEIGHT:

The gross weight of each wooden drum containing conductor shall not exceed 900 kg. with a tolerance limit of ±10 %. Drums containing conductor having gross weight above 990 kg. will not be accepted in any case. Also more than two lengths in one conductor drum will not be accepted.

STANDARD LENGTH:

Minimum length of ACSR DOG conductor should be one (01) km. Longer lengths are also acceptable provided they are within gross weight limit. The conductor shall be supplied in standard lengths of not less than 95% of the total quantity. The quantity of the conductor in lengths shorter than standard ones shall not exceed 5% of the total quantity.

Further, single conductor length in respect of such 5% (maximum) shall be supplied in random length of not less than 50% of the standard length and shall be supplied in individual drum. Such random length shall be acceptable to the maximum extent of 5% of the offered quantity.

CONSTRUCTION OF DRUMS:

All wooden components shall be manufactured out of seasoned soft wood free from defects that may materially weak on the component parts of the drums. Preservative treatment shall be applied to the entire drum with preservative of such a quality which is not harmful to the conductor. The general construction of drum shall be as shown in IS: 1778-1980. However, the drum shall be suitable for letting off the conductor under controlled tension of the order of 300 kg. min.

FLANGES:

- The flanges shall be of two ply construction with such ply at right angle of the other and nailed together. The nails shall be driven from the inside face of flanges,

punched and then cleaned on the outer face. There shall be at least 3 nail per plank of ply with maximum nail spacing 70- 75 mm.

- There will be a slot in the flange to receive the inner and of the conductor; the entrance shall be in line with the periphery of the barrel.

Spindle hole shall be provided at the center of the middle planks of the plies and spindle planets with 100 mm diameter holes shall be fitted on either side of both the flanges.

DRUM AND SUPPORTS:

The end supports shall be securely fixed by nailing and may be disc or segmental type. The middle barrel support of the two ply construction of disc type with a 100mm diameter concentric with the holes in flanges shall be provided at the centers of the barrel supports.

DRUM:

The wooden batons used for making the barrel of the conductor shall be segmental type. These shall be nailed to the barrel supports with at-least two nails. The batons shall be closely butted and shall provide a round barrel with smooth surface. The edges of the batons shall be rounded or compared to avoid damage to the conductor.

DRUM STUDS:

Barrel studs shall be used for the construction of drum. The flanges shall be holed and the barrel supports slotted to receive them. The barrel studs shall be threaded over a length on either end sufficient to accommodate washers, spindle plates and nuts for fixing at the required spacing.

IRON COMPONENTS:

Normally, the nuts on the studs shall stand pound of the flange. All the nails used on the inner surface of the flanges and the drum barrel shall be counter sunk at-least 5mm. deep. The ends of barrel shall generally be flushed with the top of the nuts.

PROTECTIVE ARRANGEMENT:

i. The inner side of the flanges and drum barrel surfaces shall be painted with bitumen based paint.
ii. Before reeling, cardboard of double corrugated or thick bituminized water proof bamboo paper shall be secured to the drum barrel and inside the flanges of drum by means of suitable adhesive materials. These protective wrappings and the adhesive material used shall be of a quality which is not harmful to the conductor.
iii. After reeling the conductor, the exposed surface of the outer layer of the conductor shall be wrapped with water proof, thick, bituminized bamboo paper and also with thick plastic sheet to prevent the conductor from dirt, grit and damage during transport and handling.

MARKING:

Each drum shall have the following information stenciled on it in indelible ink:

i. Contract / specification number, drum number and lot number
ii. Name and address of the consignee
iii. Manufacturer's name or trade mark
iv. Code name and size of the conductor

v. Length of the conductor with protective lagging including conductor
vi. Gross weight of the drum with protective lagging including conductor
vii. Weight of empty drum with protective lagging
viii. Net weight of the conductor
ix. Arrow marking for unwinding
x. Position of the conductor end
xi. Property Label – "Property of WBSEDCL"

6.13. INSULATOR

The Insulators covered by this specification should conform to the latest editions of Indian Standard Specification IS: 731, IS: 2544 and IS: 5350 or any other authoritative standard.

GENERAL REQUIREMENT:

- The Porcelain shall be free from defect, thoroughly vitrified and smoothly glazed. The Insulators shall be brown in colour. The glaze shall cover all the porcelain parts of the insulators except those areas which serve as support during fixing or left un-glaze for the purpose of assembly.
- Cement used in construction of insulators shall not cause fraction by expansion or loosening by construction and care must be taken in "curing". The cement used shall not give rise to chemical reaction with the metal fittings and its thickness shall be as uniform as possible.
- The design of Insulators shall be such that stress due to expansion or contraction in any part of Insulators shall not lead to deterioration.

PIN INSULATORS:

- The pin insulators shall be so designed that the porcelain part should not directly come in contact with any hard material.
- For this purpose the pin insulators shall be fitted with a zinc / lead thimble designed to fit with the small / large steel head of the pin.

SPECIFIC TECHNICAL PARAMETERS:

11 KV PIN INSULATOR:

Sl. No.	Description	Rating	
	Atmosphere	Moderately Polluted	Heavily Polluted
1	Nominal system voltage	11 kV	11 kV
2	Highest system voltage	12 kV	12 kV
3	Min. specific creepage distance	230 mm	320 mm
4	Minimum failing load	5 kN	5 kN
5	Power frequency visible discharge voltage	9 kV rms	9 kV rms
6	Power frequency minimum flash over voltage		
	Dry	75 kV rms	75 kV rms
	Wet	45 kV rms	45 kV rms

Sl. No.	Description	Rating	
	Atmosphere	Moderately Polluted	Heavily Polluted
7	Power frequency puncture withstand voltage	105 kV rms	105 kV rms
8	Impulse flashover voltage 1.2/50 micro second wave :		
	Positive	95 kVp	95 kVp
	Negative	100 kVp	100 kVp
9	Power frequency withstand voltage		
	Dry	60 kV rms	60 kV rms
	Wet	35 kV rms	35 kV rms
10	Impulse withstand voltage 1.2/50 micro second wave		
	Positive	75 kVp	75 kVp
	Negative	80 kVp	80 kVp

33 KV PIN INSULATOR:

Sl. No.	Description	Rating	
	Atmosphere	Moderately Polluted	Heavily Polluted
1	Nominal system voltage	33 kV	33 kV
2	Highest system voltage	36 kV	36 kV
3	Min. specific creepage distance	580 mm	840 mm
4	Minimum failing load	10 kN	10 kN
5	Power frequency visible Discharge Voltage	27 kV rms	27 kV rms
6	Power frequency minimum flash over voltage		
	Dry	130 kV rms	130 kV rms
	Wet	90 kV rms	90 kV rms
7	Power frequency puncture withstand voltage	180 kV rms	180 kV rms
8	Impulse flashover voltage 1.2/50 micro second wave :		
	Positive	210 kVp	210 kVp
	Negative	230 kVp	230 kVp
9	Power frequency withstand voltage		
	Dry	95 kV rms	95 kV rms
	Wet	75 kV rms	75 kV rms

Sl. No.	Description	Rating	
	Atmosphere	Moderately Polluted	Heavily Polluted
10	Impulse withstand voltage 1.2/50 micro second wave		
	Positive	170 kVp	170 kVp
	Negative	180 kVp	180 kVp

POST INSULATORS:

- The post type insulators, wherever required, shall be suitable for outdoor use and cap & base type. Caps & base shall have plain machined faces & zigs shall be used for drilling bolt holes on the cap & in the base for easy & perfect assembly. Regarding Test for Mechanical strength for post Insulators, all the necessary tests are as per 9.6.5.1, 9.6.5.2, & 9.6.5.3 of IS: 2544-1973 with latest amendments are to be carried out at the manufacturer's premises.
- For each of the post insulators, bolts, nuts, set screws & washers shall be supplied.
- 5% spare nuts & bolts with washers shall be supplied with no extra cost.
- The post insulator shall be free from defects, thoroughly verified, smoothly glazed. The glaze shall be brown in colour. The glaze shall cover the exposed porcelain parts of the Insulator.
- The post insulator shall be designed and manufactured to avoid stresses due to expansion and contraction which may lead to deterioration, stress concentration due to direct engagement of porcelain with metal fittings and shapes which do not facilitate cleaning by normal methods.
- Cement used in the construction of post insulator shall not cause fracture by expansion or loosening by contraction and shall not give rise to chemical reaction with the metal fittings and its thickness shall be uniform.
- All ferrous metal parts except those of stainless steel shall be hot dip galvanized and uniform zinc coating shall satisfy the requirement of IS:2633. The parts shall be galvanized after machining and the galvanized surface shall be smooth.
- The tapped holes suitable for bolts with threads shall have anti-corrosion protection. The effective length of the thread shall not be less than the nominal diameter of the bolt.
- The electrical and mechanical characteristics of post insulator shall conform to the specific technical parameters of this specification.
- Post insulator shall be suitable for upright mounting on steel structures & the cap & pedestal of post insulators shall be of malleable cast iron.

SPECIFIC TECHNICAL PARAMETERS:

11 KV POST INSULATOR:

Sl. No.	Description	Rating
1	Nominal system voltage / working voltage	11 kV
2	Highest system voltage	12 kV
3	Minimum specific creepage distance	25 mm / kV
4	Power frequency visible discharge voltage	9 kV rms

Sl. No.	Description	Rating
5	Power frequency withstand voltage	
	Dry	60 kV rms
	Wet	35 kV rms
6	Impulse withstand voltage 1.2/50 micro second wave :	
	Positive	75 kVp
	Negative	80kVp
7	Power frequency withstand voltage on single unit	105 kV rms
8	P.F. Minimum flash over voltage	
	Dry	70 kV rms
	Wet	45 kV rms
9	Impulse flashover voltage 1.2/50 micro second wave :	
	Positive	95 kVp
	Negative	120 kVp
10	Cantilever strength on single unit	
	Upright	5 kN
	Inverted	3 kN
11	Tensile strength	15 kN
12	Torsional strength	200 Nm
13	Compression strength	30 kN
14	Height	254 mm
15	Insulation part diameter	152 mm
16	Pitch circle diameter	
	Top	57 mm
	Bottom	57 mm

DISC INSULATOR:

- The Insulator discs shall be cap and ball pin type with ball and socket coupling suitable for use in suspension or tension strings.
- The porcelain shall be brown colour, non porous having high dielectric mechanical and thermal strength, free from internal stresses, blisters, laminations, voids, foreign matters, imperfections or other defects, which might in any way render it unsuitable as insulator shells. Porcelain shall be smoothly glazed to remain unaffected by climatic condition, ozone, acids, alkalis, zinc or dust. The glaze shall have bright luster, smooth surface, a good performance under extreme weather condition of tropical climate and dust resistant. The glaze shall not crack or chip due to aging under normal service condition or while handling during transit or erection.

- Cement used in the construction of Insulators shall not cause fracture by expansion or loosening by contraction and must have high compressive and shearing strength and be free from change in volume due to aging and temperature change. The cement shall not give rise to chemical reaction with metal fittings. Rapid hardening cement with special sand shall be used for assembly of metal parts.
- The caps and ball pins of disc insulator shall be hot dip galvanized and mechanically strong. The ball pins shall move freely in the cap socket, but shall be so designed that they do not disengage while in service. The caps shall be made of heat treated malleable cast iron. These shall be free from cracks, shrinks, air holes, burrs and rough edges. All load bearing surfaces shall be smooth and uniform so as to distribute loading stress evenly.
- The ball pins shall be of forged steel and so designed that they will not yield or distract under loaded conditions. The ball and socket insulators shall be provided with 'R' / 'W' clip to prevent uncoupling of insulator units from each other. The 'R' / 'W' clip shall be made of phosphor bronze or stainless steel to safe guard against corrosion. The electrical and mechanical characteristics of the Disc. Insulator shall conform to Specific Technical Parameters of this Specification.

SPECIFIC TECHNICAL PARAMETERS:

11 KV POST INSULATOR:

Sl. No.	Description	Rating
1	Nominal system voltage/Working voltage	11 kV
2	Highest system voltage	12 kV
3	Total creepage distance	320 mm
4	Spacing	145 mm
5	Minimum failing load	70 kN
6	Power frequency visible discharge voltage	9 kV rms
7	Power frequency withstand voltage	
	Dry	60 kV rms
	Wet	35 kV rms
8	Impulse withstand voltage 1.2/50 micro second wave :	
	Positive	75 kVp
	Negative	80 kVp
9	Power frequency puncture withstand voltage	1.3 times the actual dry flashover voltage
10	Power frequency minimum flash over voltage	
	Dry	75 kV rms
	Wet	45 kV rms
11	Impulse flashover voltage 1.2/50 micro second wave :	
	Positive	115 kVp

Sl. No.	Description	Rating
	Negative	120 kVp
12	Nominal dia. of ball, ball pin, socket & security cap	As per IS
13	Porcelain diameter	255 mm

6.14. DESIGN & CONSTRUCTION OF CIVIL STRUCTURE

6.14.1. CONNECTORS

The connectors used in the transformer yard and 33 kV transmission line shall be made of aluminium alloy not to cause corona, radio and audible noise, interference in the HV installations. The connectors shall conform to NEMA 107 and tested accordingly to have maximum noise level not exceeding 54dB. The fasteners shall conform to ISO 3506 and having minimum mechanical strength of Class 70. The tensile strength / electrical characteristics of the hardware shall be in accordance to NEMA CC1 publications.

6.14.2. STEEL STRUCTURE

Fully galvanized self supporting lattice steel structures of rationalized IS metric sections using bolts and nuts connections shall be used to carry the conductors with the necessary insulators and all fittings. No welding or riveting shall be allowed. The structures shall normally be fixed to anchor bolts in foundations.

6.14.3. CONDUCTOR TENSIONS

Structure design shall be done considering 500 kg / phase tension for line.

6.14.4. WIND PRESSURE

The wind loads acting on the conductors, insulators and structures shall be computed according to the latest version of IS-802 read with cl. no. 11.2.1.

6.14.5. TEMPERATURE STRESSES:

For long continuous structures such as multi-bay gantry structures etc. temperature stresses shall be considered where these stresses are expected to be of appreciable magnitude.

6.14.6. COMBINATION OF LOADS

For the design of the structures different load shall be based on IS 375 part I to V. Simultaneous application of all the following loads shall be taken into account:

- Dead loads of the structures, conductors, insulators and electrical equipment.
- Wind loads on the structures, conductors, insulators and electrical equipment.
- Incoming and outgoing line loads.
- Live load on account of three workmen and their kits 300 kg.
- Operational load of Isolators etc.

- Dynamic loads due to short-circuit forces of electrical equipment
- For take-off of all the line, gantry structure shall be designed for 80 m span with +/- 30^0 deviations both in horizontal and vertical plane and no uplift.
- All structures shall be designed for the worst combination of dead loads, live loads, wind loads as per code IS:875, seismic forces as per code IS:1893 (latest), Importance factor of 1.5, loads due to deviation of conductor, load due to unbalanced tension in conductor, torsional load due to unbalanced vertical and horizontal forces, erection loads, short circuit forces including "snatch" in the case of bundled conductors etc. Short circuit forces shall be calculated considering a fault level of 25 kA. IEC-865 may be followed for evaluation of short circuit forces.

LINE LOADS:

For the incoming and outgoing gantry structures, full dead-ending condition shall be assumed.

6.14.7. FACTORS OF SAFETY

The incoming and outgoing gantry structures shall be designed for the two conditions i.e. normal condition and short circuit condition. In both conditions the design of all structures shall be based on the assumption that stringing is done only on one side i.e. all the three (phase) conductors broken on the other side. Factor of safety of 2.0 under normal conditions and 1.5 under short circuit condition shall be considered on all external loads for the design of various structures.

6.14.8. DESIGN OF MEMBERS

The contractor are required to keep in consideration, the following points, while designing the structure:

PERMISSIBLE STRESSES:

Tensile and compressive stresses in various members of structures and bolts shall not exceed the limits as specified in IS: 802 (as amended up to date).

SLENDERNESS RATIO:

Slenderness ratio for members shall be computed in accordance with the latest edition of relevant IS. Slenderness ratio for compression and tension members shall not exceed the values specified therein.

MINIMUM THICKNESS

The minimum thickness of angle sections used in the design of structures, unless otherwise specified elsewhere in the specification, shall be kept not less than the following values:

a) For leg members : 6 mm
b) For all other members : 5 mm

- All the connections shall be detailed to minimize eccentricity of connections.
- Notching shall not be normally permitted, but if unavoidable cutting of outer flange to the extent of permissible distance from edge can be allowed, Even in those cases where clearances are critical the minimum shear edge distance from bolt hole centers shall be retained while chamfering.

- At all places where there is gap between two connected members, mild steel packing washers or wrought iron tapered washer shall be provided, wherever possible.
- The gap between the ends of two connected members in a butt joint shall not be more than 6mm and less than 4mm.
- No individual member in any type of structure shall be longer than 6 meters.
- Holes at suitable places shall be provided for earthing purposes.

6.14.9. GALVANISING

All the members of structures shall be galvanized by hot dip process conforming to latest edition of IS: 2629. The min. deposit shall be 0.610 kg/ sqm. and shall withstand four dips in copper sulphate solution. Purity of zinc to be used shall be 99.95 % as per IS: 209.

6.14.10. BOLTS, NUTS AND WASHERS

Bolts at the joints shall be so staggered that nuts may be tightened with spanner without fouling. Step bolts, at least 75 mm long and of diameter not less than 16 mm, spaced equally about 450 mm apart shall be used on one of the legs of each column structure, from 2500 mm above ground level to the top of the column. The step bolts shall be capable of withstanding a vertical load of not less than 150 kg.

Necessary quantities of various sizes of galvanized bolts, and nuts, pack washers and spring washers with 3% extra quantity shall be arranged by the contractor.

6.15. EARTHING AND LIGHTNING PROTECTION

Proper earthing and lightning protection of the power house and transformer yard together shall be provided by the contractor. The contractor, after placement of LOA, shall measure the soil resistivity of the power house and transformer yard location in presence of the employer's representative. The design of earthing system shall be carried out as per the tested soil resistivity value. Details of the requirements of earthing system are given in **Chapter – 12** of this **Volume – 6:** Technical Specification.

6.16. 11 KV AND 33 KV CABLE CONDUCTOR JOINTING KIT

One (01) no. of 11 kV and two (02) nos. of 33 kV cable conductor jointing kit shall be provided in the transformer yard as shown in the **Plant SLD**. The structures shall be of proven design, suitable for the hilly area installation. Necessary protection viz. earthing etc. shall be provided. The jointing kits shall conform WBSEDCL's standard practice. The contractor shall submit details of the equipment including structure design during detailed engineering stage for according approval of the employer.

6.17. POWER EVACUATION SYSTEM

33 KV TRANSMISSION LINE:

One (01) no. of 33 kV outgoing feeder shall be provided for transmitting the power generated from this power station. The feeder shall be terminated at the 33 kV bay of existing 33/132 kV switchyard of Rammam Stage – II Hydroelectric Power Project of WBSEDCL. Approximate distance of the transmission line would be three (03) km.

The contractor shall carry out line survey, prepare layout and detailed technical specification including Bill of Material (BOM) during detailed engineering stage in consultation with the representative of WBSEDCL. The technical specifications for 33 kV Transmission line shall be prepared based on WBSEDCL's standard.

The 33 kV bay at the receiving end substation (existing 33/132 kV switchyard of Rammam Stage – II Hydroelectric Power Project of WBSEDCL) is ready in all respect for connection of this 33 kV feeder. However, Erection of 33 kV line along with termination at both substations is under scope of contractor.

GENERAL REQUIREMENTS:

- Considering the site condition, double pole (DP) structure shall be provided after maximum four (04) Nos. of single pole structure for each transmission line.
- Distance between two adjacent pole shall be maximum fifty (50) meters.
- Necessary equipment / items required for erection of 33 kV transmission line shall be under the scope of the contract.
  - MS channel
  - MS angle
  - MS flat
  - Stay set HT
  - GI earth spike
  - ACSR Dog conductor
  - Stay wire
  - GI wire
  - Insulators (pin insulator & 120/160 kN disc insulator) etc.

6.18. TESTS

6.18.1. TYPE TESTS

All the apparatus, instruments, structures etc. required for the 33 kV power evacuation system shall be subjected to all kind of type test in accordance with the latest version of relevant standards. The contractor shall submit type test report from CPRI / NABL / Govt. approved Laboratories having identical type, rating and voltage ratio similar to the tendered item during detailed engineering stage, carried out within ten (10) years from the date of this NIT Publication. The contractor may be required to furnish the original type test reports with test results, if desired by the employer.

SWITCHGEAR PANEL (WITH CIRCUIT BREAKER INSTALLED):

i. Dielectric tests including lightning and power frequency withstand voltage test on auxiliary and control circuits
ii. Temperature rise tests
iii. Measurement of the resistance of the main circuit
iv. Short time withstand current and peak withstand current tests
v. Verification of degree of protection
vi. Radio Interference Voltage (RIV) test
vii. Short circuit test with basic duties & partial discharge test
viii. Mechanical operation test

ix. Single phase breaking capacity test
x. Cable charging breaking current test
xi. Internal arc test as per IEC 62271-200
xii. Electromagnetic compatibility tests (EMC)
xiii. Horizontal acceleration due to seismic force (if available)
xiv. Test for auxiliary devices
xv. Verification of correct wiring

The type test certificates for bought out items shall be submitted for approval of employer.

CIRCUIT BREAKER:

i. Mechanical endurance test as per M2 Class of IEC

CURRENT TRANSFORMER:

i. Short time current test
ii. Impulse voltage withstand test
iii. Temperature rise test

POTENTIAL TRANSFORMER:

i. Impulse voltage withstand test
ii. Temperature rise test

COPIES OF TEST CERTIFICATES IN RESPECT OF FOLLOWING BOUGHT OUT ITEMS:

i. Vacuum Interrupter
ii. Isolator
iii. Insulators
iv. Bus bar material
v. Cable conductor jointing kit
vi. Lightning arrestor
vii. ACSR Dog conductor
viii. Terminal connectors
ix. KEMA / CPRI Certification for relay / IED i.r.o. IEC 61850 compliance

Note: All the type test report on switchgear panel & circuit breaker to be conducted with offered vacuum interrupter.

TYPE TEST AFTER ROUTINE TESTS:

The employer shall have the right to ask the contractor to perform the type tests again, after routine test, following relevant Indian Standard from CPRI / NABL accredited / Government recognized test house or laboratory in presence of the employer's representative. The contractor shall be liable to arrange the same.

The amount charged by the test house / laboratory for carrying out such type tests only will be reimbursed to the contractor on production of necessary supporting documents.

6.18.2. ROUTINE / ACCEPTANCE TESTS

All the equipment of the 33 kV power evacuation system shall be tested in accordance with the requirement of relevant IS / IEC Code. Besides that, Energy Meter may be tested

as per relevant IS at the testing laboratory of WBSEDCL before final acceptance of the equipment.

All Acceptance tests shall be carried out at manufacturer's works on every lot offered for inspection following relevant IS & IEC in presence of the employer's representatives. Selection of samples for acceptance test as well as rejection and retesting shall be guided by relevant IS. The entire cost of acceptance and routine tests that to be carried out shall be deemed to be included in the quoted price by the contractor.

COMPLETE SWITCHGEAR PANEL:

i. Dimensional checks
ii. Operational tests
iii. Primary injection tests
iv. Calibration tests on relays and instruments
v. Power frequency withstand test
vi. Insulation test
vii. Contact resistance test of primary joints

CIRCUIT BREAKER:

i. Design and visual checks
ii. Operational tests
iii. Dielectric test on the main circuit, control and auxiliary circuits
iv. Measurement of resistance of the main circuit
v. Timing test
vi. Test certificate for all resin cast / moulded components of circuit breakers whose partial discharge measurement are specified in the relevant IEC (No. 62271-100, Cl. No.6.2.9) shall be furnished by the manufacturer.

ISOLATOR:

i. Power frequency dry test of the main circuit. (may be omitted as per IEC 60694 Cl. No. 7.1 subject to dimensional checking as per dimensions shown in type test report)
ii. Voltage test on control and auxiliary circuits
iii. Measurement of resistance of the main circuit
iv. Mechanical operation tests
v. Routine test report for all Isolators is to be submitted along with inspection offer
vi. Any other test required as per relevant IS / IEC.

CURRENT TRANSFORMER:

i. Polarity test and verification of terminal markings test
ii. Ratio and phase angle error test (accuracy class; composite error test)
iii. Power frequency withstand tests
iv. Inter-turn over voltage tests
v. Partial discharge measurement
vi. Knee point voltage for PS Class current transformers

POTENTIAL TRANSFORMER:

i. Polarity tests and verification of terminals
ii. Power frequency withstand test

iii. Determination of errors
iv. Partial discharges measurement

LIGHTNING ARRESTOR:

Each LA. shall comply with the requirements of routine test as specified in the relevant IEC: 99-4 & IS: 3070 (Part - III).

ACSR DOG CONDUCTOR:

The conductor shall comply with the requirements of routine tests as per relevant IS.

i. Visual checks for joints etc.
   Two / three drums from each lot shall be rewound in presence of the Employer's representative to facilitate visual checks for joints, scratches etc. and to verify declared length and weight etc. as per the requirement of this specification.
ii. Dimensional check on aluminium and steel strands
iii. Checking of lay ratio of each layer of conductor and lay direction
iv. Breaking load test on individual wires
v. Elongation test on steel wire
vi. Wrap test on steel and aluminium wire
vii. DC resistance test on Aluminium strands
viii. Galvanizing test on steel strands
ix. Visual check on drums
x. Ductility test on galvanized steel wires
xi. Any other test required as per relevant IS / IEC

Moreover in course of production, the contractor shall ensure and submit report for the following:

i. Checking of all joints are as per specifications
ii. Checking that there are no cuts, fins etc. on the strands
iii. Checking of correctness of stranding
iv. Checking that the drums are as per specification
v. Chemical analysis of aluminium used or making aluminium strands
vi. Chemical analysis of steel used for making steel strands
vii. Chemical analysis of zinc used for Galvanizing

INSULATOR:

i. Verification of dimensions
ii. Temperature cycle test
iii. Mechanical strength test
iv. Power Frequency Puncture test
v. Porosity test
vi. Galvanizing test
vii. Electromechanical failing load test. (for Disc. Insulator String only)
viii. Any other test required as per relevant IS / IEC

RELAY:

i. Relay pick-up test for all functions and phases

ii. Relay timing test for all functions and phases
iii. Conformance test as per IEC 61850

CABLE CONDUCTOR JOINTING KIT:

i. As per relevant IS.

6.18.3. COMMISSIONING CHECKS / SITE TESTS

After delivery and installation of all the switchgear panels and accessories at site, the afore-mentioned routine tests shall be carried out during trial run and commissioning.

All testing equipment including HV test kit, required for testing of the switchgear panels and accessories at site, shall be provided by the contractor at free of charge on returnable basis. In the event of repeated testing becomes necessary, the entire expenditure on such repeat tests shall be borne by the contractor.

All testing equipment shall have the up-to-date calibration certificate. The contractor needs to furnish the same to the employer prior to starting of testing at site as well as at manufacturer's works, whatever the case may be.

6.19. DOCUMENTS TO BE SUBMITTED AFTER PLACEMENT OF LOA

- Name of manufacturer proposed by the contractor for each item / equipment as per **Cl. No. 6.21**.
- Performance certificates of proposed manufacturers as per **Cl. No. 6.22.**
- All Type test reports of each similar rated products of the proposed manufacturer.
- Routine Test Report / Shop Test Report of each similar rated products of the proposed manufacturer performed earlier.
- Test facilities at manufacturer's test house.
- General arrangement drawing of 33 kV Indoor Switchgear and evacuation system showing constructional features, space requirements for safe operation, preliminary layout etc.

6.20. DOCUMENTS TO BE SUBMITTED DURING DETAILED ENGINEERING STAGE

Six (06) sets of data sheet, manual, leaflet, drawing and other documentation as mentioned below for 33 kV indoor switchgears and power evacuation system shall be submitted to the Controlling Officer of the employer for according approval during detailed engineering stage.

- Guaranteed Technical Particulars (GTP) as per **Chapter – 20 (Cl. No. 20.5).**
- Detailed sectional view (front view, rear view, cross sectional view, side view) of complete switchgears as well as all the compartments / cubicles and SAT.
- Detailed drawings and characteristics for individual items viz. circuit breaker, isolator, CT, PT, LA, ACSR Dog conductor, insulator, cable conductor jointing kit etc.
- Detailed layout drawing and technical specification for 33 kV transmission line.
- Schematic diagram, control philosophy & control circuit diagrams, wiring diagram etc.
- All construction drawings including equipment foundation details.
- Detailed time schedule indicating submission of drawings, tentative date of inspection, delivery of items, installation, testing, trial run & commissioning.

- Detailed Bill of Material (BOM) which shall include the spare parts for five (05) years of trouble-free operation & maintenance of the above system as per **Cl. No. 19.6** and special tools, plants and equipment as per **Cl. No. 19.15.**
- Detailed Quality Assurance Plan (QAP) for routine test and field acceptance test
- Manual for installation, operation and maintenance procedure.
- Undertakings from Relay Manufacturer as mentioned in **Cl. No. 4.19.**
- Undertakings from Meter Manufacturer as mentioned in **Cl. No. 4.20.**

After approval, six (06) sets of approved drawings and documents along with soft copies for 33 kV indoor switchgears and power evacuation system shall be submitted to the controlling officer of the employer.

Further, the contractor shall submit three (03) sets of successful shop / routine test reports to the controlling officer of the employer prior to dispatch of each item / equipment.

6.21. MAKE OF COMPONENTS

The contractor shall submit proposed make of 33 kV indoor switchgear and power evacuation system including various bought out components such as circuit breaker, isolator, CT, PT, LA, ACSR Dog conductor, insulator, cable conductor jointing kit etc. after placement of LOA. Final make shall be approved by the employer during detailed engineering stage based on the performance certificates submitted by the contractor. For approved makers list of WBSEDCL for various components, the bidders are requested to go through **Cl. No. 4.15, Cl. No. 6.5** and **Chapter – 21** of this Technical Specifications.

6.22. CREDENTIALS AND PERFORMANCE CERTIFICATES

The contractor shall submit Performance Certificates issued to the proposed manufacturers by the respective employer for similar kind of job. The contractor shall also furnish documents in support of supply, delivery of similar equipment / system indicating thereon names of the organization, quantity ordered and quantity supplied along with their submission after placement of LOA. Non-submission of the same will be liable for rejection of the proposed manufacturers.

6.23. GUARANTEE

Guarantee of the total equipment including any integral part of the equipment should be up to Defect Liability Period of the project.

6.24. COMPLETENESS OF EQUIPMENT / SYSTEM

All items, equipment, fittings and accessories etc. for any specified equipment / system that may not be specifically mentioned in the specification but necessary for completeness of the system shall be deemed to be covered under the scope of this contract. No extra charges will be paid to the contractor for the same.

6.25. SCHEDULE OF REQUIREMENT

Sl. No.	Description	Quantity
1	Complete 33 kV indoor switchgear panel comprising of 33 kV 630 A bus bar, 1 nos. of 33 kV VCB, CTs, PT, Terminal blocks, Indicating Meters, Relays and other accessories as detailed in this specification	One (01) set
2	Isolator / Disconnecting Switch as per **Cl. No. 6.6**	As required
3	Lightning Arrestor (9 kV and 42 kV) as per **Cl. No. 6.9**	As required
4	ACSR Dog Conductor as per **Cl. No. 6.12**	As required
5	Insulator as per **Cl. No. 6.13**	As required
6	All related Civil works as per **Cl. No. 6.14**	As required
7	Earthing and Lightning protection system as per **Cl. No. 6.15**	As required
8	11 kV and 33 kV cable conductor jointing kit as per **Cl. No. 6.16**	As required
9	Power evacuation system as per **Cl. No. 6.17**	As required
10	Special tools, plants & equipment as per **Cl. No. 19.15**	As required
11	Spare parts as per **Cl. No. 19.6**	As required
12	Completeness of equipment / system as per **Cl. No. 6.24**	As required

7. LT SWITCHGEAR

7.1. SCOPE

This section of the specification deals with the design, engineering, quality assurance, manufacture, shop testing at manufacturer's works, transport, transit insurance, supply, delivery to site, storage at site, erection, testing, trial run and commissioning of indoor type following 415V LT Switchgear complete with all accessories for Lodhama II SHEP.

The scope shall include supply of switchgear, distribution boards, gland plates for all power and control cables, base frames, special tools i.e. operating handles, trolley necessary for removing the circuit breakers and any other item / equipment required for successful operation and maintenance of the plant. The scope shall inter-alia include all associated devices, components, relays, contactors, switches etc. required for satisfactory operation of the switchgear as per the proposed logic control scheme. All the material & workmanship shall be of suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

The scope of supply shall also include spares, special tools and testing devices, which are essential for installation, operation and maintenance for five (05) years trouble free operation of the plant, even though these are not individually or specifically stated in this specification but recommended by the respective manufacturers. All the material & workmanship shall be of suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

7.2. CODES & STANDARDS

The design, manufacture and testing of the various equipment covered by this specifications shall comply with the requirements of the latest edition of the following standards issued by BIS (Bureau of Indian Standards), except where specified otherwise.

Sl. No.	Standards	Description
1	IS: 13947 (Part 1 to 5)	Specification for low-voltage switchgear and control gear
2	IS: 10118 (Part 1 to 4)	Code of practice for selection, installation and maintenance of switchgear & control gear
3	IS: 1248	Specifications for electrical indicating instruments
4	IS: 2633	Hot dip galvanizing
5	IS: 2705	Current transformers
6	IS: 3156	Voltage transformers
7	IS: 3231	Electrical relays for power system protection
8	IS: 5082	Wrought aluminium and aluminium alloy bars, tubes and sections for electrical purposes
9	IS: 8623	General requirement for factory built assemblies up to 1000 V
10	IS: 8828	Circuit breakers for over current protection for

Sl. No.	Standards	Description
		household and similar installations
11	IS: 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals
12	IS: 13703	Low voltage fuses for voltages not exceeding 1000V AC
13	IS: 13947/1993 Part-III	Switch fuse disconnector unit
14	IS: 5	Painting
15	IS: 375	Wiring
16	IS 8828/1996	Miniature circuit breaker
17	Indian Electricity Rules 1956	
18	Indian electricity act 2003	

Equipment meeting with any other authoritative standards which ensure an equal or better quality than the standards mentioned above will also be acceptable. Where the equipment complies with any other standards, the salient points of difference between the standards adopted and the standards specified above shall be clearly brought out, and an English version of the proposed standards shall be furnished by the contractor.

7.3. SYSTEM DETAILS

Main incoming AC circuits on LT switchgear shall be controlled through air circuit breakers (ACB). The LT switchgear shall be suitable for indoor installation in the power house at an EL 1071.55 m.

a. Three (03) nos. of 400 A ACBs shall be provided in the LT Switchgear for two (02) nos. of incoming circuits from station auxiliary transformers (SAT) and one (01) no. of incoming circuit from diesel generator (DG) set, as per **Plant SLD**.
b. Two (02) nos. of 630 A ACBs shall be provided in the LT Switchgear as bus sectionalizing breaker.
c. For interconnection with various station boards and circuits, 40 kA for 1 sec., 4 pole fixed type MCCBs with adjustable current setting shall be provided. Neutral shall be provided with disconnect-able link.

Auxiliary power required for each generating unit shall be fed from more than one (01) source, each from different bus section of the switchgear, to improve the reliability.

7.4. TECHNICAL PARAMETERS

Sl. No.	Item	Description
1	No. of phases	Three (03)
2	No. poles	Four (04)
3	System voltage	415 V ± 10%
4	Maximum voltage	1.1 kV
5	Normal Current rating at Bus Bar	630 Amp

Sl. No.	Item	Description
6	Frequency	50 Hz. ± 5%
7	Rated short time current rating	40 kA for 1 sec.
8	Controlling Device	
	Incomer from SAT	ACB (400 A) – 2 nos.
	Incomer from DG set	ACB (400 A) – 1 no.
	Bus sectionalizing breaker	ACB (630 A) – 2 nos.
	Outgoing feeders	MCCB
9	Operating duty	O – 0.3s – CO – 3m – CO
10	Normal control/ indication voltage	110 V DC (+10% to -15%)
11	One minute power frequency withstand voltage	
	Power circuit	2000 Volts (rms)
	Control circuit	2000 Volts (rms)
12	Ambient temperature for design	40°C
13	Bus bar system	TPN (with manually isolable neutral and separate earth bar)
14	Degree of protection for enclosure	IP 42
15	Altitude of installation	EL 1071.55 m

7.5. FUNCTIONAL REQUIREMENTS OF THE SCHEME

The LT switchgear shall be sectionalized in three parts by two (02) nos. of 630 A bus sectionalizing ACB to ensure continuity of supply to the auxiliaries in case of failure / fault in one section (refer Plant **SLD**). Mandatory auxiliary power requirements of either unit shall be fed from more than one (01) section of the 415 V LT bus to improve the reliability. The LT switchgear shall be connected to all the auxiliary boards through cables of suitable sizes.

The Incomers from each source shall be terminated in different sections of the LT bus bar. Feeders from SAT 1 and SAT 2 shall be terminated in bus section-A and bus section-C of the LT switchgear respectively. Feeder from Diesel Generator set shall be terminated in bus section-B of the LT switchgear.

The ACB(s) for the incoming feeders from SAT(s) shall be closed after the Generator(s) are synchronized and started feeding power to the grid. Once the SAT(s) started supplying the auxiliary power, feeder from the DG Set shall be disconnected.

It shall be ensured that there is no paralleling of supplies during changeover process. Necessary electrical and mechanical interlock shall be incorporated. The automatic changeover shall be achieved through hard wired control logic. In case of any fault on any of the section of the LT Switchgear, the affected section shall be segregated by tripping the requisite bus section breaker(s). The incomer feeder in that affected bus section shall also be disconnected by means of operating its circuit breaker. Auxiliary supply shall be continued from the healthy section(s).

In the event of fault at both of the SAT feeders and/or non-availability of power at the grid, auxiliary power requirement shall be met by the DG Set.

Control and logic diagrams for the whole system shall be submitted by the contractor during detailed design stage. The same shall be subjected to approval of the employer.

7.6. INTEGRATION WITH SCADA SYSTEM

415 V LT Switchgear and control shall be suitable for integration with SCADA system of the power house. Necessary contacts and/or ports for integration shall be provided.

7.7. CONFIGURATION

7.7.1. SWITCHGEAR

Construction of the LT switchgear shall be guided by the technical requirements as detailed in **Cl. No. 4.4.1** and **Cl. No. 6.4** of this technical specification.

The 415V LT Switchgear shall be metal-enclosed fixed type, free standing, self-supporting, floor mounted, indoor type, totally enclosed and complete with all components and accessories. Circuit breakers and other switchgear components shall be arranged in multi-tier compartments. Each compartment shall have a hinged door fitted with suitable locking arrangement. Hinged doors, covering the entire height, shall also be provided on the rear face of the switchgear, providing easy access to buses and cables. The design of the switchgear shall be such as to permit extension in either direction.

The switchgear shall be fabricated from the cold rolled sheet steel plates of not less than 2 mm thickness. Stiffeners shall be provided wherever necessary. The switchgear shall be powder coated and recommended colour shade. The housing shall be provided with a degree of protection of IP: 42 as per IS: 13947. The bottom of the switchgear shall be suitable for erection on flush concrete floor and securing to it by means of evenly spaced grout bolts projecting through the base channel members of the frame. The base frame channels and foundation bolts shall form part of the supply.

Necessary provision shall be made in switchgear so that it shall be possible to draw the Air ACBs from 'SERVICE' position to 'TEST' and 'ISOLATED' positions with the compartment door closed thereby eliminating the risk of ingress of vermin and dust while breakers are kept in 'TEST' or 'ISOLATED' positions for any length of time. It shall be possible to draw the ACBs to a fourth position viz. 'MAINTENANCE' with the compartment door open. In this position, the ACB shall be projected out of the panel and rested on the cradle's telescope rails thereby allowing easy inspection of the complete breaker.

The door of the ACB compartment shall be interlocked so that it can only be opened after withdrawing breaker to 'ISOLATED' position and the breaker cannot be racked in 'SERVICE' position unless the door is closed. The facility for padlocking the ACB in 'ISOLATED' and 'TEST' positions shall also be provided. It shall not be possible to 'trip' the circuit breaker through remote operation.

The Moulded Case Circuit Breakers (MCCB) shall be fixed type. For MCCB chassis, provision of isolable type neutral shall be made.

The 415 V LT switchgear shall be divided into distinct vertical sections, comprising:

a. A completely enclosed bus bars compartment for running horizontal and vertical bus bars comprising 3φ and one neutral bus bars (colour coded).

b. Completely enclosed switchgear compartment(s) one for each circuit for housing circuit breaker.
c. A compartment or alley for power and control cables. Cable alley door shall preferably be hinged. Cable alley shall have no exposed live parts and shall have no communication with bus bar chamber.
d. All metering and protection equipment associated with a particular circuit shall be housed in separate and independent compartment earmarked for that particular circuit and in the fixed portion of the vertical panel in case of breaker panels.

The neutral bus shall be solidly connected to ground through a single point link. The current transformers shall be provided in the run of the bus bars at accessible location for relaying and metering, wherever required. The neutral of the incoming transformer secondary shall be connected to the neutral bus of the switchgear. The neutral shall be connected to station earth.

All power and control cables shall be terminated through single compression nickel - plated brass cable glands. All cable glands and aluminum crimping type cable lugs for all power and control cables shall be in the scope of supply. Panels shall be suitable for bottom entry of cable unless otherwise specified.

Switchgear shall be designed in such a way that all components, equipment and bus bars operate satisfactorily without exceeding their respective maximum permissible temperature rise under ambient temperature conditions prevailing within the switchgear cubicle with reference to ambient temperature outside the switchgear cubicles.

The Contractor shall indicate the de-rating factors, if any, employed for each component and furnish the basis for arriving at these de-rating factors duly considering the specified current ratings, altitude and ambient temperature.

Wherever two breaker compartments are provided in the same vertical section, insulating barriers and shrouds shall be provided in the rear cable compartment to avoid accidental touch with the live parts of one circuit when working on another circuit.

Suitable base frames made out of steel channels shall be supplied along with anchor bolts and other hardware for mounting of the switchgear panels. These shall be dispatched in advance so that they may be installed and leveled when the flooring is being done. Lifting lugs shall be provided so as to allow lifting with standard lifting gear. The equipment shall comply with all safety requirements during erection and operation as per relevant standards.

The minimum clearance in air between phases and between phase and earth for the entire run of the horizontal and vertical bus bars shall be 25 mm & 20 mm respectively. The specified clearances shall be modified as necessary to take care of correction for higher altitude.

All auxiliary devices for control, indication, measurement and protection such as push buttons, control and selector switches, indicating lamps, Power monitors, kWh meters and protective relays shall be mounted on the front side of the respective compartment. The design shall be such that unless required for maintenance / inspection purposes, all power ON / OFF or START / STOP and relay reset operations shall be performed without opening the panel door.

The switchgear shall be provided with thermostatically controlled space heaters to prevent moisture condensation. The space heater shall be located at the bottom of each panel and shall be supplied from 240 V AC auxiliary bus for space heater.

LED lamp along with necessary switches shall be provided inside the panels for illumination. Each panel shall be provided with an industrial grade power socket as well.

7.7.2. AIR CIRCUIT BREAKER

The incomer ACBs from SATs and DG Set and bus sectionalizing breakers shall be micro-processor based 4 pole, air break, horizontal, draw-out type and shall be suitable for remote electrical, local electrical and manual operation.

There shall be 'SERVICE', 'TEST' and 'ISOLATED' (fully withdrawn) positions for breakers. In 'test' position the circuit breaker shall be capable of being tested for operation without energizing the power circuits i.e. the power contacts shall be disconnected while the control circuits shall remain undisturbed. Locking facilities shall be provided so as to prevent movement of the circuit breaker from the 'SERVICE', 'TEST' or 'ISOLATED' position.

The withdraw-able module shall be movable between the connected (service) and disconnected (isolated) position with the main disconnecting device in the open position. An interlocking device shall be provided in each of the draw-out module, which prevents the removal of the module from the connected position with the main disconnecting device in closed position. Also the mechanical interlocking device shall prevent the module from being inserted into the compartment with the module main disconnecting device in the closed position. A safety interlock shall also be there to block remote closing command during ACB racking.

The operating handle shall be mechanically interlocked with the module door so that the door cannot be opened with the disconnecting device in the ON position. An indication of the main disconnecting device status shall be easily visible with the module door closed.

The closing of the electrically operated circuit breakers shall be effected by a compression spring, automatically charged after each closing operation by an electric motor. The electric motor shall be a universal motor suitable for operation on AC or DC control supplies with voltage variation from 85 % to 110 % rated voltage. The motor shall be able to charge the spring from fully discharged to fully charged condition in not more than eight (08) seconds. It shall be possible to charge the springs manually with a handle which will form an integral part of ACB. Provision shall be made that as soon as the manual charging handle is coupled, the motor shall automatically get mechanically decoupled. A position indicator shall be provided on the auxiliary board showing the condition of the spring i.e. 'Charged' and 'Discharged' conditions.

All Air Circuit Breakers in the LT switchgear shall be Electrically operated and provided with electronic / electromechanical type relays suitable for over current, short circuit, and earth fault protection. The circuit breakers shall be trip free type and shall be provided with anti-pumping device.

All air circuit breakers shall be provided with 8 'NO' and 8 'NC' potential free auxiliary contacts free. These contacts shall be in addition to those required for internal mechanism / interlocking of the breaker. Separate limit switches each having required number of contacts shall be provided in both 'SERVICE' & 'TEST' position of the breaker. All contacts shall be rated for making continuously carrying 10 Amps and breaking 2 Amps (inductive) at 240 V AC / 110 V DC.

Suitable mechanical positions shall be provided on all ACBs to show 'OPEN', 'CLOSE', 'SERVICE', 'TEST' and 'SPRING CHARGED' positions. Mechanical operation counter shall also be provided. It shall be provided with 'red', 'green' and 'amber' indicating lamps to show 'closed', 'open' and 'auto-trip' conditions of the circuit breaker.

The breaker shall have an operating duty of O – 0.3 sec – CO – 3m – CO.

The following security provisions shall be made on the breakers:

- ACBs racking operation shall be protected against unauthorized access
- ON / OFF buttons shall be guarded against foul play
- Access to release settings shall be secured against tempering

7.7.3. MOULDED CASE CIRCUIT BREAKER

All outgoing feeders shall be provided with Moulded Case Circuit Breakers (MCCB). The MCCBs shall be of fixed type flush mounted type. MCCBs shall conform to IEC: 60947 / IS: 13947 with rated duty short circuit breaking current capacity of 40 kA. MCCBs shall be provided with rotary type door mounted handles. MCCBs shall be current limiting type with tripping time of less than 10 ms. MCCBs on the LT Switchgear and various auxiliary boards shall be provided with potential free contacts wired up to terminal blocks for status indication.

MCCBs shall be provided with `load' and `line' interchangeable terminals for ease of termination and maintenance. MCCBs shall have minimum electrical life of 6000 operations (close-open). The MCCBs shall be provided with site adjustable type tripping device with inverse time characteristics for overload protection and instantaneous characteristics for short circuit protection.

The normal and thermal current ratings of the MCCBs shall be as per requirement of the connected load on feeder. Further, it shall also be possible to adjust the continuous current settings over a wide range with help of setting plug. The operating mechanism shall operate independently of the speed and force with which the operating lever is moved. During trip, the moving contacts shall open even if the operating lever is held closed.

The breaker design shall ensure that the operating lever reflects the position of the moving contacts positively. The position of the operating lever shall be marked "I" for breaker closed, `O' for breaker open and intermediate (yellow) for breaker tripped.

All the MCCBs shall be provided with "ON" and "OFF" LED indications. It shall also be possible to test the operation of trip release while in service without disconnecting the MCCB. Suitable 'ON'/'OFF' indication shall be provided on MCCB panels. Padlocking of the breaker shall be possible in OFF position only for maintenance.

Feeders with intermittent frequent duty e.g. EOT crane feeders shall have provision of backup HRC Fuses of required capacity. The breakers shall be of adequate normal overload & short circuit current rating and shall be suitable for the duty imposed by the scheme.

7.7.4. BUS BARS AND BUS BAR CHAMBERS

The 415V bus shall have suitable cross-section to carry the required continuous and short circuit currents within the limits of temperature rise for the site conditions. All bus bars and jumper connections shall be of high conductivity Aluminium (E91E) of adequate size as per IS: 5082. The cross section of the bus bars shall be uniform throughout the length of switchgear and shall be adequately supported and braced to withstand the stresses due to specified short circuit currents. The current rating of the neutral shall be half that of the phase bus bars. Removable neutral links shall be provided on feeders to permit isolation of the neutral bus bar.

All bus bars shall be adequately supported on non-hygroscopic, non-combustible, track resistant and high strength type polyester fiber glass moulded insulators. Separate support shall be provided for each phase and neutral bus bar. If a common support is provided, anti-tracking barriers shall be provided between the supports.

Both horizontal and vertical bus bars, bus joints and supports shall be capable of withstanding dynamic and thermal stresses of the specified short circuit currents for one second. Only zinc passivated or cadmium plated high tensile strength steel bolts, nuts and washers shall be used for all bus bars joints and supports. All bus bars, bus taps shall be insulated with heat shrinkable PVC sleeves of 1100 V grade of high dielectric strength to provide non-ageing and non-tracking protection, impervious to water, tropical conditions and fungi. The insulation shall be non-inflammable and self extinguishing.

The joints shall be insulated in such a way as to provide easy accessibility of contact bolts for maintenance. Joints shall be covered with removable moulded shrouds made out of suitable material. The dielectric strength and properties shall hold good up to 95^0C. The bus bars shall be colour coded (red, yellow and blue for phase bus bars and black for neutral bus bars). The hot spot temperature of bus bars including joints shall not exceed 90°C for normal operating conditions.

The contractor shall furnish calculations establishing the adequacy of bus bar sizes for specified current ratings, on the basis of short circuit current and temperature rise consideration at specified ambient temperature as per relevant IS / IEC.

7.7.5. INSTRUMENT TRANSFORMERS

Instrument transformers shall be provided as per **Plant SLD**, wherever specified. The current transformer (CT) shall conform to the latest issue of IS: 2705 and the potential transformers (PT) shall conform to the latest issue of IS: 3156.

All current and voltage transformers shall be completely encapsulated cast resin insulated type suitable for continuous operation at the temperature prevailing inside the switchgear enclosure.

The adequacy of the ratings provided shall also be checked during detailed engineering stage. All voltage transformers shall be provided with HRC fuses on primary side and miniature circuit breaker (MCB) with auxiliary contact on the secondary side.

CTs shall have the features as detailed in **Cl. No. 4.4.4** and **Cl. No. 6.7** of this technical specification and PTs shall have the features as detailed in **Cl. No. 4.4.5** and **Cl. No. 6.8** of this technical specification, provided system voltage (primary side) as 0.415 kV. Electrical characteristics of the primary windings with respect to 415 V shall be as per relevant standards.

7.7.6. INDICATING METERS

Characteristics, installation and technical requirements of all metering instruments required for operation of the system shall be as per **Cl. No. 4.4.9** and **Cl. No. 6.10** of this technical specification.

7.7.7. RELAYS

Characteristics, installation and technical requirements of all relays required for operation of the system shall be as per **Cl. No. 4.4.10** and **Cl. No. 6.11** of this technical specification.

7.7.8. AUXILIARY RELAYS, CONTACTS & DEVICES

Suitable number of auxiliary contacts or auxiliary relays shall be provided with each ACB for indication, annunciation and automatic changeover and interlocking scheme. Auxiliary relays shall be provided with over current release units, wherever necessary.

Auxiliary devices, wherever required, shall be provided for operation of automatic changeover and interlocking scheme and proper sequence of switching of circuit breakers as specified in the specification.

Suitable number of potential free contacts / transducers (4 - 20 mA out put) required as per approved logic diagram shall be deemed to be included in the scope.

7.7.9. CONTROL & SELECTOR SWITCHES

Control and selector switches shall be rotary type with escutcheon plates clearly marked to show the function and positions. The switches shall be of sturdy construction suitable for mounting on panel front. Switches with shrouding of live parts and sealing of contacts against dust ingress shall be preferred.

Circuit breaker control switches shall have three (03) positions and shall be spring return to `NEUTRAL' from `CLOSE' and `TRIP' positions and shall have pistol grip handles.

Ammeter and Voltmeter selector switches shall have four stay put positions with adequate number of contacts for 3 phase 4 wire system. Ammeter selector switches shall have make before break type contacts to prevent open circuiting of CT secondary.

The contacts of the switches shall be spring assisted and shall be of suitable material to give a long trouble free service. The contact ratings shall be at least the following:

a) Make & carry continuously 10 A at 230 V AC & 110 V DC
b) Breaking current at 110 V DC, 2A (inductive)

7.7.10. INTERNAL WIRING

Panels shall be supplied completely wired internally to equipment and terminal blocks for connection to external cables entering the panel from the bottom. Terminal blocks shall be complete and provided with necessary terminal accessories for cable ends.

a. 1.1 kV grade PVC insulated stranded flexible copper wire to be used.
b. Size of wire will be as follows:

CT circuit	:	4.0 sq. mm.
PT circuit	:	2.5 sq. mm.
Main AC & DC circuit	:	4.0 sq. mm.
Other circuit	:	1.5 sq. mm.

c. A suitable wiring duct system with covers, firmly fixed on the panel shall be installed for front to rear and inter panel wiring to offer ease in inspection and maintenance.
d. Wiring between terminals of the various devices shall be point to point. Splices or tee connection will not be acceptable.
e. Wires shall be suitably bunched adequately supported to prevent sagging and it shall have sufficient clearance from High voltage system.
f. Colour of wires will be as follows:
   For CT & PT circuit: R Phase: Red; Y Phase: Yellow; B Phase: Blue; Neutral: Black

For DC circuit: Grey
For Earth circuit: Green

7.7.11. LABELS AND MARKING

Engraved PVC labels shall be provided on all incoming and outgoing breaker compartments. All selector switches shall be provided with properly designed escutcheon plates clearly marked to show operating positions. All push buttons and indicating lamps shall also be properly labeled as approved by the employer. Suitable labels shall be provided for easy identification of all equipment, located inside the panel. These labels shall be positioned so as to be clearly visible and shall give the device number as mentioned in the panel wiring diagrams.

7.7.12. EARTHING CONNECTIONS

All vertical cubicles shall be connected to earth bus bar running throughout the length of the switchgear. All doors and movable parts shall be connected to the earth-bus with flexible copper connections. Provision shall be made to connect the earthing bus bar to the plant-earthing grid at two ends. All non-current carrying metallic parts of the mounted equipment shall be earthed. Earthing shall also be provided to cable armours, if applicable.

7.7.13. PAINTING

The switchgear panels shall be powder coated in RAL 7032 shade, both for external as well as for internal panel surfaces, shall be painted as per IS: 5.

7.7.14. REMOTE CONTROL AND ANNUNCIATION

Remote control of the incomers shall be made possible through SCADA system. The remote control will comprise of 'ON'/'OFF' control; and 'trip circuit healthy' indications and trip alarm for the various circuit breakers.

7.8. TESTS

7.8.1. TYPE TESTS

All the apparatus, instruments, structures etc. required for the LT switchgear shall be subjected to all kind of type test in accordance with IS: 8623 / the latest version of relevant standards. The contractor shall submit type test report from CPRI / NABL / Govt. approved Laboratories having identical type, rating and voltage ratio similar to the tendered item during detailed engineering stage, carried out within ten (10) years from the date of this NIT Publication. The contractor may be required to furnish the original type test reports with test results, if desired by the employer.

7.8.2. ROUTINE / ACCEPTANCE TESTS

All the equipment of the LT switchgear shall be tested in accordance with the requirement of relevant IS / IEC Code. All Acceptance tests shall be carried out at manufacturer's works on every lot offered for inspection following relevant IS & IEC in presence of the employer's representatives. Selection of samples for acceptance test as well as rejection and retesting shall be guided by relevant IS. The entire cost of acceptance and routine

tests that to be carried out shall be deemed to be included in the quoted price by the contractor.

Routine / acceptance tests of individual items shall be done as per **Cl. No. 6.18.2** of this technical specifications.

7.8.3. COMMISSIONING CHECKS / SITE TESTS

Commissioning checks / site test of individual items and the total system shall be done as per **Cl. No. 6.18.3** of this technical specifications.

7.9. DOCUMENTS TO BE SUBMITTED AFTER PLACEMENT OF LOA

- Name of manufacturer proposed by the contractor for each item / equipment as per **Cl. No. 7.11**.
- Performance certificates of proposed manufacturers as per **Cl. No. 7.12.**
- All Type test reports of each similar rated products of the proposed manufacturer.
- Routine Test Report / Shop Test Report of each similar rated products of the proposed manufacturer performed earlier.
- Test facilities at manufacturer's test house.
- General arrangement drawing of LT Switchgear showing constructional features, space requirements for safe operation, preliminary layout etc.

7.10. DOCUMENTS TO BE SUBMITTED DURING DETAILED ENGINEERING STAGE

Six (06) sets of data sheet, manual, leaflet, drawing and other documentation as mentioned below for LT Switchgear and various station auxiliary boards shall be submitted to the Controlling Officer of the employer for according approval during detailed engineering stage.

- Guaranteed Technical Particulars (GTP) as per **Chapter – 20 (Cl. No. 20.6).**
- Detailed sectional view (front view, rear view, cross sectional view, side view) of complete switchgears as well as all the compartments / cubicles and auxiliary boards.
- Schematic diagram, control philosophy & control circuit diagrams, wiring diagram etc.
- All construction drawings including equipment foundation details
- Detailed time schedule indicating submission of drawings, tentative date of inspection, delivery of items, installation, testing, trial run & commissioning.
- Detailed Bill of Material (BOM) which shall include the spare parts for five (05) years of trouble-free operation & maintenance of the above system as per **Cl. No. 19.7** and special tools, plants and equipment as per **Cl. No. 19.15.**
- Detailed Quality Assurance Plan (QAP) for routine test and field acceptance test
- Manual for installation, operation and maintenance procedure.
- Undertakings from Relay Manufacturer as mentioned in **Cl. No. 4.16.**
- Undertakings from Meter Manufacturer as mentioned in **Cl. No. 4.17.**

After approval, six (06) sets of approved drawings and documents along with soft copies for LT Switchgear and various station auxiliary boards shall be submitted to the controlling officer of the employer.

Further, the contractor shall submit three (03) sets of successful shop / routine test reports to the controlling officer of the employer prior to dispatch of each item / equipment.

7.11. MAKE OF COMPONENTS

The contractor shall submit proposed make of LT Switchgear and various station auxiliary boards including various bought out components such as relays, control switches, CTs, VTs, resistors etc. after placement of LOA. Final make shall be approved by the employer during detailed engineering stage based on the performance certificates submitted by the contractor. For approved makers list of WBSEDCL for various components, the bidders are requested to go through **Cl. No. 4.15** and **Chapter – 21** of this Technical Specifications.

7.12. CREDENTIALS AND PERFORMANCE CERTIFICATES

The contractor shall submit Performance Certificates issued to the proposed manufacturers by the respective employer for similar kind of job. The contractor shall also furnish documents in support of supply, delivery of similar equipment / system indicating thereon names of the organization, quantity ordered and quantity supplied along with their submission after placement of LOA. Non-submission of the same will be liable for rejection of the proposed manufacturers.

7.13. GUARANTEE

Guarantee of the total equipment including any integral part of the equipment should be up to Defect Liability Period of the project.

7.14. COMPLETENESS OF EQUIPMENT / SYSTEM

All items, equipment, fittings and accessories etc. for any specified equipment / system that may not be specifically mentioned in the specification but necessary for completeness of the system shall be deemed to be covered under the scope of this contract. No extra charges will be paid to the contractor for the same.

7.15. SCHEDULE OF REQUIREMENT

Sl. No.	Description	Quantity
1	Complete 415V, 630 A, SCADA compatible LT Switchgear comprising three (03) nos. of incoming feeders (2 nos. of SAT and 1 no. of DG set), two (02) nos. of bus section breakers and outgoing feeders to various station auxiliary loads protected by MCB / MCCBs with all required accessories and equipment (CTs, PTs, meters, relays, wirings etc.) as detailed in this technical specification and Plant Single Line Diagram.	As required
2	Various auxiliary boards as per final plant design	As required
3	Special tools, plants & equipment as per **Cl. No. 19.15**	As required
4	Spare parts as per **Cl. No. 19.7**	As required
5	Completeness of equipment / system as per **Cl. No. 7.14**	As required

8. DC SYSTEM

8.1. SCOPE

This section of the specification deals with the design, engineering, quality assurance, manufacture, shop testing at manufacturer's works, transport, transit insurance, supply, delivery to site, storage at site, erection, testing, trial run and commissioning of DC System comprising of 110 V, 300 AH DC battery complete with battery charging equipment, DC distribution board (DCDB), associated auxiliary equipment accessories for Lodhama II SHEP.

The scope shall include all associated devices, components, relays, contactors, switches etc. required for satisfactory operation of the DC system.

The scope of supply shall also include spares, special tools and testing devices, which are essential for installation, operation and maintenance for five (05) years trouble free operation of the plant, even though these are not individually or specifically stated in this specification but recommended by the respective manufacturers. All the material & workmanship shall be of suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

8.2. CODES & STANDARDS

The equipment covered under this specification shall comply with the requirements of latest editions of the IS / IEC.

Sl. No.	Standards	Description
1	IS: 1652	Stationary cells & batteries, lead acid type (with plante positive plates)
2	IS: 266	Battery grade sulphuric acid. (battery electrolyte)
3	IS: 1069	Water for storage batteries
4	IS: 1146	Rubber & plastic containers for lead acid storage batteries
5	IS: 1248	Electrical Indicating Instruments
6	IS: 13947	Low voltage switchgear and control gear
7	IS: 3895	Mono-crystalline semi-conductor rectifier cells & stacks
8	IS: 8320	General requirement and methods of tests for lead acid storage batteries
9	IS: 6071	Synthetic separators for lead acid batteries
10	IS: 8623	Factory built assemblies of switchyard and control gear for voltage up to including 1000 V AC and 1200 V DC (Part 1 to 3)
11	IS: 4540	Non-crystalline semi-conductor rectifier assemblies & equipment

Equipment meeting with any other authoritative standards which ensure an equal or better quality than the standards mentioned above will also be acceptable. Where the equipment complies with any other standards, the salient points of difference between the

standards adopted and the standards specified above shall be clearly brought out, and an English version of the proposed standards shall be furnished by the contractor.

8.3. TECHNICAL REQUIREMENTS

The 110 V, lead acid type storage battery is required for meeting the DC load of

- Two (02) nos. of five (05) MW generating unit
- 11 kV indoor switchgear
- 33 kV indoor switchgear
- DC Supply to various protection system of the plant as per final design
- Emergency lighting of the power house
- SCADA system
- Surveillance system etc.

Two float cum boost chargers for 110 V battery set shall be provided to maintain constant voltage at DC bus bars while supplying the continuous load. The charger shall be protected against overloads by having suitable characteristics so that all loads in excess of the capacity of the charger would be transferred to the battery.

In case of sudden DC requirements due to failure of AC supply or charger itself, the battery shall be capable of meeting the system load demand within the limit of maximum design discharge. After restoration of AC supply, the boost charger on shall be able to recharge the battery in a short period. During the period of boost charging, the DC load requirements of power station shall not be interrupted.

Various local DC distribution boards shall be provided at strategic locations of the plant for distributing the DC power from the main DC distribution board (DCDB).

The contractor may give his recommendation on the scheme of operation of battery, battery chargers etc. during detailed engineering stage which will be subjected to approval of the employer.

8.4. TECHNICAL SPECIFICATION FOR LEAD ACID BATTERIES

8.4.1. RATING

Low maintenance type of Lead Acid stationary Batteries incorporating pure Lead Lamellar type with PLANTE formation positive plates assembled in 2 Volt containers with a capacity of 300 AH at 10 hour rate of discharge at 27^0C to an end voltage of 1.85 V per cell having electrical performance as per latest edition of IS: 1652 - 1991 shall be provided. 55 Nos. of 2 volts 300 AH cell connected in series shall form the set of 110 V 300 AH battery bank. The terminals of the battery shall be suitable for receiving cable lugs.

8.4.2. DESIGN CRITERIA

Plate connectors and paste shall be designed to contribute maximum effective surface area, maximum electrical conductivity and superior voltage characteristics throughout the service life. The plates shall be designed for maximum performance durability and shall not buckle during different service condition i.e. high rate of discharge and rapid fluctuation of load. The container should have provision to avoid short-circuit of plates due to deposition at the bottom.

8.4.3. CELL VOLTAGE

The nominal voltage of a single cell shall not be less than 2 volts at the beginning of charging. The trickle charging voltage per cell shall be within 2.25 volts to 2.3 volts. The boost charging voltage per cell shall be up to 2.75 volts. At the end of the charging, cell shall be floated easily around 2.25 volts without causing adverse corrosion or loss of water.

8.4.4. CHARGING CURRENT

- Trickle / float charging current shall be between 240 mA to 720 mA.
- Boost charging current shall be within following limits:
  a) Starting rate : 42 Amp.
  b) Finishing rate : 21 Amp.
- Fully charged battery shall accept about 1 mA / Ah or less under float application.

8.4.5. EXPECTED LIFE SPAN

The expected life span of the batteries shall be minimum ten (10) years. Battery manufacturer shall submit guarantee for the same to the employer.

8.5. CONSTRUCTIONAL FEATURE OF BATTERY

8.5.1. MAIN COMPONENTS OF EACH CELL

POSITIVE PLATES:

The positive plates of cell shall be constructed from pure lead consisting of laminations.

NEGATIVE PLATES:

The negative plates shall be pasted type consisting of sturdy lead alloy grid filled with active material.

PLATE CONNECTIONS:

The plug of the plates of like polarity shall be connected to terminal post for external connections. Suitable plastic buffer, moulded bottom plate support shall be used for holding plates in proper position.

SEPARATOR:

The separators shall be constructed from highly micro-porous and rigid material of appropriate shape. Separators shall be inert chemically and shall prevent internal short circuit and shall ensure minimum internal resistance.

TERMINAL POSTS:

The positive and negative terminal posts shall be clearly and indelibly marked for easy identification. The terminal posts shall be sealed properly with the lid by rubber grommets or other suitable device. The terminal posts shall have provision for inter-cell / outgoing cable connections.

CONTAINER:

Transparent Styrene Acryl Nitrile (SAN) container for each cell shall be made of sturdy construction having proven excellent clarity, outstanding chemical resistant property, rigidity with high insulating quality. The container shall provide permanent transparency to

enable visual inspection of electrolyte level and internal condition of cell. Recommended electrolyte level shall be clearly and indelibly marked.

CELL LID:

Cell lid for covering cell container shall be made from high quality non-corrosive plastic materials and shall have provision for easy removal.

VENT PLUG:

A vent plug of suitable design shall be provided on each cell lid. The vent plug shall have a micro-porous plastic alloy / ceramic filter which will prevent escape of acid fume / spreading of acid fume but will allow free exit of oxygen and hydrogen generated in the process of charging.

ELECTROLYTE:

The electrolyte for the cell shall be battery grade sulphuric acid conforming to latest edition of IS:266-1977 and diluted with distilled water to specific gravity of 1.2 at 27^0C. The lead acid cell batteries shall be supplied in dry and uncharged condition. Required quantity of diluted sulphuric acid of approved quality shall be supplied in separate non-returnable porcelain / any other acid and corrosive proof jars. 10% extra electrolyte shall be supplied.

8.5.2. OTHER COMPONENTS OF BATTERY

CELL PILLARS AND CONNECTORS:

Cell pillars and connectors shall be made from highly conductive material of lead alloy having generous cross section ideally suited for high current duties. Bolts, nuts, washers etc. for connecting the cells and connectors shall be coated with anti-corrosive highly conductive material.

BATTERY STAND:

The stand for battery cell shall be of Mild Steel finished with at least three (03) coats of anti-sulphuric paints of approved shade. The racks shall be of free standing type. Suitable porcelain / plastic insulators shall be provided between the stand and the battery room floor. Number plate to designate each cell of battery shall be provided and shall be attached on the rack. Provision shall be made for clamping outgoing cable on the rack. The cell shall be supported on the rack in suitable row and tier formation with adequate clearance between adjacent cells.

POLARITY MARKING:

The polarity marking of the terminals shall be marked for identification. The positive terminal may be identified by "P" or (+) sign or red colour and the negative terminal may be identified by "N" or (-) or blue colour. Terminal marking shall be permanent and non-deteriorating.

OTHER:

Battery shall be transported in dry, uncharged condition. The electrolyte shall be supplied separately in non-returnable container of acid resistant material. Each battery set shall be supplied with operation / commissioning manual.

The following characteristics have to be satisfied by the batteries offered:

i. Loss of capacity on storage of a fully charged battery for twenty eight (28) days shall not be more than 3 %.

ii. Ampere hour efficiency shall not be less than 97 %.
iii. Distilled water addition once in six (06) months shall be sufficient to maintain the electrolyte level.
iv. The battery shall withstand conditions of under floating and over floating.
v. The battery shall be capable of being maintained at a higher electrolyte specific gravity of 1.230 ± 0.005 without deterioration.

8.6. INSTALLATION OF BATTERY

The battery shall be mounted along the wall of the battery room on the two tier wooden racks supplied along with the battery. Each cell as well as its locations shall be numbered for proper record of maintenance operations. The battery should be placed on the porcelain base kept on the wooden rack.

Suitably coated copper / lead connector shall be employed for inter cell, inter row and inter tier connections. Tee off connections shall be made with acid resisting cables of suitable size. A suitable terminal box shall be provided. The connectors shall preferably be of bolted type and the bolts and nuts shall be of similar material as that of connectors and the same shall be provided with corrosion resistant coating.

The battery shall be connected to DC distribution board by single core cables laid above ground. Suitable terminal arrangement with glands shall be provided for this purpose.

The battery room should be painted with acid proof paint and battery room floor shall be treated as per modern practice and relevant standard.

8.7. BATTERY ACCESSORIES

Following accessories shall be supplied with battery set:

- Syringe type Hydrometer set complete in all respect and capable of indicating specific gravity reading in steps of 0.005 for PLANTE type Lead Acid Cell Battery.
- Cell testing voltmeter (Range: 3-0-3 V; having scale conforming to IS) / digital multi-meter
- Mercury glass thermometer with range 0-100^{0}C having suitable scale representing 1^{0}C temperature rise.
- Wall mounting plastic holder for holding 1 no. hydrometer and 1 no. thermometer.
- Plastic syringe: 10 Oz (ounce)
- Plastic funnel: 150 mm dia.
- Acid resistant plastic jug: 2 liter capacity
- Rubber siphon: 12.7 mm dia., 2 m long
- Rubber apron
- Rubber gloves
- Rubber boots: knee height
- Inter battery connector of lead plated copper
- Lead plated set containing 2 nuts,1 bolt and 2 washers
- Sulphuric acid of 1.190 Specific Gravity at 27°C sufficient for first filling of the battery (with 10% extra quantity)

8.8. BATTERY CHARGER

8.8.1. SYSTEM

a) The battery charger panels shall consists of the following:

i. A charger panel consisting of 02 Nos. of Float cum Boost Charger (FCBC) suitable for charging of 110 V, 300 Ah battery sets besides meeting continuous and emergency DC loads as detailed elsewhere in the specification.

The above modes of charging both automatically and manually shall be through manually operated auto / manual selection switch.

ii. The boost charger shall be capable of initially charging the 110 V, 300 Ah battery at quick rate after an emergency or after a discharge test or for giving periodical curative charge once or twice a year as per battery manufacturer's recommendations.

iii. The float charging shall maintain a steady voltage of 110 V, plus or minus 1 % using a constant potential controller.

iv. The chargers shall be provided with an automatic current limiting facility such that when float charger output current exceeds 10 % above the rated current, the float charger voltage should be brought down automatically so that the float charger output current does not exceed the set value.

v. The chargers shall have built-in automatic voltage control and load limiting features. The voltage regulator shall automatically sense, monitor and regulate the DC voltage to within ± 1 % of the set value from no load to full load and under AC input supply voltage variation of ± 10 % and frequency variation of ± 5 %. Load limiting features shall automatically reduce the output voltage of the charger on loads more than the rated load.

b) During normal condition the float charger shall be on and working in parallel with DC load and battery. The rating of the float charging shall be such as to meet the float charge current requirement of the battery plus the continuous DC load.

c) During the boost charging, if there is an AC supply failure, the battery should automatically be connected to the load to maintain continuity of DC supply.

d) Further, to have battery supply across load even during short interval of change over period and/or if float charger develops trouble, the 42th cell of the battery should be capable of being connected through a blocker diode to the load so that under boost charging condition, the float charger, the continuous DC load and battery up to 42th cell are in parallel.

8.8.2. RATING

The ratings for Float cum Boost Charger (FCBC) shall be as detailed below:

Sl. No.	Particulars	Required Value
1	Boost Charger	
	Range of voltage	92 V to 150 V
	Current Rating	Starting rate : 42 Amp. Finishing rate : 21 Amp.

Sl. No.	Particulars	Required Value
2	Trickle Charger and Float Charger	
	Range of voltage	99 V to 140 V
	Continuous current rating – float	50 A @ 50^{0}C ambient temp
	Trickle / float charging current	Less than 1 A (between 240 mA to 720 mA) or as per battery manufacturer's recommendation

8.8.3. CONSTRUCTIONAL FEATURES

Charger Panel shall consists of:

a) The boost chargers operating on AC input voltage of 3φ, 415 volts (–15 % to +10%), 50 Hz., capable of boost charging the battery comprising of 55 Nos. of 2 V 300 Ah lead acid cells up to a maximum cell voltage of 2.7 V per cell , shall be consisting of the following components:

i. AC MCCB of suitable capacity.
ii. Required nos. of HRC fuses with base, fittings etc. for DC output & AC input.
iii. Three (03) nos. of pilot lamps for indicating availability of 3φ supply.
iv. One (01) no. triple pole AC contactor with ON/OFF push button with O/L relay.
v. One (01) constant potential controller for error detection, load current detection, amplification etc., so that the boost charger output voltage is maintained automatically to the required value, with input voltage variation detailed above.
vi. One (01) set of 3φ full wave bridge connected silicon rectifier, with zener type thyristor with simple smoothening circuits, liberally rated to meet the continuous current rating specified with step-less voltage control.
vii. One (01) of set ripple filtering device to limit the ripple content to less than 2 %.
viii. Double pole MCCB backed by HRC fuses on DC output side.
ix. A set of indicating lamps for DC on indication & AC supply indication.
x. One (01) moving coil type DC ammeter with shunt etc., for measuring DC output / charge / discharge current and one (01) ammeter for measuring load current.
xi. One (01) moving coil voltmeter with selector switch to read boost charge voltage, float charge voltage and one volt meter for AC input voltage.

b) The float chargers operating on AC input voltage of 3φ, 415 volts (–15 % to +10%), 50 Hz. to meet the float charge current requirement of the 55 Nos. 2 V 300 Ah lead acid cells battery plus the continuous DC load, shall be consisting of the following components.

i. AC MCCB of suitable capacity.
ii. Three (03) nos. of HRC fuses with fittings.
iii. Three (03) nos. of pilot lamps.
iv. One (01) no. triple pole AC contactor with ON/OFF push button with O/L relay.
v. One (01) constant potential controller for error detection, load current detection, amplification etc., so that the float charger output is adjusted automatically such that the battery voltage is around 110 volts with load current and input voltage variation detailed above (both) occurring simultaneously.

vi. One (01) auto manual change over switch.
vii. One (01) raise / lower push button for manual operation.
viii. One (01) set of 3φ full wave bridge connected silicon rectifier with zener type thyristor with simple smoothening circuit liberally rated to meet the continuous current rating specified with step less voltage control.
ix. One (01) set of smoothing choke to limit the ripple content to less than 2%.
x. One (01) MCCB to control float charger DC output.
xi. Required nos. of HRC fuses with base fittings etc for DC output and AC input.
xii. One (01) moving coil ammeter for float charger current.
xiii. One (01) center zero mili-ammeter to measure trickle charging current.

c) The battery chargers shall also comprise the following equipment:

i. One (01) set of single pole two way on and off, suitably rated change over switch for selection of battery float / boost mode.
ii. A suitable volt meter with selector switch shall be provided on the panel to indicate phase to phase and phase to ground voltage of the incoming supply.
iii. One (01) centre zero DC Ammeter to be provided in the negative terminal of the battery for reading charging / discharging current of the battery. The Ammeter range shall be 60-0-60A for 300 Ah battery.
iv. Internal light for DCDB operated on 230 Volts single phase, 50 Hz., AC system with door opening/closing ON/OFF switch.
v. Two (02) nos. earthing lugs suitable for receiving 120 mm^2 copper conductors.
vi. Space heaters suitable for operation AC 230 V, 50 Hz.
vii. Heater ON/OFF switch.
viii. Cable glands for all the external cables.
ix. 1φ preventer.
x. DC contactor of suitable rating for connecting 55^{th} cell to the positive DC bus, inter-locked with AC contactor provided in the boost charger.
xi. One (01) no. silicon blocking diode connected to 42^{th} cell and the DC positive bus to maintain continuity of DC supply to the DC bus in the event of AC failure while boost charger in service and to avoid short circuit of 55^{th} cell positive and the 42th cell positive.
xii. Suitable no. of earth leakage circuits for annunciation both audible and visual with push button for reset.
xiii. One (01) set of mili-ammeter to indicate the leakage current when the midpoint of the battery is earthed.
xiv. A set of audible and visual alarm annunciation scheme with all necessary accessories to acknowledge reset and test scheme as also other necessary relays, with the following facia window.
- AC mains fail
- AC mains fail in any phase
- AC input fuse failure for float charger and boost charger
- DC fail for float charger and boost charger
- DC earth fault
- Rectifier fuse fail
- Rectifier control supply failure

- Filter fuse fail
- Blocking diode fail
- Load bus DC fail
- Float charger and boost charger over load
- Under voltage and over voltage of the battery
- AC under voltage
- Earth leakage
- Alarm supply fuse failure

All the alarms shall be provided through electronic display cards. Audio alarm through buzzer, visual indication through 10 mm LEDs & alarm ack. / reset shall be though push button.

xv. Necessary relays for the above protections shall be provided wherever necessary. Potential free contacts (minimum 3 nos.) shall be provided.

xvi. Necessary provision for self diagnostic alarm for any internal faults in the charger.

xvii. The DC system shall be provided with a continuous earth leakage indicating mili-Ammeter, suitable for operation with an earth fault on either pole together with a relay to give alarm and visual indication for an earth fault on the DC system.

xviii. Necessary relays for annunciation for faults mentioned above shall be provided. They shall be suitable for operation of 110V DC supply with + 10 % to –15 % variation. Necessary circuitry for canceling alarm shall be provided. On canceling the alarm, the sound only should go and lamp should continue till the fault is rectified / cleared.

Annunciation shall however be prevented when the charger is manually shutdown or when AC power supply is momentarily interrupted for adjustable period of 5 to 10 seconds.

xix. Necessary contacts for SCADA operations shall be provided.

xx. In the event of AC supply failure, when the battery is on boost charge, the available battery capacity shall be automatically connected to the DC bus.

xxi. All fuses shall be HRC non-deteriorating type. Unless otherwise specified, the fuses shall be of Class "4" (80 kA prospective breaking current) for AC circuits and Class "2" (33 kA prospective DC current) for DC circuits.

xxii. All MCCB shall be of breaking capacity of 25 kA with over load, short circuit and earth fault protection.

MOUNTING:

The float charging and boost charging equipment shall be mounted in a metal enclosed, sheet steel cubicle, indoor floor mounting, free standing type. It shall be totally enclosed, completely dust tight, weather and vermin proof. The cubicle shall be adequately ventilated with louvers to facilitate the cooling of transformers and rectifiers. The ventilating openings shall be less than 3 mm size. The panel shall be complete with internal wiring, terminal board for internal and external connections.

The panel shall be made out of suitable angles and MS Sheet of 16 SWG for the front,18 SWG for the back, top and sides, and 14 SWG for the bottom. Panel shall have suitable width to accommodate the charging equipment. i.e., adequate clearance / space should be provided between item to item in the charger, to facilitate easy handling at the time of attending on repairs. The charger shall be provided with hinged type rear doors.

OTHER FEATURES:

Fuses for DC output and AC input shall be brought on the front of the panel and cutouts provided. Semi conductors devices, relay, alarms on AC failure and to disconnect all internal charger loads from battery to prevent unnecessary discharging during power failure shall be provided.

Printed circuit shall be accommodated in plug in type modules and such modules shall be interchangeable in standard socket chassis.

The selection of electronic components shall be designed to ensure continuous and trouble free service considering ambient temperature as 50^0C.

Natural air cooling shall be employed in all units. Suitable louvers with fine mesh or perforations are to be provided in the panels for this purpose. The use of fans etc., for including accelerated air flow is precluded. Oil cooled components are not acceptable.

INTEREFRENCE AGAINST RF-CIRCUITS:

The equipment shall be efficiently screened against interference to radio and other communications equipment, which may be installed in the same building. All the sources of noise shall be fitted with re-suppressors in accordance with relevant ISS / IEC.

GROUND BUS:

For ensuring the rigid connection, the minimum section of the ground bus shall not be less than 160 mm^2. The ground bus shall be earthed solidly and connected to the power house main earthing system through 50 x 6 mm GI flat.

8.9. DC DISTRIBUTION BOARD

DESIGN AND CONSTRUCTION:

The DC distribution boards shall be of rugged construction, designed for working satisfactorily under severe operating and climatic conditions and shall conform to the relevant IS. The degree of protection provided by the panel shall be IP42 as per IS: 13947.

The 110 V distribution panels shall be of indoor type, suitable for floor mounting on steel frame work on cement concrete pedestal.

The thickness of the sheet steel shall be as follows:

Front & base frame	:	Not less than 2 mm
Top, sides and rear	:	Not less than 2 mm

The cabinet shall be fabricated with the MS sheet steel. The panel shall be painted with two (02) coats of light grey enamel paint (shade – 631 of IS – 5) for exterior finish and glossy white for interior finish. All hardware shall be hot dip galvanized to avoid corrosion. The panel shall be dust and vermin proof. Hinged twin doors with lever type locking handle shall be provided on the rear side. Vermin proof ventilating louvers with copper / brass / stainless steel wire mesh shall be provided on the rear door. The cable entry shall be from bottom and detachable gland plates in two halves shall be provided with 25 mm diameter. Rubber gasket shall be provided for joints. HRC fuses shall be provided for DC lightning circuit, AC supply, DC control. Grouting holes and bolts shall be provided.

Anodized Aluminium Labels shall be provided for all instruments, switches, push buttons, lamps, fuses and for name plate details of the panel.

The AC supply shall be wired neatly and kept separately from DC supply. The bus bars shall be of electrolytic grade copper only.

The DC distribution board shall be provided with a DC voltmeter & indicating lamps to indicate DC supply ON position, for all circuits.

TERMINATION OF CABLE:

Incoming and outgoing cables shall be terminated in suitable rated stud and nut type terminal block. Necessary clearance shall be maintained for easy wiring, 20% spare terminals shall be provided for future connection.

INSULATION:

The cabinet wiring and all equipment shall withstand a power frequency high voltage of 2 kV for one (01) minute between each point to ground and between circuits.

SPACE HEATERS AND LIGHTING OUTLETS:

Space heaters shall be provided inside the panel to prevent condensation of moisture. The wiring of space heaters shall be protected with porcelain beads for suitable thermal insulation for a safe length. All lighting outlets with the switches etc., shall be provided inside each entrance door at the back of the panels.

WIRING:

The internal power and control wiring of the charger shall be of adequate rating as recommended by cable manufacturers and relevant IS.

The interconnecting cables shall be 1.1 kV grade, PVC insulated, stranded copper conductor. Interconnecting leads in the control circuits and leads of filter capacitors shall also be of 2.5 sqmm copper conductors . Ends of all load current carrying cables shall be fitted with copper lugs of adequate rating and shall be soldered or crimped effectively to the conductor to ensure that the temperatures rise at the joints does not exceed that of the conductors. All cabling and wiring shall be neatly secured in position and adequately supported. All cables and wire carrying AC supply shall be kept separate from other cables. The colour scheme employed for the cabling and wiring shall be shown in the suppliers instructions manual. The colour scheme employed shall be as follows:

For AC Circuits	:	Grey
For DC Circuits +ve	:	Red
For DC Circuits –ve	:	Black
Earth	:	Green

All outgoing wiring shall be brought out to terminals on terminal blocks provided with 10% additional terminals. The terminal end shall be provided with suitable identification marks. All the terminals shall be of nut and stud type .All control wiring shall be ferruled.

MIMIC DIAGRAM:

The mimic diagram shall be incorporated with red and green lamps for indicating CB's position. Switchboard purpose, inter changeable, easy replaceable, built-in resistor type lamps of low watt consumption shall be provided. LED lamps are also acceptable.

EARTHING:

Earthing of a dead metallic part of bodies of the equipment on the panels shall be done with a soft drawn single conductor bare copper conductor. Soldered connections shall not be employed. The no. of earthing terminals shall be two (02) for the whole assembly of panels.

INDICATING INSTRUMENTS:

All instruments shall be of the square switch board type of 96 mm^2 size, back connected, suitable for semi flush mounting and provided with dust light cases for tropical use with dull black enamel finish. The accuracy class shall be minimum 1.0. The dials shall be made of such materials to ensure freedom from wrapping, fading and dis-colouring. Marking on scales shall be black on white background. The dials of the instruments shall be of 240^0 scale. All instruments shall have practicable laboratory means of adjustment to accuracy. The limits of error shall be as per IS-1248 or BSS-87.

All indicating lamps shall be of cluster type LEDs of reputed make.

REGULATION:

The DC output shall be maintained at +1% for input variation of -15 to +10% from no load to full load and input frequency variation from ±5% and also when all three variations occur simultaneously. The power factor shall not be less than 0.65.

8.10. TESTS

8.10.1. TYPE TESTS

All the apparatus, instruments, structures etc. required for the DC system shall be subjected to all kind of type test in accordance with the latest version of relevant standards. The contractor shall submit type test report from CPRI / NABL / Govt. approved Laboratories having identical type and rating similar to the tendered item during detailed engineering stage, carried out within ten (10) years from the date of this NIT Publication. The contractor may be required to furnish the original type test reports with test results, if desired by the employer.

8.10.2. ROUTINE / ACCEPTANCE TESTS

All the equipment of the DC system shall be tested in accordance with the requirement of relevant IS / IEC Code. All Acceptance tests shall be carried out at manufacturer's works on every lot offered for inspection following relevant IS & IEC in presence of the employer's representatives. Selection of samples for acceptance test as well as rejection and retesting shall be guided by relevant IS. The entire cost of acceptance and routine tests that to be carried out shall be deemed to be included in the quoted price by the contractor.

BATTERY:

i. Verification of constructional requirement
ii. Verification of marking
iii. Verification of dimensions
iv. Test for capacity
v. Test for voltage during discharge
vi. Ampere hour and watt–hour efficiency test
vii. Test for loss of capacity on storage
viii. Endurance test
ix. Any other test as per relevant IS / IEC

BATTERY CHARGER:

i. DC voltage-current characteristics

ii. High voltage test
iii. Visual inspection
iv. Operation of Auxiliary devices
v. Alternating current measurement
vi. Reverse leakage
vii. Any other test as per relevant IS / IEC

DCDB:

i. Visual examination and dimensional check
ii. Quantitative check.
iii. Functional check of MCCBs, MCBs
iv. Power frequency high voltage withstand test for all wiring and equipment
v. IR value measurement
vi. Any other test as per relevant IS / IEC

8.10.3. COMMISSIONING CHECKS / SITE TESTS

After delivery and installation of all the equipment and accessories of DC system at site, the afore-mentioned routine tests shall be carried out during trial run and commissioning.

All testing equipment including HV test kit, required for testing at site, shall be provided by the contractor at free of charge on returnable basis. In the event of repeated testing becomes necessary, the entire expenditure on such repeat tests shall be borne by the contractor.

All testing equipment shall have the up-to-date calibration certificate. The contractor needs to furnish the same to the employer prior to starting of testing at site as well as at manufacturer's works, whatever the case may be.

8.11. DOCUMENTS TO BE SUBMITTED AFTER PLACEMENT OF LOA

- Name of manufacturer proposed by the contractor for each item / equipment as per **Cl. No. 8.13**.
- Performance certificates of proposed manufacturers as per **Cl. No. 8.14.**
- All Type test reports of each similar rated products of the proposed manufacturer.
- Routine Test Report / Shop Test Report of each similar rated products of the proposed manufacturer performed earlier.
- Test facilities at manufacturer's test house.
- General arrangement drawing of DC system showing constructional features, space requirements for safe operation, preliminary layout etc.

8.12. DOCUMENTS TO BE SUBMITTED DURING DETAILED ENGINEERING STAGE

Six (06) sets of data sheet, manual, leaflet, drawing and other documentation as mentioned below for DC system shall be submitted to the Controlling Officer of the employer for according approval during detailed engineering stage.

- Guaranteed Technical Particulars (GTP) as per **Chapter – 20 (Cl. No. 20.7).**
- Detailed sectional view (front view, rear view, cross sectional view, side view) of complete switchgears as well as all the compartments / cubicles.

- Detailed drawings and characteristics for individual items viz. battery cells, battery bank, battery charger, DC distribution board with overall dimension, along with sectional views showing cable entry position etc.
- Schematic diagram, control philosophy & control circuit diagrams, wiring diagram etc.
- All construction drawings including equipment foundation details.
- Characteristic curves of battery showing
  - Ampere-hour capacity for 1 minute to 10 hour discharge rates with reference to the rated 10 hour discharge rates
  - Battery capacity vs. temperature curve for range of temperature between -3^{0}C to 40^{0}C for 1 minute, 1 hour and 10 hour discharge
  - Battery terminal voltage drop with ampere-hour discharge
  - Characteristics curves pertaining to battery charger and AVR
- Detailed time schedule indicating submission of drawings, tentative date of inspection, delivery of items, installation, testing, trial run & commissioning.
- Detailed Bill of Material (BOM) which shall include the spare parts for five (05) years of trouble-free operation & maintenance of the above system as per **Cl. No. 19.8** and special tools, plants and equipment as per **Cl. No. 19.15.**
- Detailed Quality Assurance Plan (QAP) for routine test and field acceptance test
- Manual for installation, operation and maintenance procedure.
- Undertakings from Relay Manufacturer as mentioned in **Cl. No. 4.16.**
- Undertakings from Meter Manufacturer as mentioned in **Cl. No. 4.17.**

After approval, six (06) sets of approved drawings and documents along with soft copies for DC system shall be submitted to the controlling officer of the employer.

Further, the contractor shall submit three (03) sets of successful shop / routine test reports to the controlling officer of the employer prior to dispatch of each item / equipment.

8.13. MAKE OF COMPONENTS

The contractor shall submit proposed make of DC system components such as battery, battery charging equipment and DC distribution board, relays, control switches etc. after placement of LOA. Final make shall be approved by the employer during detailed engineering stage based on the performance certificates submitted by the contractor. For approved makers list of WBSEDCL for various components, the bidders are requested to go through **Chapter – 21** of this Technical Specifications.

8.14. CREDENTIALS AND PERFORMANCE CERTIFICATES

The contractor shall submit Performance Certificates issued to the proposed manufacturers by the respective employer for similar kind of job. The contractor shall also furnish documents in support of supply, delivery of similar equipment / system indicating thereon names of the organization, quantity ordered and quantity supplied along with their submission after placement of LOA. Non-submission of the same will be liable for rejection of the proposed manufacturers.

8.15. GUARANTEE

The contractor shall submit a minimum ten (10) years guarantee for the batteries issued by battery manufacturer to the employer.

Guarantee for the other system / equipment including any integral part of the system / equipment under the system should be up to Defect Liability Period of the project.

8.16. COMPLETENESS OF EQUIPMENT / SYSTEM

All items, equipment, fittings and accessories etc. for any specified equipment / system that may not be specifically mentioned in the specification but necessary for completeness of the system shall be deemed to be covered under the scope of this contract. No extra charges will be paid to the contractor for the same.

8.17. SCHEDULE OF REQUIREMENTS

Sl. No.	Description	Quantity
1	110 V, 300 Ah lead acid PLANTE type storage battery, complete with all fittings and accessories etc.	One (01) set
2	Charging equipment comprising of Float cum Boost Charger (FCBC) for the battery set	Two (02) sets
3	110 Volt, DC distribution board (indoor type) for supplying DC power to various DC loads	One (01) set
4	Meters, relays, indication, annunciation system and other required equipment for the complete DC system	As required
5	Special tools, plants & equipment as per **Cl. No. 19.15**	As required
6	Spare parts as per **Cl. No. 19.8**	As required
7	Completeness of equipment / system as per **Cl. No. 8.16**	As required

9. DIESEL GENERATOR SET

9.1. SCOPE

This section of the specification deals with the design, engineering, quality assurance, manufacture, shop testing at manufacturer's works, transport, transit insurance, supply, delivery to site, storage at site, erection, testing, trial run and commissioning of one (01) no. of 200 kVA Diesel Generator Set for power house area with "Auto Mains Failure" panel and all accessories and spare parts required for five (05) years satisfactory operation for Lodhama II SHEP. The scope shall include all cabling, terminations and other electrical works as required at site.

The scope of supply shall also include spares, special tools and testing devices, which are essential for installation, operation and maintenance for five (05) years trouble free operation of the plant, even though these are not individually or specifically stated in this specification but recommended by the respective manufacturers. All the material & workmanship shall be of suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

9.2. CODES AND STANDARDS

The design, manufacture, installation, testing and performance of items and services provided in this chapter shall comply with the latest edition including all applicable official amendments and revisions as on date of award of the following standards.

Sl. No.	Standards	Description
1	IS: 1239	Mild steel tubes and fittings
2	IS: 1248	Specification for direct acting indicating instruments and their purposes
3	IS: 4722 / IEC: 60034	Rotating electrical machines
4	BS: 5000 (Part - III)	Rotating electrical machines of particular type of for particular applications. generators to be driven by reciprocating internal combustion engine
5	BS: 5514	Specification for reciprocating internal combustion engine
6	IS: 5	Colours for ready mixed paints and enamels
7	IS: 10000	Methods of tests for internal combustion engine
8	IS: 10002	Specification for performance requirements for constant speed compression ignition (diesel) engine for general purposes (above 20 kW).
9	IS: 8183	Bonded mineral wool

Equipment meeting with any other authoritative standards which ensure an equal or better quality than the standards mentioned above will also be acceptable. Where the equipment complies with any other standards, the salient points of difference between the standards adopted and the standards specified above shall be clearly brought out, and an English version of the proposed standards shall be furnished by the contractor.

9.3. TECHNICAL SPECIFICATION

9.3.1. ENGINE

Sl. No.	Description	Values
1	Type	Diesel, four stroke, sound proof
2	Power output, continuous rating	To match rated capacity of generator at rated power factor (0.8 lagging)
3	Overload rating	In accordance with DIN 6270 (internal combustion engines, definitions of output)
4	Speed	1500 rpm
5	Altitude of installation	Above EL 1000 m
6	Max. ambient temperature	38^0C
7	Cooling system	Radiator type
8	Lubrication system	Forced feed
9	Fuel supply system	Fuel supply pump
10	Starting	Electric starter, 24V DC supplied by own batteries of required capacity as per design
11	Degree of protection	IP 54

9.3.2. ALTERNATOR

Sl. No.	Description	Values
1	Rated output	Not less than 200 kVA
2	Nominal voltage	0.415 kV ± 5%
3	No. of phases	3
4	Frequency	50 Hz ± 3%
5	Rotational speed	1500 rpm
6	Electrical system	TN according to IEC 60364-3
7	Power factor (lagging)	0.8
8	Duty	Continuous
9	Class of insulation	F
10	Temperature rise of windings	According to IEC 60034-1 (resistance method)
11	Degree of protection	IP 54

9.4. STATURARY REQUIREMENTS

DG set shall be silent type meeting the statutory requirements of Gazette Notification of:

- State pollution control board
- Ministry of environment & forest
- CPCB guidelines as on date of issuance of LOA

9.5. EQUIPMENT DESCRIPTION

DIESEL ENGINE:

i. The diesel engine shall be of stationary type, four stroke with vertical in line or 'V' type cylinder arrangement and turbo charged water cooled.
ii. Diesel engine shall be mounted on visco-damper type vibration dampening system and shall be complete with integral air intake through dry type air filters and exhaust systems, metering facility, speed regulation system, fuel injection system and lube oil system along with necessary filters, silencers, ducts, piping and fittings, valves, instruments, etc. as required.
iii. The generating unit shall be complete with all auxiliaries and its performance, torsional vibration, materials and workmanship, etc. shall be in accordance with the standard practices of Diesel Engine Manufacturer's Association in USA, IS: 10000, BS: 5514 or equivalent. The engine shall be properly balanced so as to transmit only small unbalanced forces to the foundation.
iv. Output of the engine shall be such that the engine can continuously deliver their rated power while supplying power / driving all mechanical auxiliaries connected to shaft.
v. It shall also be capable of satisfactorily driving the alternator at 10% overload at the rated speed for one (01) hour in any period of 12 hours of continuous running.

RATED SPEED:

The engine rated speed shall not be more than 1500 rpm.

LUBRICATION:

i. The engine shall have a closed cycle lubricating system with positive oil pressure and a crank chamber for collection / storage of the lubricating oil during circulation. No moving part shall require lubrication by hand or any other external source either prior to starting of the engine or when it is in operation.
ii. A lubricating oil filter shall be capable for operation under normal conditions for a period of more than 250 hours without the necessity of its replacement or cleaning.
iii. Necessary pressure gauges and other instruments together with interconnecting pipe, filling pump etc. shall be supplied and fitted on the lubricating system.

FUEL SYSTEM:

i. The engine shall be capable of running on all types of diesel available in India.
ii. The fuel consumption of the engine at full (100%) and three quarters (33.33%) of its rated power output shall be indicated by the contractor in the guaranteed technical particulars to be submitted by him during detailed engineering stage.
iii. A hand pump for pumping the fuel into the fuel service tank together with necessary pipes or tubing shall be provided.

AIR INTAKE SYSTEM:

The diesel engine shall be provided with dry type air filters having low resistance to air passage, high dust retaining efficiency and provision for easy cleaning. Filters shall be

suitable for achieving satisfactory engine operation and life under tropical humid conditions. The minimum efficiency of the filter shall be 90% down to 5-micron size.

COOLING:

Water-cooled engine shall be of the radiator type located in front of the engine with a mechanically driven fan from the engine shaft. Forced water circulation by means of pump, driven by the engine shaft shall be employed. The radiator tube shall be of copper with sufficient heat transfer area.

ENGINE GOVERNOR:

The engine shall be equipped with suitable hydraulic governor and it shall be capable of adjusting the delivery of fuel in response to variation in the load in order to maintain the speed substantially constant. Frequency shall not vary more than 1 % under conditions of generator load from 0 % to 100 %. However, a tripping shall be provided if speed exceeds the maximum permissible limit.

FLY WHEEL:

The speed droop shall be adjustable during operation from 0 to 5 %. The engine shall have suitable balanced flywheel of cast iron to smoothen the transient load variation.

TURBO CHARGER:

It shall be of robust construction, suitable of being driven by engine exhaust, having a common shaft for the turbine and blower. It shall draw air from filter of adequate capacity to suit the requirements of the engine.

EXHAUST SYSTEM:

The exhaust gases of turbo-charger shall be taken out above the engine through piping adopter etc.

QUIETNESS OF OPERATION:

The engine shall be designed to achieve maximum quietness of operation. For this purpose, an efficient residential silencer shall be provided for the exhaust. Noise level of the set shall not exceed 75 dB at one (01) meter distance.

Engine vibration level shall not exceed 25 mm / sec at bearings.

STARTING:

i. The starting of the engine shall be either by electrical command / auto. DG set shall automatically start to meet the load requirement in event of power failure. The cranking device shall be designed in such a way that the engine starts automatically and reaches rated speed within thirty (30) seconds of a starting impulse being received. On restoring back the main supply, DG set shall have facilities of stopping automatically / manually.
ii. The fuel oil system and the lubricating oil system shall also start operating simultaneously and automatically as soon as starting impulse is received to obviate any chance of seizure of the piston and bearing as well as air locking in fuel supply system.
iii. The source of energy for cranking shall be 24 volts batteries/charger which will be included in the scope of work.

COUPLING:

Contractor shall provide the necessary coupling between the engine and alternator. The alternator shall be coupled to the engine through a suitable flexible coupling to limit the vibrations at alternator to 9 mm/sec. as per BS: 5000 - Part-3.

AUXILIARIES:

Contractor shall at least provide the following engine mounted instruments.

i. Frequency meter/ RPM meter
ii. Water temperature indicator
iii. Lub. oil temperature indicator
iv. Lub. oil pressure gauge

Necessary pressure switches, level switches, thermostats, flow switches, auxiliary relays, etc. required for the above alarm and annunciation system shall be under the scope of supply.

Contractor shall provide 2 (two) nos. of potential free contacts for each of the following conditions that may occur during operation.

i. Water temperature – high
ii. Over speed trip
iii. Lub. oil pressure – low
iv. Lub. oil pressure – very low
v. Lub. oil temperature – high

PIPING VALVES AND FITTINGS:

The engine shall be supplied with all piping, valves and fittings for the fuel oil, lubricating oil, engine starting, air inlet and engine exhaust system along with expansion joints drain plugs, flanges etc.

ANCILLARY EQUIPMENT:

The following equipment shall be supplied:

i. Fuel piping
ii. Tachometer/ RPM indicator
iii. Lubricating oil cooler (where applicable)
iv. Exhaust silencer and piping with terminal insulation
v. Fuel and lubricating oil filters, air filters
vi. Temperature gauges for water and lubricating oil
vii. Hand barring gear
viii. Starting motor
ix. Protective equipment, preferably form of fuel cut-off solenoid and suitable relays to protect the engine against low lubrication oil pressure
x. Drain taps in the cooling water system and the lubricating oil system
xi. Lifting attachment for lifting the complete set of the engine and alternator separately
xii. Radiator
xiii. Any other Auxiliary equipment not specifically mentioned in the specification but are necessary for proper operation and maintenance of the set and safety of operating personnel

ALTERNATOR:

i. The alternator shall be of totally enclosed or screen protected and self air cooled type conforming to the requirements of IS: 4722. The generator shall be driven by the Diesel engine specified above and shall match the same in all respects. The generator shall conform to IS 4722 or IEC-60034.

ii. AC generator shall be supplied along with its excitation system, AVR and include all necessary auxiliaries.

iii. The continuous rating of the alternator under the specified ambient conditions shall at least equal the net electrical output specified for the DG Set plus power requirement of all electrical auxiliaries connected to the alternator terminal including excitation (if it is taken from alternator terminals).

iv. All insulated winding conductors of the alternator shall be of copper. The alternator winding insulation shall be of Class 'F' with temperature rise limited to Class 'B'. The windings shall be given insulation treatment (i.e. two coats of varnish & baking) followed by final coat of resin. The total insulation shall be non hygroscopic. The temperature rise of the stator core & mechanical parts in contact with or adjacent to winding shall not exceed the limits of IEC 60034 Part I. The temperature rise shall be corrected for high altitude conditions as per relevant standard.

v. Suitably rated 240 V, 1φ, 50 Hz., space heater shall be provided in lower part of alternator to maintain the internal temperature above the dew point to prevent moisture condensation on the insulation when the set is not running.

vi. Separate terminal boxes (TB) shall be provided for phase and neutral side of leads. The TBs shall be dust tight, weather proof phase segregated double walled (metallic as well as insulated barriers) having degree of protection of IP-54 as per IS: 13947.

vii. The TBs shall be of sufficient size to conveniently terminate the size and number of cables required. Suitable tinned copper pads shall be provided for power cable termination along with all necessary hardware and cable lugs. For 1φ cables, gland plate shall be of nonmagnetic material and removable type. Connection between exciter and alternator shall be contained within the machine frame as far as possible and connections carrying AC and DC current shall be segregated from each other.

viii. Alternator vibration level shall not exceed the values defined in IS: 12075. Alternators shall be able to withstand vibration level of 9 mm/sec. as per BS 5000 Part III.

ix. The generator shall be provided with brushless type exciter with thyristor having excellent response characteristics, capable of supplying the excitation current of the generator under all conditions of output from no load to full load and capable of maintaining voltage of the generator constant at any value with ±10 % of the rated voltage. It shall be possible to set the same through remote operation also.

AUTOMATIC VOLTAGE REGULATOR:

a. The regulation system shall be provided with equipment for automatic and manual control. Necessary equipment shall be furnished for the following:
   i. To prevent automatic rise of field voltage in case of failure of potential supply.
   ii. To initiate transfer from automatic to manual control of excitation on fuse failure in the generator potential signal.

b. The regulator shall regulate from generator current and potential signals.

c. The above equipment shall be housed in sheet metal cubicle, and shall be completely tested and wired.

d. The regulation equipment shall function correctly between the frequency variation of ±3% and shall ensure a voltage variation not more than ±1% of the set point in steady operating condition between no load to full load.
e. The excitation and voltage regulation should be designed so as to cause necessary de-excitation in case of any short circuit.

DIESEL GENERATOR CONTROL PANEL:

a. The DG set shall be provided with independent control panels inside the acoustic enclosure for necessary control and monitoring. The same shall be visible from outside. The local control panel shall be of robust construction made of 2.0 mm thick cold rolled sheet steel. Neoprene gaskets shall be provided between all openings and joints. The control panels shall have IP-54 degree of protection as per IS: 13947 Part-I.
b. RTD for alternator and temperature scanner.
c. The control panel shall be of unit type construction, compact and neat, provided with hinged door with locking arrangement.
d. All cables shall have bottom entry. Separate cable chamber shall be provided in the control panel for all incoming and outgoing cables. Enough space shall be provided in the control panel for easy access during maintenance and repairs.
e. A tinned copper/ aluminum bar of adequate dimension shall be provided for earth connection complete with nuts and bolts as required.
f. The final paint shade shall conform to shade grey RAL 9002. The identification tag shall be white in colour shade RAL 9010.
g. CT shorting links, test terminal blocks etc. shall be provided. All the equipment mounted inside the control panel shall be identified by lamicoid labels/ stenciling by paint.
h. Panel shall be provided with panel illumination lamp operated by the door switch and thermostat-controlled space heater. Control panel shall be furnished complete with all accessories and wiring for safe and trouble free operation of the system.
i. Diesel generator is required to start up and come to operation automatically in the event of failure of normal power supply. However, manual start stop push buttons shall be provided on the control panel for manual operation of the engine. Facility of normal start/ stop from remote control room shall also be provided.
j. A three impulse starting facility using two impulse timers and a summation timer for engine shall be provided and if voltage fails to develop within 30 seconds from receiving the first start impulse, the set shall lockout automatically and alarm shall be sounded. Contacts for the purpose shall be provided.
k. The control panel shall have the following provision for the control of the DG Set.
    - Starting and stopping of the set
    - Fine adjustment of speed and voltage
    - DC Ammeter and voltmeter for 24V DC system
    - Voltmeter and ammeter for DG set output, with selector switches
    - Frequency meter
    - Watt meter
    - Auto in/out selector switch
    - CTs, VTs, relays, timers, auxiliary contacts shall be provided as per requirement

- Voltage relay, which shall operate at about 80 % of the rated voltage, shall be provided to check the voltage developed at the DG set output. The relay shall be of EE type, VAG 21 or equivalent

  Provision of remote control and metering shall be provided.

l. Indicating lamps for the following shall be provided. The lamps shall be of flush mounted filament / LED type with series resistor and of low power consumption conforming to IS-1248.
   - Charger ON / OFF
   - Set shut down due to "High Water Temp"
   - Set shut down due to "Low Lub Oil Pressure"
   - Set shut down due to "Lack of Fuel"
   - Set failed to start in 30 sec. after receiving the first start impulse
   - Over speed trip
   - Low level oil in fuel tank
   - High Lub. oil temperature
   - AVR fault
   - Set shutdown on electrical fault
   - DG set ON-OFF: this shall be duplicated on remote control panel
   - DG set tripped: this shall be duplicated on remote control panel

m. The Battery charger using semiconductor rectifier shall be capable of recharging the battery fully within fourteen (14) hours.

   The charger shall be provided with a suitable DC voltmeter and an automatic voltage stabilizer to enable it to work satisfactorily in conjunction with the battery when connected to a 1φ, 240V AC supply with 10% voltage variation. The charger shall have necessary filter circuit to limit the ripple content to less than 2% and suitable drooping characteristic by means of choke and/or suitable input transformer impedance to reduce the charging current automatically to prevent over charging as the battery gradually charges up. The charger shall be provided with suitable current limiting device.

BATTERY:

Each DG set shall be provided with 24 V Lead Acid PLANTE type battery system, separate from the power plant main DC battery system, having suitable Ah rating as proposed by the DG set manufacturer. The battery shall conform to the requirement of relevant IS. The battery for starting the engine shall be capable of performing three (03) normal starts without recharging or refilling. In any case, continuous cranking for at least one (01) minute shall be possible.

SOUND PROOFING SYSTEM:

The sound proofing system shall be designed to comply with local pollution control board requirements. The ventilation system for air intake and exhaust shall be so designed that all the exhaust is effectively removed to atmosphere and air intake is not starved for fresh air. The ventilation system shall be of adequate design to ensure no deterioration in performance of DG. Necessary acoustic sealing shall be done in the panel joints.

The acoustic enclosure shall be provided for DG set. It shall be fabricated by minimum 1.6 mm thick CRCA sheet with frame of suitable size. The construction shall be modular type to facilitate dismantling as required for maintenance. The frame shall be of sufficient stiffness

and rigidity. The construction of duct shall be from 1.6 mm thick CRCA sheet and 1 mm thick CRCA perforated sheet. The enclosure paint shade shall be grey RAL 9002.

The sound absorptive layer shall comprise of bonded type mineral wool / rock wool / glass wool of adequate thickness and density to comply with the design requirements. The exposed surface of lining inside the enclosure shall be retained in place by a 1.0 mm minimum thick CRCA / aluminium perforated sheet. Absorptive lining shall be provided between the perforated plate and absorbing material. Necessary acoustic sealing shall be done in the panels / modular unit joints. The acoustic enclosure shall be of modular construction to facilitate engine removal from front side. All hardware of mild steel shall be electro-galvanized.

The exhaust air from radiator shall be discharged through modular duct duly insulated of adequate size. The intake air shall be taken from outside through intake air duct. The door design shall be generally compatible to the enclosure design.

The door shall be provided with heavy-duty hinges and handles. The sealing shall be done with neoprene/ silicon rubber gasket to avoid leakage of noise. The size of the door shall be as per the functional requirements.

9.6. TESTS

9.6.1. TYPE TESTS

The DG set shall be subjected to all kind of type test in accordance with the latest version of relevant standards. The contractor shall submit type test report from CPRI / NABL / Govt. approved Laboratories having identical type and rating similar to the tendered item during detailed engineering stage, carried out within ten (10) years from the date of this NIT Publication. The contractor may be required to furnish the original type test reports with test results, if desired by the employer.

9.6.2. ROUTINE / ACCEPTANCE TESTS

The DG set shall be tested in accordance with the requirement of relevant IS / IEC Code. All Acceptance tests shall be carried out at manufacturer‘s works following relevant IS & IEC in presence of the employer‘s representatives. Acceptance, rejection and retesting shall be guided by relevant IS. The entire cost of acceptance and routine tests that to be carried out shall be deemed to be included in the quoted price by the contractor.

Following routine / acceptance tests shall be carried out.

i. Measurement of resistance
ii. Phase sequence test
iii. Regulation test
iv. Measurement of open circuit and short circuit characteristics
v. Efficiency test
vi. Temperature rise test
vii. Momentary overload test
viii. Over speed test
ix. High voltage test
x. Insulation resistance test (both before and after high voltage test)
xi. Noise level as per IS:12065

xii. Vibration as per IS: 12075

9.6.3. COMMISSIONING CHECKS / SITE TESTS

After delivery and installation of all the equipment and accessories of DG set at site, following tests shall be conducted after installation.

i. **Load Test:** The engine shall be given test run for a period of at least six (06) hours. The set shall be subjected to a maximum available load without exceeding the specified DG set rating. The test shall be conducted at actual power factor of the load available at site.
ii. Fuel consumptions test shall be carried out and the engine shall be tuned to achieve the fuel consumption close to the values achieved at engine manufacturers works.
iii. Insulation resistance test for alternator and wiring.
iv. Regulation test (voltage and speed).
v. Functional test on control panel.
vi. Measurement of vibration & Noise level.

All testing equipment including HV test kit, required for testing at site, shall be provided by the contractor at free of charge on returnable basis. In the event of repeated testing becomes necessary, the entire expenditure on such repeat tests shall be borne by the contractor.

All testing equipment shall have the up-to-date calibration certificate. The contractor needs to furnish the same to the employer prior to starting of testing at site as well as at manufacturer's works, whatever the case may be.

9.7. DOCUMENTATS TO BE SUBMITTED AFTER PLACEMENT OF LOA

- Name of manufacturer proposed by the contractor for each item / equipment as per **Cl. No. 9.9**.
- Performance certificates of proposed manufacturers as per **Cl. No. 9.10.**
- All Type test reports of each similar rated products of the proposed manufacturer.
- Routine Test Report / Shop Test Report of each similar rated products of the proposed manufacturer performed earlier.
- Test facilities at manufacturer's test house.
- Tentative GA Drawing

9.8. DOCUMENTS TO BE SUBMITTED DURING DETAILED ENGINEERING STAGE

Six (06) sets of data sheet, manual, leaflet, drawing and other documentation as mentioned below for Diesel Generator Set shall be submitted to the Controlling Officer of the employer for according approval during detailed engineering stage.

- Guaranteed Technical Particulars (GTP) as per **Chapter – 20 (Cl. No. 20.8).**
- General arrangement and layout of the complete set with overall dimension, along with sectional views showing cable entry position etc.
- Electrical schematic diagram showing connections and controls.
- Complete outline and foundation drawings of the equipment and general arrangement drawing showing terminals, cable entries, foundation details etc. with dimensions and bill of material.

- Detailed time schedule indicating submission of drawings, tentative date of inspection, delivery of items, installation, testing, trial run & commissioning.
- Detailed Bill of Material (BOM) which shall include the spare parts for five (05) years of trouble-free operation & maintenance of the above system as per **Chapter – 19** and special tools, plants and equipment as per **Cl. No. 19.15.**
- Detailed Quality Assurance Plan (QAP) for routine test and field acceptance test
- Manual for installation, operation and maintenance procedure.

After approval, six (06) sets of approved drawings and documents along with soft copies for Diesel Generator Set shall be submitted to the controlling officer of the employer.

Further, the contractor shall submit three (03) sets of successful shop / routine test reports to the controlling officer of the employer prior to dispatch of each item / equipment.

9.9. MAKE OF COMPONENTS

The contractor shall submit proposed make of Diesel Generator and associated battery and other accessories after placement of LOA. Final make shall be approved by the employer during detailed engineering stage based on the performance certificates submitted by the contractor. For approved makers list of WBSEDCL for various components, the bidders are requested to go through **Chapter – 21** of this Technical Specifications.

9.10. CREDENTIALS AND PERFORMANCE CERTIFICATES

The contractor shall submit Performance Certificates issued to the proposed manufacturers by the respective employer for similar kind of job. The contractor shall also furnish documents in support of supply, delivery of similar equipment / system indicating thereon names of the organization, quantity ordered and quantity supplied along with their submission after placement of LOA. Non-submission of the same will be liable for rejection of the proposed manufacturers.

9.11. GUARANTEE

Guarantee of the total equipment including any integral part of the equipment should be up to Defect Liability Period of the project.

9.12. COMPLETENESS OF THE EQUIPMENT / SYSTEM

All items, equipment, fittings and accessories etc. for any specified equipment / system that may not be specifically mentioned in the specification but necessary for completeness of the system shall be deemed to be covered under the scope of this contract. No extra charges will be paid to the contractor for the same.

9.13. SCHEDULE OF REQUIREMENTS

Sl. No.	Description	Quantity
1	200 kVA, 415V, 0.80 pf, 50 Hz, 3φ DG set complete with all accessories as detailed in this specifications.	One (01) set
2	AMF panel with all protection and monitoring instruments	One (01) set
3	24 V DC system of required capacity and battery charger	One (01) set

Sl. No.	Description	Quantity
4	Air intake and exhaust system	As required
5	Complete piping work with bends, elbows, bellow etc.	As required
6	Special tools, plants & equipment as per **Cl. No. 19.15**	As required
7	Spare parts	As required
8	Completeness of equipment / system as per **Cl. No. 9.12**	As required

10. SUPERVISORY CONTROL AND DATA ACQUISITION SYSTEM (SCADA)

10.1. SCOPE

This section of the specification deals with the design, engineering, quality assurance, manufacture, transport, transit insurance, supply, delivery to site, storage at site, erection, testing and commissioning of Control, Monitoring & Data Acquisition (SCADA) System comprising of computers with all accessories (key board, mouse, printers etc.), visual display unit (VDU), relays, fields sensors, panel / cubicles for housing above equipment / devices, power supplies, transducers, converters, wiring etc. to make the system complete for Lodhama II SHEP.

The scope of supply shall also include spares, special tools and testing devices, which are essential for installation, operation and maintenance for five (05) years trouble free operation of the plant, even though these are not individually or specifically stated in this specification but recommended by the respective manufacturers. All the material & workmanship shall be of suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

10.2. SYSTEM REQUIREMENTS

The Control system requirements are mentioned below:

a. **LOCAL / MANUAL CONTROL of Units** shall be provided at respective governor / excitation panels / 11 kV indoor switchgear / unit control panels (UCP) / 33 kV indoor switchgear / LT switchgear etc. at EL above 1067.55 m.

b. **UNIT AUTOMATIC CONTROL PANELS (UACP)** shall be located in the control room of Lodhama II SHEP at EL about 1071.55 m. Necessary systems and accessories, as required shall be under the scope of this contract.

   The units shall be started by single push button through the system. Provision of emergency stopping of the units shall be there.

c. The SCADA panels / work station shall be located at the control room.

d. Push button at local control panel for starting and emergency stopping shall be interlocked by means of hardware and software (Logic) to ensure smooth and safe operation of the plant.

10.3. CONTROL PHILOSOPHY

10.3.1. GENERAL

For operation & control of turbo-generator sets, all necessary binary and analog input / output signals from field equipment shall be connected to digital turbine control system of respective units. The application software of turbine control system (included in the scope of work) shall enable the start / stop, loading and emergency operations of the unit and shall monitor important feedback loops by diagnostic program assuring the healthiness of process parameters.

The following modes of operations & controls shall be provided.

10.3.2. START

Auto starting cum auto sequencing of unit by single push button (at local control panel) / SCADA work station computer & auto stopping of the unit.

The sequence of Starting Operation shall be:

- **Pre-start check conditions:** All pre-start checks shall be made to ensure normal operation of the machines.
- **11 kV generating unit breaker control:** It shall be ensured that 11 kV circuit breaker control is transferred to the control centre from where unit automatic start is intended.
- **33 kV outgoing feeder breaker control:** It shall be ensured that 33 kV outgoing feeder breaker control is also transferred to the control centre from where unit automatic start is intended.
- **Actuation of Machine Start** by either local or remote control shall enable auto start by sequencing and checking of the auxiliaries like cooling water, governor oil pressure system, lubrication system and other electrical and mechanical auxiliaries etc.
- If all starting and interlocking conditions are satisfied, turbine control system shall display that "MACHINE IS READY TO START".
- Sequential operation shall then start the machine till SYNCHRONIZATION.

Detail philosophy for starting of the units shall be submitted by the contractor during detailed engineering stage. In the event of defect / malfunctioning / non-functioning of any event in chain of this sequence, unit shall be taken to safe mode of operation, if possible, otherwise it shall be shut down through governor / AVR shutdown relays.

10.3.3. SHUTDOWN

The shutdown of the machine shall be possible in following modes depending under which condition the unit is running.

- **Emergency Shutdown:** On actuation of emergency shutdown push button or energize of shut down relays by operation of any of turbine generator protections of urgent nature, generator breaker shall be immediately opened. Electrical breaking system shall be operated and simultaneously needles of each nozzle of the turbine(s) shall be closed followed by closing of Main Inlet Valve (MIV).
- **Control Action Shutdown:** Under normal mode of shutdown, the machine shall be stopped under control action shutdown i.e. generator breaker opening shall be delayed till needles of each nozzle of the turbine(s) and Main Inlet Valve (MIV) is closed.

Detail philosophy for shutdown of the units shall be submitted by the contractor during Detailed Engineering Stage.

10.3.4. SYNCHRONIZATION

The synchronization of the units at 11 kV level shall be carried out from synchronizing panel in the following way:

- **Automatic Synchronizing:** This shall be done through auto synchronizer.
- **Manual Synchronizing:** This shall be done manually but the check synchronizing relay shall be in circuit.

10.3.5. LOAD OPERATION OF UNIT

After the unit is synchronized with grid and loaded up to initial load, the unit can be loaded to the desired level through load limiter and speed setting adjustment. These adjustments shall be controlled from either control room or unit control panel (local), as per the operation mode. The electrical output of the generator shall correspond to the setting needle position at each nozzle of the turbine(s).

10.4. DATA ACQUISITION AND MONITORING

i. System shall acquire on continuous basis the parameters of:
   - **Turbine:** like needle position, water flow, water pressure, net head, rpm, bearing temperatures, oil pressure, cooling water flow & pressure etc.
   - **Generator:** like phase voltages, currents, power factor, MW, MVAR, MWh, MVARh, frequency, bearing temperatures, generator stator winding, core & teeth temperatures, excitation voltage / current etc.
   - **Main Transformer:** phase currents, phase voltages, power factor, MW, MVAR, MWh, MVARh, frequency, oil temperature, winding temperature, oil level etc.
   - **Station Auxiliary Transformer:** phase currents, phase voltages, power factor, kW, kVAR, kWh, kVARh, Frequency, oil temperature, winding temperature etc.
   - **DC System:** DC voltage, charging status, battery room temperature etc.
   - **Surveillance System:** Continuous CCTV footage at power house and transformer yard.

ii. The parameters shall be indicated on LED type VDU mimic (minimum 40" LED screen) along with required necessary devices at the control room.

iii. Separate LED type VDU (minimum 40" LED screen) along with required necessary devices shall be provided as standby which shall be under the scope of supply.

iv. The system shall monitor and indicate status of all electrical devices of 11kV, 33kV, 415V AC System as well as 110 V DC System on the VDU.

v. Mimics of main Single Line Diagram (SLD), auxiliary SLD and DC SLD in colour shall be shown. The parameters as stated above shall be displayed by the side of respective device in proper units of measurement.

vi. Any change in values within five (05) minutes shall be displayed in different colour.

vii. Occurrence of alarm shall be shown at the bottom of the VDU screen. Non trip signals shall be shown in blue and trip signals shall be shown in red.

viii. Absence of red trip alarm shall not prevent action on operation / safety of concerned equipment.

10.5. FUNCTIONAL REQUIREMENTS

The control & monitoring system for the generating units shall be microprocessor based digital control. Microprocessor based automatic sequence control equipment shall be provided for each unit. Sequential control equipment shall be designed to provide overall sequential operation viz. automatic sequential start up, auto synchronizing, auto loading, shutdown of machines etc. Automatic sequential control of each unit shall be connected to centralized automatic control system in control room through intra plant bus (coaxial cable or fiber optic type) and man machine interface (MMI).

Unit control panels shall be hard wired and shall provide a local control of the units in automatic mode through conventional means by single push button command.

The control room in Lodhama II SHEP shall have LED based integrated control i.e. MMI and Data Acquisition System (DAS). which shall be capable of performing following functions:

i. Supervision of plant processes
ii. Processing of plant information & presentation
iii. Analysis of plant events
iv. Computer based control of the plant
v. Long time storage of data for analysis of plant performance
vi. Monitoring of plant performance by periodic calculations

MMI / DAS system shall be made of processors (CPU) in redundant standby mode interfaced to interplant bus (data highway) and shall be accessible by two Operators' Work Stations (OWS) consisting of display units, functional keyboards & processing unit. Any of the workstations shall be capable of controlling all the units and other shall be in standby mode.

It shall be ensured that even if SCADA system is down or undergoing preventive checks / maintenance, the unit can be run safely in auto mode with all primary & secondary protections in healthy condition.

10.6. TECHNICAL REQUIREMENTS

Separate unit control panels (UCP) located in power house shall be provided for control and monitoring of turbine, main inlet valve, generating units, main transformers, 33 kV lines, station auxiliary system, DC system etc. and shall have necessary controls & equipment. The following panels provided for the power plant shall be connected with SCADA:

Panel 1 – Unit 1 (**Chapter – 4** and **Cl. No. 2.26**)
Panel 2 – Unit 2 (**Chapter – 4** and **Cl. No. 2.26**)
Panel 3 – Main Transformer (**Cl. No. 5.20**)
Panel 4 – Synchronization (**Cl. No. 4.16**)
Panel 5 – Outgoing Feeder (**Chapter – 6**)
Panel 6 – Station Auxiliary Transformer 1 (**Cl. No. 4.5**)
Panel 7 – Station Auxiliary Transformer 2 (**Cl. No. 4.5**)
Panel 8 – Diesel Generator Set (**Chapter – 9**)
Panel 9 – LT Switchgear (**Chapter – 7**)
Panel 10 – DC System (**Chapter – 8**)
Panel 11 – Hydro-mechanical systems (**Volume – 6; Part – II**)
Panel 12 – Fire Fighting System (**Chapter – 16**)
Panel 13 – Surveillance System (**Chapter – 17**)

Various Inputs such as Governor supervision & Control, Excitation Supervision & Control, Temperature Supervision, Forebay Water Level etc. shall be connected with SCADA. The contractor, in consultation with the manufacturer, shall prepare and submit the scheme during detailed engineering stage for according approval from the employer.

Sequence of Event Recorder (SER) showing & displaying sequence of events in chronological order with time stamping in a format XX: XX: XX (hours: minutes: seconds) shall be provided. The resolution required shall be 1 mili-second.

The required contacts and sensor outputs provided by the manufacturer's of individual item / equipment / system shall be used wherever available.

10.7. SYNCHRONIZATION

Synchronization shall be done with dual voltage, dual frequency meter as per the relevant breaker requirement. Synchro-check ON / OFF switch shall also be provided.

10.8. TRIP LOGICS / OPERATIONS

Various trip commands, initiated by VDU screen selection, shall be password controlled. This command will be in the form of a closure of a contact in respective controlled system / device. Contradictory commands to same equipment shall RESULT IN NO OPERATION.

10.9. POWER SUPPLY

The power required for the SCADA system shall be supplied from the power plant DC system at required voltage level. If the DC voltage requirement is less than the power plant DC system voltage i.e. 110 V, necessary tapping with required protection shall be done by the contractor.

10.10. CONFIGURATION AND LAYOUT

All the Programmable Logic Controller's (PLC) output relays, input / output devices, sensors, transducers, power supplies and equipment shall be cubicle mounted and wired. Suitable isolating links, provisions shall be made in the wiring hardware, for on-line testing / calibration of these devices.

MCBs, fuses, and LED indication lamps for internal safety and supervision of this system shall be provided on these cubicles.

Computer, CPU shall be programmed to accept GPS time pulses. Provision shall be included to adjust the time as and when necessary.

Two (02) Nos. of LED Type VDU (Main & Standby) with key boards, mouse and other required accessories for various parameter control & monitoring shall be provided. One (01) no. of colour printer (upto A3 paper printing) and one (01) no. of colour printer (upto A4 paper printing) shall be provided.

Necessary cabling, special cabling and connectors shall be included to integrate entire system equipment / devices. Necessary filter(s) and protection of the system from electromagnetic induction, spurious signals shall be provided.

Necessary transducers for conversion of analog signals shall be included. It shall not permit access to electrical analogue parameters like voltage, current etc. from protective relays.

10.11. COMMISSIONING CHECKS / SITE TESTS

The contractor shall demonstrate various functionalities of the SCADA system during pre-commissioning stage following the approved design. The test results shall satisfy the requirements as approved during detailed engineering stage. The contractor shall provide training to employer's personnel on operation and maintenance of SCADA system. Lifetime License of the software, if applicable, shall be provided by the contractor.

10.12. DOCUMENTS TO BE SUBMITTED AFTER PLACEMENT OF LOA

- Name of manufacturer proposed by the contractor for each item / equipment as per **Cl. No. 10.14.**
- Performance certificates of proposed manufacturers as per **Cl. No. 10.15.**
- All Type test reports of each similar rated products of the proposed manufacturer.
- Routine Test Report / Shop Test Report of each similar rated products of the proposed manufacturer performed earlier.
- Test facilities at manufacturer's test house.
- Tentative GA Drawing

10.13. DOCUMENTS TO BE SUBMITTED DURING DETAILED ENGINEERING STAGE

Six (06) sets of data sheet, manual, leaflet, drawing and other documentation as mentioned below for SCADA system shall be submitted to the Controlling Officer of the employer for according approval during detailed engineering stage.

- Guaranteed Technical Particulars (GTP) as per **Chapter – 20 (Cl. No. 20.9).**
- General arrangement, layout and schematic diagram of the complete system with panel dimension along with sectional views, wiring layout etc.
- Electrical schematic diagram showing connections and controls.
- Descriptive data and literature describing complete system philosophy as well as each type of equipment offered.
- Complete outline and foundation drawings of the equipment and general arrangement drawing showing terminals, cable entries, foundation details etc. with dimensions and bill of material.
- Detailed time schedule indicating submission of drawings, tentative date of inspection, delivery of items, installation, testing, trial run & commissioning.
- Detailed Bill of Material (BOM) which shall include the spare parts for five (05) years of trouble-free operation & maintenance of the above system as per **Cl. No. 19.9** and special tools, plants and equipment as per **Cl. No. 19.15.**
- Detailed Quality Assurance Plan (QAP) for routine test and field acceptance test
- Manual for installation, operation and maintenance procedure.

After approval, six (06) sets of approved drawings and documents along with soft copies for SCADA system shall be submitted to the controlling officer of the employer.

Further, the contractor shall submit three (03) sets of successful shop / routine test reports to the controlling officer of the employer prior to dispatch of each item / equipment.

10.14. MAKE OF COMPONENTS

The contractor shall submit proposed make of SCADA system after placement of LOA. Final make shall be approved by the employer during detailed engineering stage based on the performance certificates submitted by the contractor.

10.15. CREDENTIALS AND PERFORMANCE CERTIFICATES

The contractor shall submit Performance Certificates issued to the proposed manufacturers by the respective employer for similar kind of job. The contractor shall also furnish documents in support of supply, delivery of similar equipment / system indicating thereon

names of the organization, quantity ordered and quantity supplied along with their submission after placement of LOA. Non-submission of the same will be liable for rejection of the proposed manufacturers.

10.16. GUARANTEE

Guarantee of the total equipment / system including any integral part of the equipment should be up to Defect Liability Period of the project.

10.17. COMPLETENESS OF THE EQUIPMENT / SYSTEM

All items, equipment, fittings and accessories etc. for any specified equipment / system that may not be specifically mentioned in the specification but necessary for completeness of the system shall be deemed to be covered under the scope of this contract. No extra charges will be paid to the contractor for the same.

10.18. SCHEDULE OF REQUIREMENT

Sl. No.	Description	Quantity
1	Complete supervisory control and data acquisition system as per the requirements detailed in the technical specifications	As required
2	Operator's work station complete with CPU, hard disk of adequate capacity, VDUs, keyboard, mouse, printers, DVD writer, LAN card, graphic card of adequate resolution, other peripheral devices, computer furniture etc.	As required
3	Software to carry out the functional operations of SCADA system	As required
4	Special tools, plants & equipment as per **Cl. No. 19.15**	As required
5	Spare parts as per **Cl. No. 19.9**	As required
6	Completeness of equipment / system as per **Cl. No. 10.17**	As required

11. CABLES, CABLE RACKS & TRAYS

11.1. SCOPE OF WORK

This section of the specification deals with the design, engineering, quality assurance, manufacture, shop testing at manufacturer's works, transport, transit insurance, supply, delivery to site, storage at site, erection, testing and commissioning of Power, Control and Instrumentation Cables along with Cable Terminals and all Accessories for making the system complete and for warranting a trouble free and safe operation of Lodhama II SHEP.

The scope shall also include supply of all material, fabrication and erection of cable supporting structure, cable racks & trays as well as laying of cables on cable racks etc.

Spare length of cable shall be provided at each terminal as loop following the installation requirement and relevant standards and spares for cable supporting structure, cable racks & trays, as required, shall be supplied at site within the scope of supply under this contract.

11.2. CODES AND STANDARDS

The design, manufacture, testing and performance of cables and accessories covered under this specification shall comply with latest edition of the following standards.

Sl. No.	Standards	Description
1	IS: 7098 (Part-1)	Cross linked polyethylene insulated PVC sheathed cables for working voltage up to and including 1.1 kV
2	IS: 7098 (Part-2)	Cross linked polyethylene insulated PVC sheathed cables for working voltage from 3.3 kV up to and including 33 kV
3	IS: 10418	Drums for cables
4	IS: 8130	Conductors for insulated electric cables and flexible cords
5	IS: 10877	Moulds suitable for cast resin based indoor terminals for cables for voltage 3.3 kV and above up to and including 11 kV
6	IS: 11979	Moulds for cast resin based straight through joints for cable for working voltage 3.3 kV and above up to and including 11 kV
7	IS: 8308	Compression type tubular inline connectors for aluminium conductors
8	IS: 8309	Compression type tubular terminals for aluminium conductors
9	IS: 8438	Moulds of cast resin based straight joints of cable up to including 1.1 kV
10	IS: 11967	Specifications for co-axial cables
11	IS: 2062	Structural steel (standard quality)
12	IS: 513	Cold rolled low carbon steel sheets & strips
13	IS: 277	Galvanized sheet steel
14	IS: 808	Rolled steel beam, channels and angle section

Sl. No.	Standards	Description
15	IS: 2629	Recommended practice for hot dip galvanizing of iron and steel
16	IS: 2633	Method of testing uniformity of coating on zinc coated articles.
17	IS: 800	Specification for use of structural steel in general building construction.

Equipment meeting with any other authoritative standards which ensure an equal or better quality than the standards mentioned above will also be acceptable. Where the equipment complies with any other standards, the salient points of difference between the standards adopted and the standards specified above shall be clearly brought out, and an English version of the proposed standards shall be furnished by the contractor.

11.3. ASSESSMENT OF QUANTITATIVE REQUIREMENTS

The bidders shall assess the quantity of various sizes of the power, control, instrumentation and communication cables & its accessories along with cable racks & trays including the spares required for the project. The Contractor shall furnish the details scheme of the same to the employer for approval during detailed engineering stage. The scope of works shall cover the cables required for:

- Connecting generators with 11 kV indoor switchgear
- Connecting step-up transformer with 11 kV indoor switchgear
- Generator neutral grounding system
- Connecting step-up transformer with 11 kV indoor switchgear
- Outdoor feeder connection up to transformer yard
- Connecting station auxiliary transformer
- Secondary connection of all CTs, PTs and auxiliary transformers etc.
- Various control system, panels etc.
- Various panels for mechanical auxiliaries, pumps etc.
- DC System
- SCADA System
- Surveillance System
- Connecting various loads of the plant with their respective sources etc.

11.4. GENERAL TECHNICAL REQUIREMENTS

a) All cables shall be Fire Retardant Low Smoke (FRLS) type. The cables shall be sized based on the following considerations:
   - Rated current of the equipment
   - The voltage drop in the cable during motor starting condition and during full load condition shall be limited to 10% and 2% of the rated Voltage respectively.
   - Short circuit withstand capability.
   - De-rating factor for various conditions of installations viz. variation in ambient temperature for cables laid in air, grouping of cables, variation in ground temperature and soil thermal resistivity for buried cables etc. shall be considered while selecting the cable size.

b) For design, maximum short circuit current for 33 kV, 11 kV & 415 V systems may be considered as 25 kA for 3 sec., 25 kA for 3 sec. and 40 kA for 1 sec. respectively.

c) Size of Aluminium power cable shall in no case be less than 16 mm^2 and Copper power cable shall not be less than 6 mm^2. Where there is requirement of cables less than 16 mm^2, copper cable of appropriate size but not less than 6 mm^2 may be used.

d) Unearthed type XLPE power cables shall be used.

e) Minimum size of the control cable for CT circuit shall be 4 mm^2 and that for potential circuit shall be 2.5 mm^2.

f) The cables shall be capable of satisfactory operation under a power supply system voltage variation of ±10% and frequency variation of ±5% and a combined frequency voltage variation of 10 % (absolute sum).

g) The cables shall have heat and moisture resistant properties.

h) All Cables shall be of type tested, approved design with proven record of similar power station installations.

i) Cable lengths shall be considered in such a way that straight through cable joint is avoided. Minimum two (02) nos. of loops as per respective cable specification and relevant standard shall be provided at each termination point.

j) Wherever bending is necessary, minimum bending radius as per manufacturer's recommendation and relevant standard shall be maintained.

k) Cable terminals, cable tray and racks shall be made as per relevant IS / IEC. Painting as per IS: 5 shall be provided in each tray and racks.

l) Cables passing through different fire zones shall be provided with fire-proof barriers with the same fire rating as the penetrated walls or partitions. The location of such barriers shall be finalized during execution work.

Contractor shall be responsible for complete design of the cable network comprising of following:

i. Preparation of coordinated drawings for termination of cables for all equipment in power house including turbine, generator, transformer, HV & LV switchgear, DC cables etc.

ii. Cable routing drawings and the estimation of cable quantities of different sizes

iii. Preparation of cable schedules

iv. All cable termination kits including cable termination kits for high voltage cable and cable glands for low voltage power cables and control cables

v. Cable conduits/ pipes, cable glands etc.

vi. Cable identification tags for cables and wires, lugs etc.

Any other item necessary for completeness of the cable, cable laying termination system shall be supplied.

11.5. XLPE POWER CABLES

XLPE cables for 33 kV, 11 kV and PVC insulated cable for 415 V system shall be armoured, heavy duty, stranded, aluminium conductor of suitable cross-section and shall be provided with semi-conducting conductor shield, XLPE Insulation, semi-conducting insulation shield, copper tapped metallic shield and PVC outer sheath conforming IS 7098 (Part: II).

Sizes of the cables shall be as mentioned below:

- From Generator(s) to 11 kV Indoor Switchgear: 11 kV, 1C, 1R, 300 mm^2 XLPE Insulated armoured Aluminium Cable

- From 11 kV Indoor Switchgear to Main Transformer: 11 kV, 1C, 2R, 300 mm^2 XLPE Insulated armoured Aluminium Cable
- From Main Transformer to 33 kV Indoor Switchgear and from 33 kV Indoor Switchgear to transformer yard: 33 kV, 1C, 1R, 150 mm^2 XLPE Insulated armoured Aluminium Cable
- From 11 kV Indoor Switchgear to HT side of the Station Auxiliary Transformers: 11 kV, 1C, 1R, 35 mm^2 XLPE Insulated armoured Aluminium Cable
- From LT side of the Station Auxiliary Transformers to LT Switchgear: 1.1 kV, 3½C, 1R, 240 mm^2 PVC Insulated armoured Aluminium Cable
- From Diesel Generator Set to LT Switchgear: 1.1 kV, 3½C, 1R, 240 mm^2 PVC Insulated armoured Aluminium Cable

The semi-conducting conductor shield shall ensure perfectly smooth profile and avoid stress concentration and free from voids. The conductor shield shall be extruded in the same operation as the insulation. The insulation shall withstand mechanical and thermal stresses under steady state and transient operating conditions. A non-magnetic semi-conducting insulation shield shall be applied over insulation to confine electrical field to the insulation. The insulation shield shall be extruded in the same operation as the conductor shield and the insulation by triple extrusion process. A copper tape / wire metallic shield shall be put over non-metallic insulation shield. An extruded PVC outer sheath shall be applied over metallic shield with suitable additives to prevent attack by rodents and termites.

11.6. PVC CABLES

All single and multi core PVC cables for low voltage AC and DC system shall conform to IS: 1554 (Part I). These cables shall be heavy duty aluminium conductor with heat resistant PVC insulated, colour coded, laid up, un-armoured, inner and outer extruded PVC sheath. The outer sheath shall be of specially formulated PVC compound having Flame Retardant Low Smoke (FRLS) characteristics as per relevant standards. All the materials used for conductor and insulation shall be new and of requisite quality. Necessary tests during manufacturing shall be conducted in conformity with relevant standards.

11.7. CONTROL CABLES

The control cables shall be multi-core, colour coded, annealed, stranded high conductivity copper, single conductor, insulated with HR-PVC insulation, PVC sheathed, un-armoured FRLS type conforming to is 1554 (part I & II) / relevant IEC. The outer sheath is of specially formulated PVC compound. The conductor shall be made from stranded annealed copper to form compact conductor having a resistance within the limits specified in relevant IS / IEC.

11.8. INSTRUMENTATION CABLES

The instrumentation cables in addition to meeting the requirements of control cables shall be provided with electrostatic shielding by aluminium tape and screening by annealed tinned copper wire. Each cable shall consist of twisted pairs having an overall screen only or multiple fibers, together with drain wires, fillers, shielding, wire, armour and outer sheath as specified.

Maximum loss for fiber optic cables shall not exceed 3 dB / km at 850 nm and 1 dB / km at 1300 nm. Bandwidth of fiber optic cables shall be 160 Mhz-km at 850 nm and 500 Mhz-km at 1300 nm. Fiber cables with 8, 12 or 18 multimode fibers (62.5 / 125 µm) shall be used.

11.9. TEMPERATURE WITHSTAND CAPACITY

The continuous temperature withstand ability shall be 90^0C and 70^0C for XLPE and PVC insulated cables respectively.

The short circuit temperature withstand ability shall be 250^0C and 160^0C for XLPE and PVC insulated cables respectively.

11.10. COLOUR SCHEME

To facilitate easy identification of phases, following colour scheme in accordance with IS 1554 (Part I) shall be adopted.

- R Phase: Red
- Y Phase: Yellow
- B Phase: Blue
- Neutral: Black

11.11. IDENTIFICATION

Cables for each equipment must be tagged with permanent metal tag of impregnated cable number, size, voltage rating as per drawings at MCC / switchgear end and equipment terminal end as well as in the mid portion of the cables at certain distances as instructed by the employer or his authorized representative. Beside this, the contractor shall provide cable identification number as per approved drawing at each terminals and at an interval of max. two (02) meter throughout the laying of each cables during installation.

For control cables, self-adhesive marker in the form of strips of any one character, which can be applied on the cable easily peeled from the backing cards, shall be supplied. The strips shall be water- proof duly marked with special formulated ink with specific thermo-setting adhesive to withstand high temperature. Suitable plastic ring type ferrules marked with engraved indelible ink for control cables and sticker type ferrules for power cables shall be supplied. These shall be marked as per cable schedule such that each core of each cable can be identified easily.

11.12. JOINTING BOXES / JOINTING KITS

Straight through joints in the run of cables, wherever unavoidable, shall be made through joint boxes. The contractor shall design the system considering suitable jointing boxes for the type and size of cables as per the schedule. The design of the jointing boxes must ensure that the actual insulation strength between phases and phase to earth is greater than that of the associated cable and eliminate any possibility of moisture entering the joint or the compound surrounding the joint. Provision shall be made for binding the sheaths of the two cables being joined solidly by approved means to ensure the electrical continuity of the sheath from one end of the cable run to other.

Full details of the jointing boxes and the joints including dimensions shall be provided by the contractor during detailed engineering stage. The jointing boxes shall comply in all aspects with the provision of the latest issue of relevant standards.

11.13. CABLE TERMINATION KITS AND SEALING ENDS

Heat shrinkable cable terminations wherever required shall be supplied. The termination kits shall be of reputed make only. Full details, dimensions and drawings of the cable terminations kits shall be furnished by the contractor during detailed engineering stage.

11.14. JOINTING AND SEALING MATERIAL

All hardware, filling compounds, plumbing metal, tapes and other materials required for the installation and terminal connections of the various size of cables shall be within the scope of supply under this contract.

11.15. CABLE LUGS

For termination of cables inside the panels, cable lugs, suitable for the type and sizes of cables as required, shall be offered. The cable lugs shall be made of copper tube electro-tinned. Longneck crimping lugs shall be supplied for cables of size 300 mm^2 and above.

11.16. CABLE GLANDS (DOUBLE COMPRESSION TYPE)

The cable glands, made of brass, electro tinned in order to avoid corrosion and oxidation of the surface, shall be offered. The nipple threads shall be in accordance with IS 12943. Glands shall provide neat, tight, dust and vermin proof termination. Glands shall be provided with rubber ring to hold the cables firmly when check nut is slightly tightened. Glands shall be complete with suitable washers. Glands shall be of reputed make.

11.17. CRIMPING TOOL

Crimping tool suitable for manual operation for making joints with lugs for Aluminium conductor up to size of 50 mm^2 shall be provided. A portable hand crimping tool for making compression terminal on the cable conductor up to 400 mm^2 size shall also be supplied within the scope of this contract.

11.18. BUTTON TAPE (STRAP & STUD)

Perforated cable strapping with holes conveniently spaced for assembly and moulded studs shall be provided, as required. The strapping shall be made of NYLON Grade 220 or other elastic material to give proper performance. The studs shall be made of 'NYLON'.

11.19. CABLE ROUTING

For the main cable ways, a system of cable racks and trays as well as cable ducts and trenches shall be provided. The power and the control cables shall run on separate trays. The cables for emergency lighting, fire alarm systems, etc. shall run on separate trays. The power cables shall be laid on the uppermost rack to prevent spread of fire. When power cables are laid in the proximity of communication cables, the minimum horizontal and vertical separation between them shall be 600 mm. Wherever possible the power and the communication cables shall be located as far from each other as possible. Tre-foil arrangement shall be followed for cable laying as per relevant IS / IEC.

The cables shall be handled with care to avoid kinking and damage. Sufficient slack shall be allowed in each run of cable to permit contraction and expansion. Suitable loops

between gland and terminating point shall also be provided. Necessary rollers etc. shall be used while pulling and laying of the cables.

Cables shall be properly clamped at regular intervals with the help of non magnetic / moulded fiber glass strip clamps / PVC sleeved clamps, of suitable size. Contractor shall submit typical drawings along with tender giving proposed clamping arrangement and also give distance of clamping at bends and in regular run of cables.

11.20. TECHNICAL REQUIREMENTS OF CABLE RACKS AND TRAYS

SUPPORT STRUCTURES:

The contractor shall fabricate and supply all mounting arrangements for support and installation of the suspended cable trays on galvanized steel structure including channels, angles, rods etc. at requisite spacing, cable trenches in machine hall floor, switchgear floor, interconnection between power house and transformer yard and all other required areas. The contractor shall provide embedment / anchor fasteners for fixing the supporting structures. These supporting structures shall be fabricated from structural steel members (channels, angles and rods) of the required size. The steel section for fabrication of trays and supports shall be of reputed make and re-rolled by approved re-rollers.

The vertical member of the support shall be of ISRO12 threaded rod or ISMC100 channel. The horizontal member of the support shall be of angle ISA 50 x 50 x 6mm. For threaded rod support configuration, the horizontal member shall be fixed by bolting whereas for channel configuration, the horizontal member shall be fixed by welding to the channel.

TRAYS:

Trays shall be of ladder type. The side channel (runners) shall be of size 20 x 100 x 20 mm and the cross channel (rungs) shall be of size 20 x 40 x 20 mm. The trays shall be fabricated from Hot Rolled Carbon Mild Steel (conforming to IS 1079, Grade "O", of chemical composition (C, Si, Mn, S, Ph) sheet of thickness 2 mm. The length of each tray shall be of 2500 mm and the spacing between the two rungs shall be 250 mm at centre to centre. The rungs shall be slotted and shall be welded to the side channels. The trays shall be hot dip galvanized after Finish (as per IS 2629 / ASTM: A123-97m). The minimum zinc deposit shall be 460 g / m^2 and the thickness shall be 56 micron minimum.

HOLD–DOWN CLAMPS:

Cable trays shall be fixed with support by hold-down clamps. The clamps shall be fabricated from MS sheet of 2 mm thickness and hot dip galvanized.

TRAY FITTINGS & ACCESSORIES:

The contractor shall supply various tray fittings and accessories like coupler plate with fasteners, horizontal tees, vertical and horizontal elbows, adjustable connectors required for the mentioned trays. The cable trays shall be part of a modular system having all required accessories and transition pieces from one to another direction or elevation. All accessories, fittings, elbows and tees shall be hot dip galvanized after finish. The nuts, bolts and washers shall be cadmium plated or electrolitically galvanized.

INSTALLATION OF TRAYS AND SUPPORTING STRUCTURE:

The contractor shall install the cable trays following all relevant standards. The contractor shall ensure proper earthing of the trays and continuity between tray components. The risers of the main earthing system shall be available for the connection.

For the supporting structures, the threaded rod shall be supported from roof through anchor fasteners whereas the channels shall be supported by welding to the inserted plate (the inserted plate shall be fixed to the roof through anchor fasteners). For the trenches the supports shall be fixed to the side wall through anchor fasteners. The distance between the two support systems shall be 1500 mm.

Above specifications for cable racks and trays are indicative. The final design of cable racks and trays shall be decided during detailed engineering stage.

11.21. TESTS

11.21.1. TYPE TEST

All the items, instruments, structures etc. required for cables, cable racks & trays shall be subjected to all kind of type tests and FRLS tests in accordance with latest version of IS 1554 (Part I) and relevant IEC. The contractor shall submit type test report from CPRI / NABL / Govt. approved Laboratories having identical type and rating similar to the tendered item during detailed engineering stage, carried out within ten (10) years from the date of this NIT Publication. The contractor may be required to furnish the original type test reports with test results, if desired by the employer.

11.21.2. ROUTINE / ACCEPTANCE TESTS

All the items, instruments, structures etc. required for cables, cable racks & trays shall be tested in accordance with the requirement of relevant IS / IEC Code. All Acceptance tests shall be carried out at manufacturer's works on every lot offered for inspection following relevant IS & IEC in presence of the employer's representatives. Selection of samples for acceptance test as well as rejection and retesting shall be guided by relevant IS. The entire cost of acceptance and routine tests that to be carried out shall be deemed to be included in the quoted price by the contractor. Routine tests shall include but not limited to the following:

a. Conductor resistance test
b. High voltage test at room temperature
c. Insulation resistance tests before and after HV test
d. Annealing test (for Cu.)
e. Tensile test (for Al.)
f. Wrapping test (for Al.)
g. Test for thickness of insulation and sheath
h. Tensile strength and elongation at break of insulation and sheath etc.

11.21.3. COMMISSIONING CHECKS / SITE TESTS

After delivery and installation of all the equipment and accessories of complete cabling system at site, the afore-mentioned routine tests shall be carried out during trial run and commissioning.

All testing equipment including HV test kit, required for testing at site, shall be provided by the contractor at free of charge on returnable basis. In the event of repeated testing becomes necessary, the entire expenditure on such repeat tests shall be borne by the contractor.

All testing equipment shall have the up-to-date calibration certificate. The contractor needs to furnish the same to the employer prior to starting of testing at site as well as at manufacturer's works, whatever the case may be.

11.22. DOCUMENTS TO BE SUBMITTED AFTER PLACEMENT OF LOA

- Name of manufacturer proposed by the contractor for each item / equipment as per **Cl. No. 11.24**.
- Performance certificates of proposed manufacturers as per **Cl. No. 11.25.**
- All Type test reports of each similar rated products of the proposed manufacturer.
- Routine Test Report / Shop Test Report of each similar rated products of the proposed manufacturer performed earlier.
- Test facilities at manufacturer's test house.
- General arrangement drawing of the system showing constructional features, space requirements for safe operation, preliminary layout etc.

11.23. DOCUMENTS TO BE SUBMITTED DURING DETAILED ENGINEERING STAGE

Six (06) sets of data sheet, manual, leaflet, drawing and other documentation as mentioned below for complete cabling system shall be submitted to the Controlling Officer of the employer for according approval during detailed engineering stage.

- Guaranteed Technical Particulars (GTP) as per **Chapter – 20 (Cl. No. 20.10).**
- Complete cable layout drawing with constructional and installation arrangements
- Detailed drawing and data sheet for various cables, cable tray, cable racks, cable support structures, earthing arrangement etc.
- Detailed drawing and data sheet for cable jointing kit, termination kit etc.
- Detailed drawings for terminal connection arrangement
- Detailed time schedule indicating submission of drawings, tentative date of inspection, delivery of items, installation, testing, trial run & commissioning.
- Detailed Bill of Material (BOM) which shall include the spare parts for five (05) years of trouble-free operation & maintenance of the above system as per **Cl. No. 19.10** and special tools, plants and equipment as per **Cl. No. 19.15.**
- Detailed Quality Assurance Plan (QAP) for routine test and field acceptance test
- Manual for installation, operation and maintenance procedure.

After approval, six (06) sets of approved drawings and documents along with soft copies for complete cabling system shall be submitted to the controlling officer of the employer.

Further, the contractor shall submit three (03) sets of successful shop / routine test reports to the controlling officer of the employer prior to dispatch of each item / equipment.

11.24. MAKE OF COMPONENTS

The contractor shall submit proposed make of power, control & instrumentation cables, cable racks & trays etc. after placement of LOA. Final make shall be approved by the employer during detailed engineering stage based on the performance certificates submitted by the contractor. For approved makers list of WBSEDCL for various components, the bidders are requested to go through **Chapter – 21** of this Technical Specifications.

11.25. CREDENTIALS AND PERFORMANCE CERTIFICATES

The contractor shall submit Performance Certificates issued to the proposed manufacturers by the respective employer for similar kind of job. The contractor shall also furnish documents in support of supply, delivery of similar equipment / system indicating thereon names of the organization, quantity ordered and quantity supplied along with their submission after placement of LOA. Non-submission of the same will be liable for rejection of the proposed manufacturers.

11.26. GUARANTEE

Guarantee of the total equipment including any integral part of the equipment should be up to Defect Liability Period of the project.

11.27. COMPLETENESS OF EQUIPMENT / SYSTEM

All items, equipment, fittings and accessories etc. for any specified equipment / system that may not be specifically mentioned in the specification but necessary for completeness of the system shall be deemed to be covered under the scope of this contract. No extra charges will be paid to the contractor for the same.

11.28. SCHEDULE OF REQUIREMENT

Sl. No.	Description	Quantity
1	33 kV XLPE Power Cables	As required
	11 kV XLPE Power Cables	As required
2	1.1 kV XLPE Power Cables	As required
3	LT Cables	As required
4	DC Cables	As required
5	Control and Instrumentation Cables	As required
6	Communication Cables	As required
7	Special tools, plants & equipment as per **Cl. No. 19.15**	As required
8	Spare parts as per **Cl. No. 19.10**	As required
9	Completeness of equipment / system as per **Cl. No. 11.27**	As required

12. EARTHING SYSTEM

12.1. SCOPE

This section of the specification deals with the design, engineering, quality assurance, manufacture, transport, transit insurance, supply, delivery to site, storage at site, erection, testing and commissioning of Earthing System along with all materials for power house and transformer yard of Lodhama II SHEP for trouble free and safe operation.

The scope of supply shall also include special tools and testing devices, which are essential for installation, operation and maintenance for five (05) years trouble free operation of the plant, even though these are not individually or specifically stated in this specification but recommended by the respective manufacturers. All the material & workmanship shall be of suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

12.2. STANDARD

The grounding system shall conform to the requirement of following standards.

Sl. No.	Standards	Description
1	ANSI / IEEE 80 –2000	Guide for safety in AC Substation Grounding
2	CBIP Publication: 223	Design of Earthing Mat for High Voltage substation
3	IS: 3043	Code of Practice for Earthing Indian Electricity Rules

Equipment meeting with any other authoritative standards which ensure an equal or better quality than the standards mentioned above will also be acceptable. Where the equipment complies with any other standards, the salient points of difference between the standards adopted and the standards specified above shall be clearly brought out, and an English version of the proposed standards shall be furnished by the contractor.

12.3. OBJECTIVE

The grounding system shall be designed with the following objectives:

i. To provide low impedance path to fault currents, during ground faults, to ensure prompt and consistent operation of protective devices to effect isolation.
ii. To keep the maximum voltage gradient during ground faults along the surface inside and around the power house within safe limits.
iii. To protect the life and property from electrical shocks due to over voltage.
iv. To stabilize circuit potentials with respect to ground and limit the overall potential rise.

12.4. AVERAGE SOIL RESISTIVITY OF THE SITE

Average Soil Resistivity (ρ) of the power House and switchyard location of Lodhama II SHEP is **2710.57 Ω-m** as measured by WBSEDCL on 18.01.2019. The result clearly indicates special treatment of the soil (by providing Ground Enhancement Material) at the power house and transformer yard for achieving the desired earth resistance.

However, the contractor shall test the SOIL RESISTIVITY at his own cost, risk and arrangement (to be carried out during dry season) before submitting the earthing system design during detailed engineering stage. Such test shall be carried out in presence of the employer's representative. The soil resistivity test report to be submitted by the contractor prior to design of the earthing system shall be duly signed by the employer's representative. The installation of the system shall be done after employer's approval of the whole design.

The Ground Enhancement Material (GEM) shall be selected based on the following characteristics:

- It shall be a noncorrosive, low-resistance enhancement substance (e.g. conductive cement) that can be installed in wet or dry condition.
- It shall not leach into the soil.
- It shall not dissolve or decompose over time.
- It shall not require periodic maintenance.
- It shall not require periodic charging treatments or replacements.
- It shall not depend on the continuous presence of water to maintain conductivity.
- It shall be an eco-friendly material.
- It shall not chemically react with the earth conductor and earth electrodes.

12.5. DESIGN REQUIREMENTS

The earth mat, comprises of closed current conductor grid of steel laid over the excavated surface of power house and transformer yard, shall extend to the tailrace, if required to obtain the path of low resistance for passage of heavy currents during the fault. A number of ground rods (25 mm dia. x 3250 mm long) shall be added to the earth mat to obtain consistent lower resistance path under all weather conditions. The earth mat shall be connected to the following in powerhouse.

i. The neutral point of each system / equipment through its own independent earth
ii. Equipment framework, supporting Steel structures and other non-current carrying parts
iii. All extraneous metallic frame work not associated with equipment
iv. Earth point of lightning arrestors; voltage transformers and lightning conductors through their permanent independent earth electrodes
v. Fence of Power House and transformer yard

The conductor shall be of adequate cross-section to safely withstand the system fault current for time duration of fault clearance by the remotest / back up protective system. Also sufficient allowance needs to be provided for corrosion of the embedded conductor on account of chemical properties of soil and also due to galvanic action with other embedded systems.

To protect the power house building, the lightning conductor shall be provided on the top which shall be connected to the station mat by GS flat.

The design of the earth mat shall be done to achieve the final earth resistance **less than One (01) ohm (Ω)**.

12.6. EARTHING NETWORK CALCULATION

The earthing network calculation shall be determined on basis of the short-circuit currents, the relevant design criteria for the layout of the plant's earthing network and the potential gradient control system, such as:

- Earth conductors (material, size, depth of burial, spacing between parallel grid conductor etc.) and electrodes (material, size, number, depth of burial etc.)
- Mesh network and other means for potential gradient control for different locations (mesh widths and dimensioning)
- Maximum allowable touch voltage, step voltages and ground potential rise
- Generator Earthing System Calculation: The calculation shall prove the correct selection of the generator earthing equipment.

The detailed design report of the earthing system must contain:

- Details of soil treatment by means of Ground Enhancement Material (GEM)
- Maximum allowable touch voltage & step voltage and ground potential rise
- Verification for touch and step potential to check that the designed values are within the allowable limit

12.7. SIZE OF THE CONDUCTOR

For determination of the size of the conductor, following parameters shall the considered.

- fault levels at 11 kV and 33 kV shall be considered as 25 kA for 3 sec. and that for 415 V system shall be considered as 40 kA for 1 sec.
- Duration of fault current shall be considered as 0.5 second
- An extra allowance of 20 % to take care of corrosion shall be added to arrive at final conductor size

12.8. MATERIAL OF EARTH CONDUCTOR AND RODS

The material of ground mat conductor shall be MS Flat and that of risers emanating from ground mat shall be GI flats. It shall be ensured by the contractor during detailed engineering stage that the materials for earth conductor and rods are compatible with the selected Ground Enhancement Material (GEM).

12.9. LAYOUT OF THE EARTHING MAT

The ground mat, comprising of MS Flats of suitable size, shall be laid over the excavated surface in powerhouse and transformer yard and shall be covered by Ground Enhancement Material (GEM).

Wherever mat crosses cable trenches or other foundation blocks, it shall be laid suitably to avoid interference. It is proposed that a number of ground rods (25 mm dia. x 3250 mm) may be driven along the periphery of the mat at an interval of 1.5 - 1.8 m and connected to the MS flat of main mat through welding. A number of GI flat risers shall take-off from the main mat and shall be taken up in the powerhouse along main columns as well as in the transformer yard, as per requirement.

The riser flats shall be of higher size or same size as the ground mat conductor. These risers shall be utilized to connect the metallic frames of all electrical equipment and other metallic structures, neutral grounding etc.

The mat shall be designed to obtain safe touch / mesh potential and step potential for a person of 70 kg body weight as per relevant IEEE / Indian Standard. The earth mat shall be sub-divided by inter-connectors to form small grids of 4 m x 4 m or as required to achieve the desired result for grounding.

12.10. NUMBER OF GROUND RODS

It is proposed to provide 25 mm dia., 3250 mm long MS rods at all / alternating peripheral joints; at and around riser junctions and at other strategic locations. The Contractor shall work out the exact requirements of the ground rods and indicate the same in the detailed design report. The adopted quantity shall be substantiated with calculations.

12.11. CONSTRUCTION DETAILS

- The ground mat shall be laid along excavated surface. Where the ground profile is not leveled, the grounding conductor shall follow the available profile.
- All joints in the earthing mat shall be made by welding except those where earthing mat may have to be separated from the equipment for testing etc. Continuous lap welding shall be done instead of tack welding.
- For protection against rusting, the welds shall be treated with Barium Chromate. Welded surface shall then be painted with red lead and Aluminium paint in turn and afterwards coated with bituminous paint. Risers above ground shall be painted with Zinc rich paint above Anti-oxide primer.
- All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load to it. Artificial forced cooling shall not be allowed.
- Earthing of transformer neutral and LAs shall be done separately through plate electrodes & further connected to the main mat by using risers.
- To provide testing facility with clip-on type earth resistance measuring meter one test link with ACSR Dog conductor having compression type joint with socket of total length of about 300 mm (combined) shall be incorporated between earth pit and neutral of the transformers, PTs / LAs, grid corners etc. which in turn shall be connected to main earth mat. The socket shall be connected with the flat through bimetallic strip. Two interconnected earth pits shall be provided in each case for transformer neutral(s), generator neutral(s). The interconnection of the two earth pits in each case as mentioned above shall be done through two (02) nos. of flat. One flat shall be directly connected to one earth electrode through welding and the other flat shall be connected with other earth pit through a testing link. All accessories associated with the electrical system shall be connected to the main earthing grid at minimum two (02) points.
- The point for testing purpose should be so placed that the earth grid can be frequently supervised.
- The joints which may require to be opened for testing shall be bolted.
- All exposed steel conductors shall be given two coats of red oxide followed by one coat of bituminous paint.
- The MS rods shall be welded to the earth mat at alternate peripheral joints, at and around riser junctions and other strategic locations for equipment connections.

- Risers shall be taken off from the mat for convenience of connection of equipment and other objects to the mat.
- The risers from the mat shall be so connected to avoid contact with reinforcement to guard against false grounding during resistance tests.
- Bolted type junction boxes shall be provided at the junction of riser and equipment connectors to facilitate segregation whenever required.
- All non-current carrying metal parts of electrical equipment and apparatus shall be earthed through two separate diametrically / diagonally opposite connectors.
- Earth pit without having any test link shall be at least 400 x 400 mm in size and 375 mm deep and earth pit with test link shall be at least 700 x 700 mm in size and 375 mm deep. The earth pit shall be constructed with RCC (M-15) in surrounding wall and floor (minimum wall thickness 125 mm and floor thickness 100 mm) with a removable cover slab of 75 mm thick with RCC (M-15) (0.8% reinforcement by volume of concrete). Cover slab shall be plastered with cement mortar (1:4) on all sides.
- The earthing conductor around power house building shall be buried in earth at a minimum horizontal distance of 1500 mm from the outer boundary of the building and which in turn shall be connected to transformer yard earthing system as per approved earthing layout design.
- Steel to copper connection, if any, shall be brazed type and shall be treated to prevent moisture ingression.
- Bending of earthing rod shall be done preferably by gas heating.
- All panels shall be earthed by 50 x 6 mm GS Flat (2 nos. flat, one each on opposite side) to MS earth bus.
- MS Flat runs on the top of the tier and all along the cable trenches and the same shall be welded to each of the racks. Further this flat shall be earthed at both ends at an interval of 30 m. The MS Flat shall be finally painted with two coats of red oxide primer and two coats of bitumen compound.
- Earthing conductor for main earthing grid in outdoor areas shall be buried at least 600 mm below finished ground level or more as per design consideration.
- Earthing conductor or leads along their run on cable trench, ladder, wall, etc. shall be supported by suitable welding / cleaning at interval of 1200 mm. Wherever it passes through walls, floors, etc., galvanized steel sleeves shall be provided for passage of conductor and both end of sleeves shall be sealed to prevent passage of water through sleeves.
- Grid perimeter ground conductor shall be buried at an horizontal distance of 1000 mm (min.) outside the power house and transformer yard fence. All gates and every alternate post of fence shall be connected to earthing grid. Gravel / crushed stone spreading shall also be done 1000 mm (min.) outside the fence. However criteria of gravel / crushed stone spreading shall be followed in line with requirement of approved drawing.
- Flexible earthing connectors shall be provided for moving parts.
- The earth mat design shall be based on uniform spacing method. However closely paced corner mesh shall be provided at all corners of the main earth mat in addition to main earth grid conductor to minimize ground potential rise and to control perimeter gradients and step potential, two or more parallel conductor having same diameter as of main earth mat shall be buried all along the perimeter.
- All above ground conductive metal parts that might accidentally energized shall be connected to main earth mat.

- For equipment connection to mat / riser, 50 mm x 6 mm or higher size GI steel flat shall be used.
- Each penstock shall be considered to be an auxiliary mat and shall be connected to the main mat so as to effectively reduce the grid resistance. Two flats in parallel on either side of penstock shall connect each penstock with the main earth mat.
- After placing the earth mat conductors, the same shall be covered with ground enhancement material as per design.

12.12. EARTHMAT RESISTANCE

The earth mat shall be so designed & constructed that with the measured soil resistivity at power house and transformer yard, the **earth resistance is lesser than One (01) Ohm (Ω)**. Also the potential rise of the mat during passage of fault current shall remain within the tolerable limits. To limit the potential rise within safe limits, with the object of reducing the effective resistance, the main mat may be connected to each penstock, which can be considered as separate mat for this purpose. If necessary to reduce the mat resistance within specified limit, the main mat may also be extended to tail race area.

12.13. LIGHTNING PROTECTION OF THE SWITCHYARD

- Lightning masts of suitable heights as per relevant standard shall be designed, fabricated, supplied and erected at 33 / 11 kV transformer yard of Lodhama II SHEP for all voltage classes so that the entire area is protected from lightning strike.
- Location of lightning masts shall be finalized after approval of Direct Stroke Lightning Protection (DSLP) calculations.
- In calculation of protection zone of a lightning mast, method followed by Prof. D.V. Rejevig shall be adopted.
- Provision for fixing transformer yard light fittings in lightning mast shall be kept and stairs and platform shall be provided for fixing and maintenance of light fittings.
- Protection of building and allied structures against lightning shall be designed as per IS: 2309.

12.14. TESTS

12.14.1. TYPE TESTS

All the items, materials etc. required for the complete earthing system shall be subjected to all kind of type tests in accordance with latest version of relevant standards. The contractor shall submit type test report from CPRI / NABL / Govt. approved Laboratories having identical type and rating similar to the tendered item during detailed engineering stage, carried out within ten (10) years from the date of this NIT Publication. The contractor may be required to furnish the original type test reports with test results, if desired by the employer.

12.14.2. COMMISSIONING CHECKS / SITE TESTS

After installation of the complete earthing system at site, following minimum operational tests shall be carried out prior to trial run and commissioning.

- Visual Inspection of whole work
- Measurement of final earth resistance etc.

All testing equipment for testing at site, shall be provided by the contractor at free of charge on returnable basis. In the event of repeated testing becomes necessary, the entire expenditure on such repeat tests shall be borne by the contractor.

All testing equipment shall have the up-to-date calibration certificate. The contractor needs to furnish the same to the employer prior to starting of testing at site as well as at manufacturer's works, whatever the case may be.

12.15. DOCUMENTS TO BE SUBMITTED AFTER PLACEMENT OF LOA

- Name of manufacturer proposed by the contractor for each item / equipment as per **Cl. No. 12.17.**
- Performance certificates of proposed manufacturers as per **Cl. No. 12.18.**
- Site test reports of previous installations of the proposed manufacturer.

12.16. DOCUMENTS TO BE SUBMITTED DURING DETAILED ENGINEERING STAGE

Six (06) sets of data sheet, manual, leaflet, drawing and other documentation as mentioned below for Earthing System shall be submitted to the Controlling Officer of the work, WBSEDCL for approval of the system.

- Soil resistivity test report pursuant to **Cl. No. 12.4**.
- Guaranteed Technical Particulars (GTP) as per **Chapter – 20 (Cl. No. 20.11)**.
- Detailed design report containing drawing for earth mat, disposition of the mat along with proposed grid arrangement of conductor with ground rods, welding arrangement of risers with the mat, location of terminals for measurement of mat resistance, details of junction boxes etc. following the design criteria as mentioned in this specification.
- Calculations to justify the design of the earth mat submitted by the contractor. Detailed time schedule indicating submission of drawings, tentative date of inspection, delivery of items, installation, testing, trial run & commissioning.
- Detailed time schedule indicating submission of drawings, delivery of items, installation, testing, trial run & commissioning.
- Detailed Bill of Material (BOM) which shall include special tools, plants and equipment as per **Cl. No. 19.15.**
- Detailed Quality Assurance Plan (QAP) for field acceptance test
- Manual for installation, operation and maintenance procedure.

After approval, six (06) sets of approved drawings and documents along with soft copies for earthing system shall be submitted to the controlling officer of the employer.

12.17. MAKE OF COMPONENTS

The contractor shall submit proposed make of various earthing system components after placement of LOA. Final make shall be approved by the employer during detailed engineering stage based on the performance certificates submitted by the contractor.

12.18. CREDENTIALS AND PERFORMANCE CERTIFICATES

The contractor shall submit Performance Certificates issued to the proposed manufacturers by the respective employer for similar kind of job. The contractor shall also furnish documents in support of supply, delivery of similar equipment / system indicating thereon names of the organization, quantity ordered and quantity supplied along with their

submission after placement of LOA. Non-submission of the same will be liable for rejection of the proposed manufacturers.

12.19. COMPLETENESS OF EQUIPMENT / SYSTEM

All items, equipment, fittings and accessories etc. for any specified equipment / system that may not be specifically mentioned in the specification but necessary for completeness of the system shall be deemed to be covered under the scope of this contract. No extra charges will be paid to the contractor for the same.

12.20. SCHEDULE OF REQUIREMENT

Sl. No.	Description	Quantity
1	Complete earthing system following the specification and criteria mentioned in this chapter	As required
2	Special tools, plants and equipment etc. as per **Cl. No. 19.15**	As required
3	Completeness of the equipment / system as per **Cl. No. 12.19**	As required

13. VENTILATION SYSTEM

13.1. SCOPE

This section of the specification deals with the Design, engineering, quality assurance, manufacture, transport, transit insurance, supply, delivery to site, storage at site, erection, testing, trial run, and commissioning of Ventilation System of power house for Lodhama II SHEP.

The scope of supply shall also include spares, special tools and testing devices, which are essential for installation, operation and maintenance for five (05) years trouble free operation of the plant, even though these are not individually or specifically stated in this specification but recommended by the respective manufacturers.

All the material & workmanship shall be of suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

13.2. STANDARDS

The ventilation system shall comply with the requirement of the latest issue of Indian standards or equivalent British Standards.

Sl. No.	Standards	Description
1	IS: 4720	Code of Practice for Ventilation of Surface Hydel Power Station
2	IS: 2312	Specifications for propeller type AC Ventilating fans.
3	IS: 3103	Code of Practice for industrial ventilation

Equipment meeting with any other authoritative standards which ensure an equal or better quality than the standards mentioned above will also be acceptable. Where the equipment complies with any other standards, the salient points of difference between the standards adopted and the standards specified above shall be clearly brought out, and an English version of the proposed standards shall be furnished by the contractor.

13.3. SYSTEM REQUIREMENT

Lodhama II SHEP is a surface type hydro power station with an installation of two (02) nos. of five (05) MW unit. Forced air ventilation by means of exhaust fans shall be provided for the power house.

Beside this, air conditioners (split type) in control room, office room and conference room as indicated in the Plant General Layout Drawing shall be within the scope of supply under this contract.

The scope shall include all required cabling, terminations and other electrical works.

13.4. AIR CHANGE PER HOUR (ACPH)

The capacity and pressure developed by exhaust fans and air conditioners shall be adequate to induce following air charges per hour.

Sl. No.	Premises	Air change per hour
1	Service bay	4
2	Machine hall	4
3	Battery room	8
4	WC	8
5	Control room	4
6	DG set room	8
7	Stair case	4
8	Office room	4
9	Conference room	4

13.5. SYSTEM DESIGN

- Based on the air change per hour, the volume of air to be handled by ventilation system shall be designed by the contractor during detailed engineering stage
- Exhaust fans shall be fitted with weather hoods to protect the fans from rain. The weather hoods shall have galvanized wire mesh at its outlet to prevent the entry of the birds etc.
- Propeller fans shall be employed for exhaust of air from machine hall / service bay / stair case. The fans shall conform to the requirements of IS: 2312 in all respects. The fans shall be direct connected complete with totally enclosed type motor, inlet and outlet guards and mounting fixtures. The fans shall have capacity and pressure characteristics suitable for the type of service for which these are used. The fan impeller shall be operating quietly, accurately balanced and securely fastened to the motor shaft.

  The fans shall be provided with automatic multi-louver dampers which open and close respectively when the fan motor starts and stops. The louvers shall be of galvanized steel with blades set at a suitable angle and spacing to prevent entry of rain water.
- The motor and fans shall be resistant to the moisture and shall be duly tested for the same. The fans shall be supplied with resilient mounting.
- Resilient bases shall be designed to support both fan and motor in such a manner to effectively dampen vibration and reduce its transmission into the structure. Each base shall be of steel and rubber, or steel and steel spring construction, carefully designed for the loading and frequency of vibration to which it will be subjected. It shall be completely fabricated and assembled in one place with provisions for mounting the fan and motor in their relative positions on it and for anchoring it to the foundation.
- Axial flow exhaust fans shall be employed for exhaust of air from WC and Battery Room. The fans for battery room shall be protected against the corrosive effect of Sulphuric Acid fumes by a suitable protective coating or plastic, which shall be applied to the fan impeller inside the housing and that part of the shaft which is exposed to the gases passing through the fan. The coating shall be erosion and corrosion resistant, securely bonded to the base metal.
- Suitably designed guards shall be provided by the contractor to prevent accidental contact with the rotating blades of the fans. The guards shall be substantially constructed of heavy wire screen firmly held in a steel frame. The screen shall be square or diamond mesh, woven from steel wire of suitable size. The frame shall be of steel of

adequate strength, carefully fitted to the fan inlet/outlet, and shall be provided with suitable clips or other approved devices for attaching to the fan housing. Guards shall have provisions for access to the fan or motor bearings or other parts which may require lubrication or maintenance. When the guards are in two pieces, positive locking arrangement to keep the two pieces together shall be made.

All equipment shall be new and of latest proven design, shall be first-grade quality of material and workmanship.

Incidental fittings, fixtures, accessories, and supplies shall be of approved manufacture and standard first-grade quality.

Number and capacity of exhaust fans, location of installation, make, protection and other design shall be submitted by the contractor during detailed engineering stage for employer's approval. The plant shall be installed as per approved design.

13.6. AIR CONDITIONERS

The scope shall include air conditioners (split type) for control room, office room, and conference room as shown in the Power House General Arrangement Drawing.

Split type energy efficient (5 star rating only) air conditioners of reputed make shall be provided in the locations mentioned above.

Number and capacity of air conditioners, location of installation, make, protection and other design shall be submitted by the contractor during detailed engineering stage for employer's approval. The plant shall be installed as per approved design.

13.7. NOISE LEVEL

The noise levels caused by operation of ventilation system shall not exceed

- 45 dB(A) in the battery room and toilet
- 60 dB (A) in all other rooms and areas

13.8. TESTS

13.8.1. TYPE TESTS

All the items, materials etc. required for the ventilation system shall be subjected to all kind of type tests in accordance with latest version of relevant standards. The contractor shall submit type test report from CPRI / NABL / Govt. approved Laboratories having identical type and rating similar to the tendered item during detailed engineering stage, carried out within five (05) years from the date of this NIT Publication. The contractor may be required to furnish the original type test reports with test results, if desired by the employer.

13.8.2. COMMISSIONING CHECKS / SITE TESTS

After installation of the complete earthing system at site, following minimum operational tests shall be carried out prior to trial run and commissioning.

- Visual inspection
- Functional test of electrical controls
- Measurements of load characteristics
- Temperature and humidity measurements in the rooms

- Any other test as desired by the employer following relevant standards

All testing equipment, required for testing at site, shall be provided by the contractor at free of charge on returnable basis. In the event of repeated testing becomes necessary, the entire expenditure on such repeat tests shall be borne by the contractor.

All testing equipment shall have the up-to-date calibration certificate (from NABL accredited test laboratory). The contractor needs to furnish the same to the employer prior to starting of testing at site as well as at manufacturer's works, whatever the case may be.

13.9. DOCUMENTS TO BE SUBMITTED AFTER PLACEMENT OF LOA

- Name of manufacturer proposed by the contractor for each item / equipment as per **Cl. No. 13.11**.
- Performance certificates of proposed manufacturers as per **Cl. No. 13.12.**
- All Type test reports of each similar rated products of the proposed manufacturer.
- General arrangement drawing of the system showing constructional features, space requirements for safe operation, preliminary layout etc.

13.10. DOCUMENTS TO SUBMITTED DURING DETAILED ENGINEERING STAGE

Six (06) sets of data sheet, manual, leaflet, drawing and other documentation as mentioned below for complete ventilation system shall be submitted to the Controlling Officer of the employer for according approval during detailed engineering stage.

- Guaranteed Technical Particulars (GTP) as per **Chapter – 20 (Cl. No. 20.12)**.
- Detailed design calculation for selection of number, type and capacity of exhaust fans as well as air conditioners at various required locations.
- Detailed layout of equipment and complete assembly drawings.
- Foundation drawings of all parts set into or coming in contact with the floor, ceilings or walls. The drawings shall also indicate the method of support and anchoring.
- Control and electric wiring diagrams.
- Electric motor data sheets showing outlines, principal dimensions, location of anchor bolts and conduit connections.
- Performance characteristics of fans and motors.
- Detailed time schedule indicating submission of drawings, delivery of items, installation, testing, trial run & commissioning.
- Detailed Bill of Material (BOM) which shall include the spare parts for five (05) years of trouble-free operation & maintenance of the above system as per **Chapter – 19** and special tools, plants and equipment as per **Cl. No. 19.15.**
- Detailed Quality Assurance Plan (QAP) for field acceptance test.
- Manual for installation, operation and maintenance procedure.

After approval, six (06) sets of approved drawings and documents along with soft copies for complete ventilation system shall be submitted to the controlling officer of the employer.

13.11. MAKE OF COMPONENTS

The contractor shall submit proposed make of ventilation system after placement of LOA. Final make shall be approved by the employer during detailed engineering stage based on the performance certificates submitted by the contractor.

13.12. CREDENTIALS AND PERFORMANCE CERTIFICATES

The contractor shall submit Performance Certificates issued to the proposed manufacturers by the respective employer for similar kind of job. The contractor shall also furnish documents in support of supply, delivery of similar equipment / system indicating thereon names of the organization, quantity ordered and quantity supplied along with their submission after placement of LOA. Non-submission of the same will be liable for rejection of the proposed manufacturers.

13.13. GUARANTEE

Guarantee of the total equipment including any integral part of the equipment should be for a period of five (05) years from the date of commissioning of the same.

13.14. COMPLETENESS OF EQUIPMENT / SYSTEM

All items, equipment, fittings and accessories etc. for any specified equipment / system that may not be specifically mentioned in the specification but necessary for completeness of the system shall be deemed to be covered under the scope of this contract. No extra charges will be paid to the contractor for the same.

13.15. SCHEDULE OF REQUIREMENTS

Sl. No.	Description	Quantity
1	Complete ventilation system as per the requirements mentioned in this specification	As required
3	Special tools required for erection, operation and maintenance of the system as per **Cl. No. 19.15**	As required
4	Completeness of the equipment / system as per **Cl. No. 13.14**	As required

14. EOT CRANE FOR POWER HOUSE

14.1. GENERAL

This specification covers the design, engineering, quality assurance, manufacture, transport, transit insurance, supply, delivery to site, storage at site, erection, testing and commissioning of 40 / 10 T EOT Crane which shall consist of the hoist with its platform mounted on frame, long travel motion assemblies, lifting beam and control & operation equipment mounted in operator's cabin for Lodhama II SHEP.

The EOT Crane shall consist of all the necessary equipment, accessories and mountings for satisfactory and safe operation of the crane and shall include rope drums, wire-ropes, reduction gears, gear boxes, hoist motor, electromechanical brakes, parking brake and the lifting beam. There shall be two long travel motion assemblies each consisting of a long travel motor, suitable gear boxes / gears and an electromechanical brake. The crane shall be provided with a self-winding main power supply cable reel.

The scope of supply shall also include special tools and testing devices, which are essential for installation, operation and maintenance for five (05) years trouble free operation of the plant, even though these are not individually or specifically stated in this specification but recommended by the respective manufacturers. All the material & workmanship shall be of suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

14.2. STANDARDS

The EOT crane and their components shall be manufactured and tested in accordance with latest version of applicable IS or equivalent international standard.

Sl. No.	Standard	Description
1	IS: 3177 / BS: 466	Code of Practice for EOT cranes and gantry cranes other than steel work crane.
2	IS: 807 / BS: 2573	Code of practice for design, manufacture, erection and testing (Structural portion) of cranes and hoists.
3	IS: 5749 / BS: 3017	Forged Ram shorn hooks.
4	IS: 2266 / BS: 302	Specifications for steel wire ropes for general engineering purposes.
5	IS: 6938	Code of Practice for design of rope drum and chain hoists for hydraulic gates.
6	IS: 325 / BS: 2960	Three phase induction motors.
7	IS: 13947 (Part 4 / sec 1)	Contactors and motor starters - Electromechanical contactors & motor starter.
8	IS: 2062	Steel for general structural purposes
9	IS: 1030	Carbon steel castings for general engineering purposes

Sl. No.	Standard	Description
10	IS: 1875	Carbon steel billets, bloom, slabs and bars for forgings
11	IS: 210	Grey Iron castings
12	IS: 1363 (Part 1, 2, 3)	Hexagon head bolts, screws & nuts of product grade- C
13	IS: 1364(Part 1, 2, 3, 4, 5)	Hexagon head bolts, screws & nuts of product grade A & B
14	IS: 4460 (Part 1, 2, 3)	Gears - spur & helical gears - calculation of load capacity
15	IS: 800	Code of practice for general construction in steel
16	IS: 276	Wire rope slings and sling legs
17	IS: 2266	Specifications for steel wire rope for general engineering purpose

Equipment meeting with any other authoritative standards which ensure an equal or better quality than the standards mentioned above will also be acceptable. Where the equipment complies with any other standards, the salient points of difference between the standards adopted and the standards specified above shall be clearly brought out, and an English version of the proposed standards shall be furnished by the contractor.

14.3. DESIGN PARAMETERS

The EOT Crane in the power house shall be used to lift the equipment & unit parts of the electrical & Mechanical equipment on the power house.

Sl. No.	Description	Quantity
1	Type	Indoor, Double Rope Drum Electrically operated
2	Mechanical class	Class I / M3 as per IS: 3177-1999
3	No. of Gantries	One
4	Hoist capacity	40 Tonnes + 10 Tonnes
5	Crane Rail Level	El 1075.55 m
6	Length of Crane Track	Thirty two (32) metres (approx.)
7	Span	11.70 meters +/- 10 %
8	Crane rails	Crane Rails CR-60 (approx.)
9	Hook-Approach	Up to 9.0 metre below Crane rails
10	Cross Travel	minimum 2.5 m movement of lifting hook within the legs of EOT crane
11	Power supply	3 phase, 50 Hz., 400/440 V AC power supply from plug points at the middle of crane runway length

Sl. No.	Description	Quantity
12	Hoist motion motor	Slip ring induction motor
13	Operating speeds	
	Raising / Lowering	1.5 metre / min
	Long travel	5 metre / min
	Cross travel	1 metre / min
14	LT motion motors	Squirrel cage induction motors
15	Cable reel with cable	Suitable for cable length of about 10 metres
16	Lifting Beam	Self engaging and self disengaging type

14.4. DESIGN & CONSTRUCTION

14.4.1. CRANE

General architectural treatment that are considered as essential features of the design shall be incorporated in the design and construction.

The Crane frame shall be fabricated from structural steel sections and plates and shall be of either riveted or welded construction. The legs shall be of box type/rolled, with all angles on the inside of the leg. Field welding will not be accepted. Diaphragms shall be provided to distribute the loads properly to the two sides of the legs and plate stiffeners shall be provided where necessary. Bearing surfaces of joints designed to transmit stress by bearing shall be machine finished to provide full contact. Shop connection in the frame shall be riveted or welded so that the surface of the crane including the outside of the frame cabin and hoist housing when viewed along the runway, will be a plane surface, except for the projection of rivet heads if any. The structures shall be designed adequately safe for each of the following load combinations.

- Dead and live loads with 50 kg/m^2 wind load on the crane and impact Loads
- Dead and live loads with 50 kg/m^2 wind loads on the crane and tractive forces
- Dead loads with no load on lifting blocks and 150 kg. per sq. m. storm loads.
- Breakdown torque of motor
- Collision of buffers and track stops.

The Crane legs shall be connected to the crane members by heavy gussets in a manner that will prevent skewing and ensure rigidity and strength. Diaphragms shall be provided to distribute properly the loads from the cross members to the side of the legs. If the centre lines of the legs are not matching with the centre lines of the crane runway rails, the eccentricity shall be considered in determining the stresses.

14.4.2. MACHINERY HOUSING

A weather tight housing constructed of structural steel sections and plates shall be provided. The floor shall be constructed of reinforced chequered steel plates not less than 8 mm thick and shall be welded or riveted to the framework. Clearance between the machinery floor and the roof framing shall not be less than two (02) meters.

14.4.3. OPERATOR'S CABIN

The cabin shall be of closed type for outdoor services made of structural steel and shall be provided with sufficient ventilating type window to allow the operator to have a clear view of all operations and the cabin shall have ample space for the operation and maintenance of the equipment located in it. The floor of the cabin shall be made of steel plates fastened securely to the frame of the cabin and covered with 'TRANSITE' having not less than 12 mm thickness. A foot operated rotary alarm gong of at least 300 mm diameter shall be provided to the crane and shall be arranged for the operation from the cabin. Provision shall be made for access to the cabin by means of walkway from the ladders.

14.4.4. WALKWAYS, LADDERS AND RAILINGS

All ladders, platforms and walkways necessary to provide access to the crane drive machines, shall be provided. The platform and walkways shall be designed for a live load of at least 500 kg/m^2 and shall consist of suitable non-slip steel plates riveted or welded together and riveted or bolted to the steel framework except that the walkway on the top deck of the EOT Crane shall be constructed of floor grating. The ladders shall not be less than 400 mm width between side parts and shall have round rungs 20 mm in diameter spaced at 300 mm centre to centre. The walkways shall provide clearance of not less than 600 mm between machinery and / or the structure and the railings. Clips shall be provided on all open edges of the walkways and platforms. Standard pipe railings with two horizontal pipe rails shall completely enclose all walkways. The railings and ladder rungs on the outside of the crane shall be made of steel having fittings of the flush jointed type. Railings shall be provided along the open sides of the walkways, platform, stairs and other locations where required. The platforms are required to be proportioned for a moving single load of 300 kg. Railings are to be proportioned for a travelling horizontal single load of 30 kg acting on the rail iron.

14.4.5. BUFFERS

The spring buffers shall be provided at either end of the travel of EOT crane and movable trolley and shall be capable of bringing the crane to a gradual stop in a distance of not more than 200 mm when traveling in either direction at rated speed while power off and brakes not applied, without producing excessive stress or damage in the structure. The buffers stops shall be of cat or structural steel, accurately mounted to meet the buffer squarely. The centre line of contact shall not be more than the centre line of wheel base. The design of the buffers shall provide minimum factor of safety of six (06).

14.4.6. MECHANICAL EQUIPMENT

The hoist shall be designed in accordance with the IS: 6938 & IS: 3177. All mechanical equipment shall be simple and substantial in design and capable of being easily erected, inspected, painted and taken apart. The hoist shall be single motor twin drum type connected through gearing and shafting. The capacity of motor shall be such that the specific performance of the hoist at rated load will not demand more than full load torque. The shaft connecting the end gear trains shall be provided with flexible coupling of the geared type, or any other approved arrangement which will permit one drum to be rotated with respect to the other drum and keeps the lifting beam in a level position. All shaft loads shall be transmitted by suitable keys, splines or pins. The transmission of loads by press fit only will not be permitted. A factor of safety of FIVE over UTS based on the rated capacity of the crane (exclusive of duty factor, impact factor, acceleration and

retardation) shall be used in design of all mechanical parts provided that all parts of the equipment shall have sufficient strength to resist the forces provided by the rated breakdown torque of the motor without exceeding 80% of the yield point strength of the material used. Duty factor shall also be considered in breakdown torque condition or the stresses limited to those under breakdown torque condition as per IS: 3177. The hoist shall be so designed as to limit the maximum rope fleet angles to one in twelve, unless otherwise approved. The grooving on the main hoist drum shall be such as to allow the lifting beam to travel vertically. The hoist shall be provided with an electro-magnetic brake and means for position control of the loading movements of the hooks.

WHEELS AND AXLES:

The crane shall be carried on not less than eight wheels, four wheels in tandem, fully equalized and provided for each crane travel base. The wheels shall be heat treated properly and certified copies of the test of the heat treatment shall be furnished by the wheel manufacturer. The tread width shall have the proper clearance for the rail head and shall be of sufficient size to withstand satisfactorily maximum standing and rolling loads. In no case shall the diameter of the crane wheels be less than that given in IS: 3177. The wheels shall be turned or ground to true and uniform diameter concentric with the bore. The wheel axles shall be made of forged carbon or alloy steel and shall be accurately turned, ground and polished at journals. All axles shall be forced into the wheels at a force of not less than 3200 kg/cm^2 of axle diameter and driving wheel shall be keyed to the axles in addition to the forced fit. All wheels journal boxes shall be drip proof and shall be provided with self lubricating bronze bearings accurately machined and correctly bored for the axle fits or may be provided with roller bearings with high pressure grease lubrication. The wheel assemblies shall be designed to facilitate removal of wheels, bearings and journals from the frames. This shall be arranged such that wear may be compensated in order to maintain the drive gears in proper mesh. The size of the journal shall be ample to carry the load at the specified speed without excessive heating during continuous operation. Track sweeps on each end shall be provided and shall extend below the top of the rail on both sides. Wheels shall be interchangeable.

CRANE DRIVE:

The Crane drive motion shall be affected by means of motors and shall be designed to move the crane at a rated speed while supporting the maximum load for operating the gates. Not less than 50 % of the wheels on each track shall be connected for driving. Each motor mounted at one end of the EOT crane shall be arranged to drive one track on each side of the crane through gears. The general arrangement is shown in the drawing. The drive shall be free from vibrations while moving and in no case, there shall be any tendency for EOT crane structure to get misaligned.

BRAKES:

Following brakes shall be provided on the EOT crane:

a) HOIST BRAKE

The hoist shall be provided with an automatic electro-magnetic brake and a hydraulic thruster brake of suitable capacity. The electro-magnetic brake shall be mounted on the same base as the hoist motor and shall be electrically operated spring set, solenoid release, shoe type and shall be equally effective in both directions of motor rotation. The brakes shall be capable of overcoming at least one and half times the rated full load torque exerted by the motor. The brakes shall be rated on an hour's basis and shall be capable of withstanding not less than four operations per minute. The brake shall be equipped with manual release, which must be held by

hand and cannot be left in the released position or one which will automatically reset at all times when the power is disconnected. The terminals of brake magnet shall be protected from accidental contact. The connections and windings shall be effectively protected from mechanical damage. When necessary, magnet shall be provided with an efficient cushioning device. In addition, a mechanical load brake is to be interposed between the winding drum and the source of power. It shall have a capacity equal to one and a half times the rated load and shall be designed to prevent the load from moving downward unless the hoist motors are revolving under power in the lowering direction. The brake shall preferably be of suitable multiple disc type and shall run in a bath of oil. The castings shall have sufficient heat dissipating capacity to maintain the temperature of bath below 93 degrees centigrade when lowering the rated load with the electro-magnetic brake in operation, and if required, an external cooling device shall be provided to prevent this maximum temperature from being exceeded.

b) CRANE MOTION AND PARKING BRAKES

A shoe type mechanically or hydraulically operated brake controlled through a foot pedal in the operator's cabin shall be provided to control the crane travel in both directions of motion. The brake shall be capable of overcoming at least one and a half times rated full load torque of driving motors and shall be so designed that it may be secured in the set position. The foot brake shall require a force not more than 25 kgs. at pedal and the pedal stroke shall not exceed 250 mm. Electro-magnetic brakes shall be provided for parking of crane, which shall apply automatically when the current supply to the mains is switched off. These parking brakes shall be in accordance with IS: 3177. (All brakes shall be of standard / reputed make).

WIRE ROPE:

The wire rope shall be made of special improved plough steel construction, ordinary lay, fibre or steel main core and shall conform to IS: 2266. While calculating the diameter of wire rope, the efficiency of pulleys, sheaves and drums shall be considered. No rope thicker than 38 mm in diameter shall be used.

ROPE DRUM:

The drum design, shape of grooves etc. shall conform to IS: 6938 & IS: 3177.

GEARS AND PINIONS:

Spur gears of 20 degrees pressure angle full depth involutes system conforming to IS: 3681 shall be provided in end reduction gear unit. While designing the gears and pinions, in accordance with IS: 6938 and IS: 4460, the correction factor for peripheral speeds and the efficiency shall also be considered. The teeth of gears and pinions shall be cut from solid metal and shall be free from chatter marks and other imperfections. In the design of gears, due consideration should be given for duty factor for appropriate class of mechanism. The materials for pinions shall be harder than that of gears by at least 50 Brinell Hardness Number (BHN).

REDUCTION GEAR BOX:

It shall consist of worm & worm wheel of bronze or steel and whole assembly housed in a dust proof steel casing with suitable lubrication facility. The gear box shall have self locking characteristic. The shaft shall extend from housing for a sufficient length to permit the attachment of flexible couplings in proper alignment and shall be designed and rated in accordance with the accepted Indian Standard Code of Practice. Gear Boxes shall be of reputed makes.

SHAFTS FOR GEARS AND PINIONS:

The shafts shall be designed for combined torsion and bending and the angle of twist shall be taken into account, as detailed in the IS: 6938. The shaft for drum shall preferably be stationary.

SHEAVES AND PULLEYS:

The rope sheaves shall conform to IS: 6938. All pulleys shall be in true running balance and shall be provided with antifriction bearing with pressure greasing arrangement.

BEARINGS:

All the running shafts shall be provided with ball, roller or self lubricating bronze bush bearings. The selection of bearings shall be done on considerations of duty, load and speed of the shafts as recommended by the manufacturer. All bearings shall be weather proof, drip proof and shall be protected against the entrance of rain, dust or any other foreign matter (Bearings shall be of standard / reputed make).

FLEXIBLE COUPLINGS:

Flexible couplings shall be all metallic, fully enclosed, dust proof, self oiling type and shall be bored for tight fits on the shafts. Straight square keys shall be provided for fitting the couplings on shafts. All couplings shall fit true on shafts and shall be fitted accurately on shafts. The flange couplings between motors and worm gear reducers shall be provided for both angular and offset misalignment of the coupled shafts. Flexible couplings shall be of standard / reputed make.

LIFTING HOOK AND BLOCK:

The block shall be arranged to lift the stop-log without twisting. The pulleys shall be mounted on roller bearings. The blocks shall be so designed and constructed so as to guide the hoisting ropes fully and prevent them from leaving the sheaves under any operating condition. A guiding arrangement shall be provided for the pulleys to prevent the rope from leaving the pulleys due to any jerk.

SOCKETS FOR WIRE ROPES:

The sockets may be cast, forged or machined. Molten zinc shall be used to socket the ropes. Such specimen shall be subjected to destructive tensile tests in which rope shall fail first than the socket or joints.

GEAR BOX COVERS:

Gear box covers shall be of rigid construction fitted with inspection covers and lifting handles. The covers shall be so shaped that the gears can be easily removed or replaced. Facilities for lubrication, oil draining, oil level indication etc. shall be provided where necessary. The thickness of metal sheet for cover shall not be less than 3 mm.

COUNTER WEIGHT:

Suitable counter weight shall be provided to make the crane stable under all operating conditions.

KEYS AND KEYWAYS:

The size of the keys shall be such as to be within safe bearing and shear limits for the materials in contact and, in general shall conform to the relevant IS for square and flat keys. Where round end keys are used, the total cross sectional area may be considered in effective shear. But in calculating bearing stresses in keys and keyways, the projected area of the rounded ends shall not be included in the effective bearing area. If two keys are

used, they shall be placed 120 degree apart. The design shall be such as to hold all keys effectively in place. Further, keys and keyways shall have rounded ends having tight fits in the seats. Keyways shall not be extended into the bearings.

WRENCHES AND TOOLS:

A suitable grease gun and a complete set of wrenches and tools in a pressed tool box shall be furnished for the crane. Sufficient quantity and variety of tools shall be furnished to cover all ordinary maintenance work of the crane. Operating instructions in a suitable metal frame covered with glass shall be mounted at a convenient location in operator's cabin.

14.5. ELECTRICAL EQUIPMENT

All electrical equipment furnished under these specifications will be subjected to severe moisture condition and shall be designed to prevent deterioration from corrosion and shall be insulated accordingly. All wirings of the electrical equipment shall be in accordance with the Indian Electricity Act in force and relevant Indian Standard. The wiring shall be in hot dipped galvanized metal conduits. Conductors having equivalent copper area of cross section of minimum 16 mm^2 shall be used for power wiring and those for control circuits and auxiliary wiring of 1.5 mm^2. Conductors shall normally be insulated for not less than 1.1 kV and shall have standard moisture resisting, double braided insulation cover.

ELECTRIC MOTOR:

Motors shall be of crane duty, totally enclosed fan cooled, squirrel cage induction type design for operation on 3 phase, 400 / 440 volts, 50 Hz. conforming to IS: 325 of rated capacity. Each motor shall be equipped with built in heater to prevent condensation of moisture drawn into the motor during shut down periods.

The contractor shall clearly specify the breakdown torque of the motor during detailed engineering stage. All hoist components shall be checked for their stress value under these conditions.

Selection of motor shall be as per IS: 3177. Motors of 40 HP or less shall be rated in accordance with IS: 325. Service factor of 1.15 shall be accounted in deciding the capacity of motor. Motor shall be of Energy efficient, BIS or equivalent international standard marked and of reputed make like Siemens / Kirloskar / NGEF / GEC etc.

MASTER CONTROL EQUIPMENT:

Master control equipment shall be so placed in the operator's cabin that the operator may control all the functions of the crane from there. The operator's stand shall be placed in such a convenient position that enough room is available for various operations of EOT crane and operator may have unrestricted view of the load. All motor controls shall be fully magnetic, reversing with definite time limit and equipped with frequency controlled acceleration devices, instantaneous over current, over loads and low voltage protections. They shall be designed so that it will be possible to limit the vertical movement of the hook, with full rated load, when starting from complete stand still to within 10 mm from main hook. All hoist motor controls shall have at least six speed control points in each direction of operation. The contact of protection relays of any motor shall be so wired that the operation of the relay will trip the motor primary conductor, thus making it necessary to return all control to the 'OFF' position before the motor can be started. The control shall be so interlocked that only one operation can be performed at a time.

The instantaneous relays shall be adjustable between 200 % to 300 % of motor full load current. The power supply from the main connections, shall be protected by three pole

400 / 440 V AC totally enclosed air circuit breaker equipped with three time relays, direct acting overload tripping element and one shunt trip coil located in the operator's cabin for emergency tripping. A circuit breaker shall be provided to control and protect the control circuit for each motor and all control circuits shall have fuse of appropriate rating. An indicating lamp shall be provided to show that the control circuit is healthy. All switches, contactors and relays shall be enclosed in suitable cabinets and placed in accessible location to facilitate inspection and maintenance. All motor controls shall have master switches with vertical handles. Changes in speed while lowering the load shall be under the direct control of the operator and shall permit him to stop the motor without time delay from any position by the master switches. All resistors shall be unbreakable, corrosion resisting type and shall have a lower temperature coefficient. Where practicable, controller handle should move into the direction of the resultant movement. Each controller shall be marked in a permanent manner to show the motion concluded and wherever practicable of the direction of the movement. The notching for the controller handle in 'off' position shall be more positive than the notching in other position. The control lever shall be provided with stop and / or latches, to ensure safety and facility of operation.

The resistors shall be placed in accessible places outside the cabin and in a well ventilated non-combustible cabinet which will not emit flame. Each main supply circuit breaker shall have interrupting capacity of not less than 10 kA. All switches, conductors, primary relays and preliminary circuits on controllers shall have a thermal capacity of 10 kA, for one second without injury. The resistor shall preferably be intermittently rated and their rating will be as per IS: 3177. Allowable temperature rise during operation of the crane under service condition shall not exceed and limits specified in relevant IS codes. The contractor shall state in his tender the make and types of all electrical equipment, which he proposes to furnish. All switches, controller levers and other operating mechanism and electrical devices shall be subject to the approval of the Employer.

CABLES AND CABLE REEL:

The polyvinyl chloride (PVC) insulated cables used for crane wiring should comply with the relevant Indian Standard. The EOT crane shall be equipped with an automatic spring actuated device to take up cable reel. Power will be obtained from plug receptacles placed at convenient point of the runway. The cable reels shall be provided with sufficient length of flexible cable and with limit switches arranged to cut off the power supply to the cable of the motors, when all but two turns of the cable are unreeled. The attachment plug for the receptacle end of the cable shall be furnished by the contractor.

WIRING:

All wiring shall be in the hot dipped galvanized metal conduits. All conductors for primary power lighting and control circuit shall be insulated for not less than 1.1 kV and shall have standard moisture resisting double braided covering. All conductors between the secondaries of the motor conductor and resistors shall have sufficient current carrying capacity in accordance with Indian Standard and shall be insulated with 1.1 kV class asbestos. The primary conductor to the motor shall have standard continuous current carrying capacity of not less than 120% of the rated full load primary current of the motor. Cables having conductors smaller than 4 mm^2 nominal equivalent copper areas of the cross section shall not be used for the power wiring for any of the motor. For control circuits and auxiliary wiring, cables having a sectional area smaller than 1.5 mm^2 nominal equivalent copper area shall not be used. All cables shall be adequately protected against mechanical damage and metal trunking may be used if desired. Electrical conduit shall comply with the relevant Indian Standard. For outdoor cranes except where flexible unarmoured cables are essential, cables shall be either armoured or enclosed

throughout their length in galvanized trunking or conduit, either flexible or rigid. A flexible metallic tube or duct may not form an effective earth connection and shall not be used for that purpose. Tapped and braided varnished cambric insulated cables shall not be used for outdoor crane.

LIMIT SWITCHES:

The limit switches shall be of the totally enclosed type. All limit switches shall be capable of being reset by reversing the controllers. The limit switches shall have water proof coverings and shall be suitably designed and tested for normal lift and satisfactory operation under the humid outdoor climatic conditions. They shall be of approved and standard type and shall be suitable for service under extreme position in either direction. The design shall be such as to facilitate easy servicing and replacement when worn-out. Limit switches shall be provided for following operations:

- To limit the travel of EOT crane at both ends of the travel and to stop the crane at centre of each span
- To limit the hoisting travel of the hook

ISOLATING SWITCHES:

The manufacturer shall fit a main isolating switch in the cabin or adjacent to it, capable of disconnecting the supply for power driven and associated equipment on the crane but not the auxiliary loads such as lighting and heating circuit. In the case of main isolating switches being combined with the crane protective panel, it shall be mechanically interlocked with the door giving access to the panel, and the terminal shall be screwed to prevent accidental contact when the door is opened. When so combined a suitably worded red warning plate shall be attached to the cover of the protective gear and all other panels and controllers, not fitted with interlocked isolators. The main isolating switch and the additional isolating switches should be so situated that it will be possible to carry out any maintenance work or functional testing on them without danger.

PROTECTIVE EQUIPMENT:

Iron clad electric protective gear in accordance with IS: 3177 shall be provided except that if the aggregate power of the two largest motors is less than 30 kW and their aggregate current rating is less than 60 amps, a manually operated equipment as per IS: 3177 may be used.

LIGHTING FIXTURES:

The permanent 240 volt lighting system on the crane shall consist of Four (04) Nos. of One Hundred and Fifty (150) Watt LED Lamps units to illuminate the area under the crane, One (01) No. of One Hundred and Fifty (150) Watt LED Lamp to illuminate the area under the cantilever and Two (02) Nos. of Forty (40) Watt LED Lamps in the operator's cabin. The system shall be supplied from 415 V crane power system taken from LT Switchgear through a 415 V circuit breaker with a convenient outlet in the operator's cabin. Four (04) Nos. 150 W LED Lamps may be connected by means of two circuits with Two (02) Nos. LED Lamps. The wiring shall be done in accordance with the Indian Electricity Rules, 2003. The 415V circuit breakers shall be of enclosed, four pole type with an over load tripping element in individual phase.

INTERLOCKING AND EARTHING:

'OFF' position interlocking, earthing and other electrical equipment shall be provided as per IS: 3177.

14.6. TEST

14.6.1. TYPE TEST

The contractor shall submit the type test reports of the equipment / items / materials / whole system as per relevant IS / IEC to the Employer at the detailed engineering stage. The type tests of similar rated items / equipment / systems shall be carried out from CPRI / NABL / Govt. approved Laboratories within ten (10) years from the date of this NIT Publication. The contractor may be required to furnish the original type test reports with test results, if desired by the employer.

14.6.2. COMMISSIONING CHECKS / SITE TESTS

All tests of the EOT crane at the manufacturing site in presence of the Employer's representative shall be carried out following relevant Indian Standard / IEC.

All testing equipment, required for testing at site, shall be provided by the contractor at free of charge on returnable basis. In the event of repeated testing becomes necessary, the entire expenditure on such repeat tests shall be borne by the contractor.

All testing equipment shall have the up-to-date calibration certificate. The contractor needs to furnish the same to the employer prior to starting of testing at site as well as at manufacturer's works, whatever the case may be.

14.7. DOCUMENTS TO BE SUBMITTED AFTER PLACEMENT OF LOA

- Name of manufacturer proposed by the contractor for each item / equipment as per **Cl. No. 14.9**.
- Performance certificates of proposed manufacturers as per **Cl. No. 14.10.**
- All Type test reports of each similar rated products of the proposed manufacturer.
- Routine Test Report / Shop Test Report of each similar rated products of the proposed manufacturer performed earlier.
- Tentative GA Drawing

14.8. DOCUMENTS TO BE SUBMITTED DURING DETAILED ENGINEERING STAGE

Six (06) sets of data sheet, manual, leaflet, drawing and other documentation as mentioned below for EOT Crane for Power House shall be submitted to the Controlling Officer of the employer for according approval during detailed engineering stage.

- Guaranteed Technical Particulars (GTP) as per **Chapter – 20 (Cl. No. 20.13)**.
- Detailed design and of the EOT crane considering weight of various equipment
- GA Drawings, foundation drawings etc.
- Electrical system drawing with control & accessories
- Detailed time schedule indicating submission of drawings, delivery of items, installation, testing, trial run & commissioning.
- Detailed Bill of Material (BOM) which shall include the spare parts for five (05) years of trouble-free operation & maintenance of the above system as per **Cl. No. 19.11** and special tools, plants and equipment as per **Cl. No. 19.15.**
- Detailed Quality Assurance Plan (QAP) for field acceptance test.
- Manual for installation, operation and maintenance procedure.

After approval, six (06) sets of approved drawings and documents along with soft copies for EOT Crane for Power House shall be submitted to the controlling officer of the employer.

14.9. MAKE OF COMPONENTS

The contractor shall submit proposed make of various bought out components of EOT Crane for Power House after placement of LOA. Final make shall be approved by the employer during detailed engineering stage based on the performance certificates submitted by the contractor.

14.10. CREDENTIALS AND PERFORMANCE CERTIFICATES

The contractor shall submit Performance Certificates issued to the proposed manufacturers by the respective employer for similar kind of job. The contractor shall also furnish documents in support of supply, delivery of similar equipment / system indicating thereon names of the organization, quantity ordered and quantity supplied along with their submission after placement of LOA. Non-submission of the same will be liable for rejection of the proposed manufacturers.

14.11. GUARANTEE

Guarantee of the total equipment including any integral part of the equipment should be up to Defect Liability Period of the project.

14.12. COMPLETENESS OF EQUIPMENT / SYSTEM

All items, equipment, fittings and accessories etc. for any specified equipment / system that may not be specifically mentioned in the specification but necessary for completeness of the system shall be deemed to be covered under the scope of this contract. No extra charges will be paid to the contractor for the same.

14.13. SCHEDULE OF REQUIREMENT

Sl. No.	Description	Quantity
1	EOT Crane, suitable for 10.7 ± 10 % m. span for power house having main hoist of capacity Forty (40) Tonnes and Auxiliary hoist of capacity Ten (10) Tonnes and complete with motors, reducers, brakes, drums, wire ropes, slings, protective and control equipment, speed control, runway rails along with fixing arrangement, down shop lead conductors, insulators, current collectors etc in complete as described in this technical specification.	One (01) Set
2	Special tools, plants and equipment etc. as per **Cl. No. 19.15**	As required
3	Completeness of the equipment / system as per **Cl. No. 14.12**	As required

15. ILLUMINATION SYSTEM

15.1. SCOPE

This section of specification covers design, engineering, quality assurance, manufacture, transport, transit insurance, supply, delivery to site, storage at site, erection, testing and commissioning of Illumination System comprising of main illumination switchboards, distribution boards, sub distribution boards, switchboards, led lights with lighting fixtures, convenience power outlets, conduits & fittings, cabling, outdoor lighting including mounting structures & poles, flood lighting etc. for power house, access road, transformer yard, tailrace area, forebay and ADIT-II tunnel of Lodhama II SHEP. Any assessment required for any illumination related calculation is to be done by the bidder through site visit and survey.

The illumination system shall cover entire AC & DC Emergency Lighting. The scope of supply shall also include spare parts required for normal operation & maintenance of illumination system for a period of five (05) years & special tools & plants required for erection & maintenance. All the material & workmanship shall be of suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

15.2. STANDARDS

The material, equipment and its installation under the scope shall comply with all applicable provisions of the latest Indian standards and codes of practice.

Sl. No.	Standards	Description
1	IS: 3646	Code of practice for interior Illumination (Part I, II, III)
2	IS: 6665	Code of Practice for Industrial Lighting
3	IS: 732	Code of Practice for Electrical wiring installations
4	IS: 9537	Conduits for Electric installations
5	IS: 2418	Tubular fluorescent lamps for general lighting service

The installation shall generally be carried out in conformity with the requirements of Indian Electricity Act (latest Amendment) & Indian Electricity Rules.

15.3. ILLUMINATION LEVELS, FITTINGS & LAMPS

The required Illumination Levels, type of fittings and lamps for various areas shall be as mentioned below. The system shall be designed in accordance with these stipulations.

Sl. No.	Premises	Avg. Illumination Level in horizontal Plane (Lux.)	Preferred Lamp
1	Service Bay	300	LED Lamp (150 W)
2	Machine Hall	300	LED Lamp (150 W)
3	Control Room	500	LED Lamp (40 W)

Sl. No.	Premises	Avg. Illumination Level in horizontal Plane (Lux.)	Preferred Lamp
4	Office Room	300	LED Lamp (40 W)
5	WC & Stair case	100	LED Lamp (20 W)
6	Battery room	200	LED Lamp (40 W)
7	DG Room	200	LED Lamp (40 W)
8	Transformer enclosure	100	LED Lamp (20 W)
9	Pump house	150	LED Lamp (80 W)
10	Transformer yard	300	Sodium vapour
11	Permanent stores	200	LED Lamp (40 W)
12	Cable galleries	50	LED Lamp (40 W)
13	Roads	20	LED Lamp (20 W)
14	Forebay area	50	Sodium vapour
15	ADIT-II tunnel	150	LED Lamp (80 W)

Number of lighting fittings of each type required for Illumination system i.r.o. required Illumination Level at various locations as specified above shall be calculated by the contractor. The contractor shall to design and submit the complete Illumination System indicating the no. of fitting of each type as required, conduit / cable layouts, location of Distribution / Sub-distribution / Switchboard / Power-boards etc. during detailed engineering stage.

15.4. CONSTRUCTION DETAILS OF DIFFERENT BOARDS

The Main Illumination Board shall be of MS Sheet Steel not less than 2.5 mm having an enclosure protection of IP-54, totally enclosed free standing or wall mounted type and provided with cable glands for incoming & outgoing circuits. The board shall be provided with 3φ & neutral (TPN) bus bars of Aluminium / Copper having adequate current rating on insulator support. GI Earth bus shall be provided inside the main Illumination board.

The AC / DC distribution boards, sub-distribution boards shall be constructed of sheet steel of thickness not less than 2 mm. Adequate wiring space shall be provided at the sides. Minimum degree of protection for indoor enclosures shall be IP-42 and those for the outdoor enclosures shall be IP-54. The board shall be suitable for wall mounting on steel / concrete structure. They shall be installed 1200 mm above floor level.

The switchboards with required number of switches; fan regulators, sockets etc. shall be made of GI sheet on all sides except on front and shall be mounted at a height of 1200 mm. Bakelite or Hylam sheets of not less than 3 mm thickness shall be fixed on the front with brass screws.

15.5. LIGHTING ACCESSORIES

LED type energy efficient lamps shall be used for the purpose of illumination system of the Plant, except where specific light fixtures required.

Necessary accessories like lamp holders, brackets & supports, light switches, power sockets, junction boxes to house the bends & extra length of wires, lighting poles etc. shall be in the scope of the contractor. All accessories shall conform to the relevant Indian Standard / IEC and modern practices.

15.6. CABLES, CONDUCTORS & WIRING

All cables beyond sub distribution board shall be single core, PVC insulated stranded copper conductor having section not less than 2.5 mm^2. The wiring shall be done in looping back system. Live conductor shall be looped at switchboard and the neutral conductor can be looped either from switchboard or from the lights & socket outlet.

No joints shall be made at intermediate point in the run of cables, unless the length of final sub-circuit or sub main or main is more than the available commercial length of the standard cable.

Power & heating sub-circuit shall be kept separate and distinct from lighting sub circuits. All types of wiring whether concealed or unconcealed shall be capable of easy inspection.

15.7. MCB / MCCB

The TPN MCCBs for both the main lighting boards & distribution boards shall be of specified rating with breaking capacity not less than 40 kA. All the MCBs shall be of suitable rating and 9 kA breaking capacity & shall conform to IS: 8828 in all respect.

15.8. CONDUITS AND FITTINGS

The contractor shall furnish & install all conduits, boxes, wire ways and fittings required to complete the job. All necessary hardware, such as screws, bolts, hangers, concrete inserts, clamps, locknuts, bushings, conduit pipe, tee and box drains, couplings, pulling irons, identification tags etc. shall be under the scope of supply.

Rigid metal & flexible steel conduits shall be hot dip galvanized. Metal conduit fittings & covers shall also be galvanized. Expansion joint & fittings shall permit a small amount of transverse movement as well as longitudinal movement.

15.9. CONDUIT INSTALLATION

Installation of conduits, boxes, fittings and accessories shall conform to the requirements of relevant standards and shall be performed with good workmanship by skilled personnel. During installation, due precautions shall be taken to protect conduit & conduit thread from mechanical injury. All joints shall be made water tight by use of red lead & oil or other approved compound.

Exposed conduits shall run in straight lines parallel to walls, beams or columns. Uniform offset shall be accomplished in a manner that will present symmetrical appearances. Exposed conduits, size up to 25 mm shall be supported at maximum 1.5 m interval, and conduit over 25 mm at maximum 2.5 m interval. Galvanized or cadmium plated clamps, or U and J bolts, shall be used to fasten conduits. Conduit pipes shall be fixed by heavy gauge saddles, secured to suitable wood plugs or other approved plugs with screws in an approved manner. But on either side of couplers or bends or similar fittings, saddles shall be fixed at a distance of 30 cm from the centre of such fittings. Conduits embedded in concrete shall be sloped toward drain points and rigidly braced to avoid shifting during concrete pouring. Drain tee shall be installed where sloping is not possible. Embedded

conduits shall be supported on spacers at not more than 1 m interval. Suitable expansion fittings shall be provided at points where conduits cross expansion joints.

Field bending of metallic conduit shall be performed with a bending machine or other approved device. Bends shall be free from kinks, indentation or flattened surfaces.

Conduits shall be designated at each end, at hand-hole and at junction and pull boxes by means of suitable tags.

15.10. LAYING OF CABLES

Laying of cables shall conform to the requirements of relevant standards. Cable runs shall be continuous from terminal to terminal to the extent permitted by available commercial length. The laying of cables shall include terminations at both ends and supply and installation of all accessories to make the cable installation complete in all respect. Where the cables are directly buried in the ground, all the necessary excavation and other works for laying of cables shall be carried out by the contractor.

Insulated wire & cable shall be handled with care to avoid kinking and damage. No cable shall be pulled into ducts unless the latter are clean & dry. Sufficient slack shall be allowed in each run to permit contraction and expansion. Cable identification tags, of a permanent type shall be provided and installed on all cables except branch lighting conductors.

15.11. EARTHING

Distribution system shall suitably be earthed through station earthing system. Continuous earth shall run for 3 pin sockets. In addition to neutral being earthed at the distribution transformer, the three phase four wire distribution system shall be connected to the station earthing system at two or more places. Metallic covering or supports of all the medium pressure apparatus & conductors shall be connected to the station earthing system by two separate & distinct connections.

15.12. ILLUMINATION LEVEL VERIFICATION

After completion of lighting installation at various locations as specified above, the actual illumination level shall be measured by the contractor in presence of employer's representative. If the measured illumination levels are lower than the respective specified level, the contractor shall provide additional lighting fixture{s) to achieve the specified illumination level.

15.13. EMERGENCY LIGHTING

In case of failure of AC system, emergency lighting shall be provided in the strategic locations of the Power House as well as transformer yard through the 110 V DC source of the Plant. The contractor shall submit the scheme during detailed engineering stage.

15.14. TESTS

15.14.1. TYPE TEST

All the items, materials etc. required for the lighting system shall be subjected to all kind of type tests in accordance with latest version of relevant standards. The contractor shall

submit type test report from CPRI / NABL / Govt. approved Laboratories having identical type and rating similar to the tendered item during detailed engineering stage, carried out within ten (10) years from the date of this NIT Publication. The contractor may be required to furnish the original type test reports with test results, if desired by the employer.

15.14.2. COMMISSIONING CHECKS / SITE TESTS

- Illumination level test at various location
- Testing the effectiveness of all earthing connections
- Complete operational tests on the whole installation
- Any other test as mutually agreed following applicable standard

All testing equipment required for testing at site, shall be provided by the contractor at free of charge on returnable basis. In the event of repeated testing becomes necessary, the entire expenditure on such repeat tests shall be borne by the contractor.

All testing equipment shall have the up-to-date calibration certificate. The contractor needs to furnish the same to the employer prior to testing at site.

15.15. DOCUMENTS TO BE SUBMITTED AFTER PLACEMENT OF LOA

- Name of manufacturer proposed by the contractor for each item / equipment as per **Cl. No. 15.17**.
- Performance certificates of proposed manufacturers as per **Cl. No. 15.18.**
- All Type test reports of each similar rated products of the proposed manufacturer.

15.16. DOCUMENTS TO BE SUBMITTED DURING DETAILED ENGINEERING STAGE

Six (06) sets of data sheet, manual, leaflet, drawing and other documentation as mentioned below for complete illumination system shall be submitted to the Controlling Officer of the employer for according approval during detailed engineering stage.

- Guaranteed Technical Particulars (GTP) as per **Chapter – 20 (Cl. No. 20.14)**.
- Detailed calculations to justify the number of lighting fixtures to achieve the desired lux level for various areas as mentioned in this specifications.
- Key electrical distribution scheme for both AC & DC illumination system, drawings of various boards & panels, scheme for earthing, lighting fixtures layout drawings showing location of fittings, location of distribution; sub-distribution & switchboards, conduit / cable routing etc.
- Catalogues, leaflets and other details of Lighting fixtures, with data on reflection factors and room indices etc.
- Detailed time schedule indicating submission of drawings, delivery of items, installation, testing, trial run & commissioning.
- Detailed Bill of Material (BOM) which shall include the spare parts for five (05) years of trouble-free operation & maintenance of the above system as per **Cl. No. 19.12** and special tools, plants and equipment as per **Cl. No. 19.15.**
- Detailed Quality Assurance Plan (QAP) for field acceptance test.

After approval, six (06) sets of approved drawings and documents along with soft copies for complete illumination system shall be submitted to the controlling officer of the employer.

15.17. MAKE OF COMPONENTS

The contractor shall submit proposed make of various bought out components of Illumination System after placement of LOA. Final make shall be approved by the employer during detailed engineering stage based on the performance certificates submitted by the contractor. For approved makers list of WBSEDCL for various components, the bidders are requested to go through **Chapter – 21** of this Technical Specifications.

15.18. CREDENTIALS AND PERFORMANCE CERTIFICATES

The contractor shall submit Performance Certificates issued to the proposed manufacturers by the respective employer for similar kind of job. The contractor shall also furnish documents in support of supply, delivery of similar equipment / system indicating thereon names of the organization, quantity ordered and quantity supplied along with their submission after placement of LOA. Non-submission of the same will be liable for rejection of the proposed manufacturers.

15.19. GUARANTEE

Guarantee of the total equipment including any integral part of the equipment should be up to Defect Liability Period of the project.

15.20. COMPLETENESS OF EQUIPMENT / SYSTEM

All items, equipment, fittings and accessories etc. for any specified equipment / system that may not be specifically mentioned in the specification but necessary for completeness of the system shall be deemed to be covered under the scope of this contract. No extra charges will be paid to the contractor for the same.

15.21. SCHEDULE OF REQUIREMENT

Sl. No.	Description	Quantity
1	Complete illumination system as mentioned in this technical specification	As required to achieve desired Lux. Level at various Location of the project
9	Special tools, plants and equipment as per **Cl. No. 19.15**	As required
10	Spare parts as per in **Cl. No. 19.12**	As required
11	Completeness of equipment / system as mentioned in **Cl. No. 15.21**	As required

16. FIRE PROTECTION SYSTEM

16.1. SCOPE

This section of the specification covers design, engineering, quality assurance, manufacture, transport, transit insurance, supply, delivery to site, storage at site, erection, testing, trial run, and commissioning of Fire Protection System complete with all accessories for Lodhama II SHEP.

The scope shall include supply of fire detectors, generator fire protection system as per manufacturer's recommendation, CO_2, foam and dry chemical type portable fire extinguishers etc. as required to make the fire protection system complete in all respects for safe operation of the plant.

The scope of supply shall also include spare parts required for normal operation & maintenance of fire protection system for a period of five (05) years & special tools & plants required for erection & maintenance. All the material & workmanship shall be of suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

16.2. STANDARDS

The material, equipment and its installation under the scope shall comply with all applicable provisions of the latest Indian standards and codes of practice.

Sl. No.	Standards	Description
1	IS: 3034	Code of Practice for Fire Safety of Industrial buildings: Electrical generating and distributing stations.
2	IS: 1646	Code of Practice for fire safety of buildings (General) Electrical Installations
3	IS: 7760	Specification for Steel glass front cabinets
4	IS: 2878	Specification for fire Extinguishers – Carbon dioxide type
5	IS: 2175	Specification for heat sensitive fire detectors for use in automatic electrical fire alarm system
6	IS: 2189	Code of Practice for installation of automatic fire alarm system using heat sensitive type fire detectors
7	IS: 4927	Specification for unlined fax canvas hose for fire fighting
8	NFPA	Codes and Practice for Fire Protection System

Equipment meeting with any other authoritative standards which ensure an equal or better quality than the standards mentioned above will also be acceptable. Where the equipment complies with any other standards, the salient points of difference between the standards adopted and the standards specified above shall be clearly brought out, and an English version of the proposed standards shall be furnished by the contractor.

16.3. GENERAL DESCRIPTION OF FIRE PROTECTION SYSTEM

Suppression systems adopted for use on fires involving electrical equipment shall not increase the risk of electrocution to personnel involved in fighting the fire.

Best design for smoke/heat detectors shall be installed in the indoor switchgear & LT switchgear room, battery room, office room, conference room, workshop and store room. On occurrence of fire, the presence of smoke shall trigger electronic circuit of detector and send signal to fire alarm panel. Heat detector shall be provided along with fire detectors in the battery room.

Generator fire fighting system, as per manufacturer's recommendation shall be used for generators. Generator fire protection system following all relevant standards shall be considered. Suitable nos. of portable CO_2 type, foam type and dry chemical type fire extinguishers shall be provided in the powerhouse in the strategic locations which are prone to electrical and oil fires.

Design of the complete fire protection system shall be finallised during detailed engineering stage.

16.4. FIRE DETECTION AND ALARM SYSTEM

Detection system for the control room, switchgear room, battery room, DG set and station auxiliary transformer room and other equipment shall consist of smoke detectors of ionization as well as photoelectric type, distributed in the area to be protected. Detectors offered shall be approvable by TAC / NFPA / or other similar reputed organizations.

The complete area shall be covered by detectors by cross-zoning method with suitable time delay (about 30 sec.). The system shall be so designed that the fire shall be detected by at least one ionization and/or photoelectric detector at each covering zone. Number of detectors required for protecting an area shall be decided on the basis of ceiling height and area to be protected. Independent cross-zone detection system with annunciation system shall be provided for each zone. Interconnection between detectors in each zone shall be done by the contractor.

16.5. FIRE PROTECTION PANEL

The fire protection panel shall be of free standing sheet metal construction and shall consist of all required control and annunciation equipment like relays, push button, facias etc. The control circuit shall be designed to automatically switch off the air conditioning and ventilation system, as and when required. The panel shall be housed in the control room. Contractor shall submit the drawing indicating size and installation details of panels during detailed engineering stage. The design of alarm system should be such that the alarm gets sounded in the area under fire and also gets repeated in audio as well as visual manner on the fire protection panels.

The panel shall be complete with cable glands, gaskets, door operated illumination lamp & thermostatically controlled space heaters, two earthing terminals etc. and shall be suitable for bottom cable entry.

Visual alarms in the form of alarm facias shall be provided on the panel to indicate the minimum conditions as mentioned below.

- Fire in main transformer
- Fire in control room

- Fire in indoor switchgear room
- Fire in office room / conference room
- Fire in battery room

The Fire protection panel shall be interconnected with station supervisory control and data acquisition system (SCADA).

16.6. CABLES AND WIRE

Input power shall be supplied at 415 V AC and 110 V DC. It shall be available from LT switchgear and DC distribution boards (DCDB).

All control wirings inside control panel shall be carried out by the supplier with 1.1 kV grade, 1.5 mm^2 PVC insulated flexible copper wires as per IS 1554.

16.7. PORTABLE FIRE EXTINGUISHER

Portable 5 kg capacity CO_2 type, 9 liter capacity foam type and dry chemical type fire extinguishers shall be installed at strategic locations of the power house. These shall conform to latest versions of relevant standards. The min. number of portable fire extinguishers shall be as mentioned below:

- CO_2 type : Fifteen (15) nos.
- Dry chemical type : Fifteen (15) nos.
- Foam type : Four (04) Nos.

Each type of extinguisher shall be similar in shape and appearance and have the same method of operation. The capacities and number of such extinguishers required is given in schedule of requirements. In addition, minimum three (03) nos. of wheel mounted CO_2 type fire extinguishers shall also be provided.

16.8. FIRE PROTECTION SYSTEM FOR GENERATOR

Fire protection system of the generators shall be designed following the relevant standard and manufacturer's recommendation. The system shall be designed to extinguish the fire as early as possible based on the nature of fire (electrical) and personnel safety.

CO_2 type automatic fire fighting system, as per manufacturer's recommendation shall be used for generators. The system shall contain ANSI compliant 3 panel warning signs, manual lockout valves with audible and visible alarms.

Design of the complete fire protection system shall be finallised during detailed engineering stage.

16.9. TESTS

16.9.1. TYPE TEST

The contractor shall submit the type test reports of the equipment / items / materials / whole system as per relevant IS / IEC to the Employer at the detailed engineering stage. The type tests of similar rated items / equipment / systems shall be carried out from CPRI / NABL / Govt. approved Laboratories within ten (10) years from the date of this NIT Publication. The contractor may be required to furnish the original type test reports with test results, if desired by the employer.

16.9.2. COMMISSIONING CHECKS / SITE TESTS

Operational tests of the generator fire protection system in presence of the employer's representative shall be carried out following relevant Indian Standard / IEC.

All testing equipment, required for testing at site, shall be provided by the contractor at free of charge on returnable basis. In the event of repeated testing becomes necessary, the entire expenditure on such repeat tests shall be borne by the contractor.

All testing equipment shall have the up-to-date calibration certificate. The contractor needs to furnish the same to the employer prior to starting of testing at site as well as at manufacturer's works, whatever the case may be.

16.10. DOCUMENTS TO BE SUBMITTED AFTER PLACEMENT OF LOA

- Name of manufacturer proposed by the contractor for each item / equipment as per **Cl. No. 16.12**.
- Performance certificates of proposed manufacturers as per **Cl. No. 16.13.**
- All Type test reports of each similar rated products of the proposed manufacturer.
- Routine Test Report / Shop Test Report of each similar rated products of the proposed manufacturer performed earlier.

16.11. DOCUMENTS TO BE SUBMITTED DURING DETAILED ENGINEERING STAGE

Six (06) sets of data sheet, manual, leaflet, drawing and other documentation as mentioned below for Fire Protection System shall be submitted to the Controlling Officer of the employer for according approval during detailed engineering stage.

- Guaranteed Technical Particulars (GTP) as per **Chapter – 20 (Cl. No. 20.15)**.
- Calculations and justification for selecting pump rating, designing the locations and numbers of temperature sensing elements and projectors for the system.
- Drawing showing layout for water piping indicating the size of pipes.
- Design of Generator fire fighting system.
- Plan and Sectional Views showing the General Constructional Features for various equipment.
- Fire alarm system design.
- Electrical wiring drawing, installation drawings of various equipment.
- Detailed time schedule indicating submission of drawings, delivery of items, installation, testing, trial run & commissioning.
- Detailed Bill of Material (BOM) which shall include the spare parts for five (05) years of trouble-free operation & maintenance of the above system as per **Cl. No. 19.13** and special tools, plants and equipment as per **Cl. No. 19.15.**
- Detailed Quality Assurance Plan (QAP) for field acceptance test.
- Manual for installation, operation and maintenance procedure.

After approval, six (06) sets of approved drawings and documents along with soft copies for Fire Protection System shall be submitted to the controlling officer of the employer.

16.12. MAKE OF COMPONENTS

The contractor shall submit proposed make of various bought out components of Fire Protection System after placement of LOA. Final make shall be approved by the employer during detailed engineering stage based on the performance certificates submitted by the contractor.

16.13. CREDENTIALS AND PERFORMANCE CERTIFICATES

The contractor shall submit Performance Certificates issued to the proposed manufacturers by the respective employer for similar kind of job. The contractor shall also furnish documents in support of supply, delivery of similar equipment / system indicating thereon names of the organization, quantity ordered and quantity supplied along with their submission after placement of LOA. Non-submission of the same will be liable for rejection of the proposed manufacturers.

16.14. GUARANTEE

Guarantee of the total equipment including any integral part of the equipment should be up to Defect Liability Period of the project.

16.15. COMPLETENESS OF EQUIPMENT / SYSTEM

All items, equipment, fittings and accessories etc. for any specified equipment / system that may not be specifically mentioned in the specification but necessary for completeness of the system shall be deemed to be covered under the scope of this contract. No extra charges will be paid to the contractor for the same.

16.16. SCHEDULE OF REQUIREMENTS

Sl. No.	Description	Quantity
1	Fire Fighting system for the generators as per **Cl. No. 16.8**	As required
2	Complete set of portable 5 kg CO_2 type fire extinguishers	As required
3	Complete set of portable 9 Liter foam type and dry chemical type fire extinguishers	As required
4	Special tools plants and equipment as per **Cl. No. 19.15**	As required
5	Spare parts as per **Cl. No. 19.13**	As required
6	Completeness of equipment as per **Cl. No. 16.15**	As required

17. COMMUNICATION, SUPERVISION AND SURVEILLANCE SYSTEM

17.1. SCOPE

This section of the specification covers design, engineering, quality assurance, manufacture, transport, transit insurance, supply, delivery to site, storage at site, system integration, erection, testing, trial run, and commissioning of the Communication System (Public Address System, Micro-processor based EPABX System etc.) and CCTV System (for Supervision and Surveillance) with all required accessories for Lodhama II SHEP.

The contractor's responsibility shall include but not limited to supply all the active devices, passive components, other hardware and software items and any additional materials not specifically mentioned in this chapter, but required for successful operation of the system.

The scope of supply shall also include special tools and testing devices, which are essential for installation, operation and maintenance for five (05) years trouble free operation of the system, even though these are not individually or specifically stated in this specification but recommended by the respective manufacturers. All the material & workmanship shall be of suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

17.2. COMMUNICATION SYSTEM

17.2.1. STANDARDS

The system and equipment shall be designed, built, tested and installed in accordance with latest version of applicable Indian standards or equivalent international standards viz.

Sl. No.	Standard	Description
1	IEC: 60065	Audio, video and similar electronic apparatus – Safety requirements
2	IS: 10426	Specification for public address amplifier
3	IS: 1881	Code of practice for indoor installation of public address system
4	IS: 1882	Code of practice for outdoor installation of public address system
5	IS: 9302	Characteristics and method of measurement for sound systems equipment
6	IEC: 62326-1	Printed Boards
7	IEC: 60445	Basic and safety principles for man-machine interface, marking and identification – Identification of equipment terminals, conductor terminations and conductors
8	IEC: 60478	Stabilized power supplies, DC output
9	IEC: 60870-5	Tele-control equipment and systems

17.2.2. SCOPE OF WORK

a) Public address system comprising of:
- Master Control Station (MCS) including microphone and all accessories required for the system
- Central control equipment consisting of Central switching system (CSS), Central paging control and amplifier rack, preamplifier, power amplifiers and all required accessories
- Field handset stations consisting telephone set with wall / column / structure mounting arrangements etc.
- Loud speakers with wall / column / structure mounting arrangements
- Head microphones

b) Microprocessor based (digital) EPABX system comprising of:
- 32 lines EPABX system for the power house area
- 8 lines EPABX for the barrage area
- UPS for power house and switchyard areas
- Minimum ten (10) nos. of telephone sets
- Sockets / telephone jacks for the telephone wiring network
- The telephone cabling system

17.2.3. SPECIFIC PARAMETERS AND LAYOUT CONDITIONS

a) The major areas of coverage are as follows:
- Power house machine hall floor including service bay area
- Control room
- Office room
- Conference room
- DG set room
- Staircase
- Entrance gate
- Store room
- Workshop
- Outdoor transformer yard
- Any other area not specified shall be decided during detailed engineering stage

b) The communication system shall consist of zones, sub-zones and exchanges to interface all these zones among themselves and with Employer's existing telephone exchange.

c) The entire system shall comprise of Public Address system and EPABX System.

d) The Power house complex including transformer yard shall be provided with Public Address system as well as EPABX system.

e) The main panel of the public address system shall be located at power house control room (preferably) or some specific location of power house complex and shall be connected to EPABX exchange.

f) All the cabling necessary for installation & commissioning of entire communication system including telephone cabling shall be included in the scope. Optical fibre link shall be used for interconnections of EPABX system of Power house and transformer yard for communication between the two locations, the details of which shall be finalised during detail engineering stage.

g) The loud speakers, the head microphones, the call station connecting points and the other telephone connecting points shall be located at various points.

h) The system shall be adequately protected from signal and power line noise and meet the surge withstand capability requirements of ANSI C37.90 A / IEEE standard 472-1989 equivalent.

17.2.4. RATING AND FUNCTIONAL CHARACTERISTICS

Capacity and bandwidth (± 3 dB) for wall / column mounted horn type loudspeakers shall be at least 15 W (rms) and 500 – 4500 Hz respectively.

Capacity and bandwidth (± 3 dB) for wall / column mounted cone type loudspeakers shall be at least 4 W (rms) and 100 – 7000 Hz respectively.

17.2.5. PUBLIC ADDRESS SYSTEM

a) General

Public address system shall be a microprocessor controlled software programmable, centralized amplifier based system.

b) Page Channel

This provides loud speaking facility and is used to broadcast / announce messages, instructions and to locate field people in the plant. The loudspeakers can be arranged in different groups and the announcements can be made either in individual group or all groups.

c) Master Control Station (MCS)

Master Control Units shall be microprocessor based and of modular design. It shall be desktop type construction and installed in the control room.

The MCS shall be comprised of the at least following:

- Two (02) dynamic microphones
- All zone / Individual zone selection switches
- Field paging 'ON' indication
- Siren access
- Press to talk switch
- Digital display for identification of calling station number and area name
- Dial key pad
- Function keys (programmable for different features of the system like call answer, call transfer, call release, call end, call hold, call wait, memory dialling, Redial etc.)
- Hands free dialling
- Monitor the functionality and status of individual field handset stations
- Automatic fire alarm tone generation

It shall possible that during an emergency, control room operator can broadcast siren / alarm tone in selected or all zones. Control room operator shall have page priority over the paging from field.

d) Central Control Equipment

Central control equipment shall be located in the Control Room.

Central Switching System (CSS):

CSS shall be in non-blocking architecture and based on TDM / PCM technology or state of art technology which shall have improved speech quality, the noise interference and the distortion is reduced to minimum.

Central Paging Control and Amplifier Rack:

The racks shall be designed for free floor standing. The system shall have high reliable amplifiers with built in protection circuitry. The system shall be provided with standby amplifier with changeover circuitry to ensure continuous operation at all times. The system shall have provision in the amplifier for further expansions to meet the requirements. The rack shall have preamplifier with built in mic. and aux. input, Control panel, Power supply unit, Individual / all zone selection switch, Chime module, siren access, Priority matrix, etc.

Central paging control and amplifier rack shall have solid state, Class B, Push – Pull type Power amplifiers fully conforming to IS: 10426 or equivalent international standard.

Total harmonic distortion shall be less than 1% at rated output at 1 kHz, Signal / Noise ratio shall be 60 dB.

All the heat generated devices shall be operated well within their rated limits to minimize the thermal stresses. The temperature sensors shall be provided on the heat sinks to monitor the temperature. The Amplifier shall be comprised of at least following minimum features:

- Mains power supply
- Mix and match capabilities
- Adjustable sensitivity as volume control with facility for coarse and fine setting
- Bass and treble control
- Electronic protection

e) Field Handset Stations

The field handset station shall be weatherproof and located / installed at multiple locations in the indoor and outdoor field. These shall be wall / column / structure mounted. The minimum quantities of field handset station shall be eight (08), however, the exact quantity shall be finalized during detail engineering based upon the requirements.

The handset stations in the noisy areas shall be housed in acoustic hoods. The design noise level within the hood shall be limited to a maximum of 60 db SIL. Handset transmitter / microphone shall be noise cancelling type for effective communication from noise areas. The handset shall consist of push button type keys, handset cord and external canopy in fibre for extra protection. Handset transmitter / microphone shall have filters to protect from dust. The weatherproof station for outdoor areas shall be made of corrosion resistance aluminium alloy.

f) Loudspeaker

The loudspeaker shall be weatherproof and located / installed at multiple locations in the indoor and outdoor field. These shall be wall / column / structure mounted. The minimum quantities of cone & horn loudspeakers shall be eight (08) & five (05) respectively,

however, the exact quantity shall be finalised during detail engineering stage based upon the requirements.

Loudspeaker shall have control switch to vary the loudspeaker output. Its cabinet shall be treated with acoustic under-coats to prevent resonance.

g) Junction Boxes

Junction boxes shall be used for connecting field handset stations, loudspeakers, etc from central equipment. The Junction box shall be constructed with suitable locking arrangement. All junction boxes shall have minimum 20% spare terminals for future requirements. Junction box shall be of 4-way type having opening on each side. The degree of protection shall be minimum IP-42. Disconnecting (sliding) cage clamp type terminal blocks shall be provided, to facilitate testing and maintenance without disconnecting the cables.

17.2.6. EPABX SYSTEM

a) General

The EPABX system shall be fully automatic microprocessor based, stand alone modular system with one touch line / feature selection and flexible user friendly programmable push buttons. The system shall support full duplex voice and data transmission on a twisted pair line. The system shall have redundant power supply in hot swappable redundant mode without call drops.

The EPABX system of Power house area shall have at least eight (08) subscriber ports with future expandability of another four (04) ports. The EPABX system of switchyard area shall have at least two (02) subscriber ports with future expandability of another one (01) port. Each EPABX system shall have minimum eight (08) line port (P&T) and OLTE card for termination of optical fiber line. The EPABX system at Power House shall be integrated with the public address system.

The type and standard shall be submitted by the contractor during detailed engineering stage for approval.

EPABX system shall be provided with at least following features:

- P&T line connectivity
- PA system connectivity
- Call transfer
- Call back
- Call forwarding
- Account code,
- Group calling
- Conference facility
- Automatic voice prompt facility
- Messages wait lamps etc.

Telephone sets with at least following features shall be provided:

- Re-dialing
- Adequate memory for storage of minimum 10-15 numbers
- Hands free answer & dialling
- minimum two line display CLI etc.

The available power supply for the EPABX system shall be 415V AC. The required voltage level for EPABX system shall be arranged by Contractor through suitable converters. EPABX system shall be connected with Plant DC system through converters and associated accessories to maintain the supply in case of power failure.

b) Telephone Network

Control rooms, offices, conference room, switchgear room, store room, workshop, transformer yard etc. shall be equipped with sockets for the telephone network. The type and standard shall be submitted by the contractor during detailed engineering stage for review approval.

The number of points shall be according to the following:

- At least one (01) telephone outlet for every seven (07) meter in office area or two (02) outlets, whichever is higher
- At least one (01) telephone outlet for every seven (07) meter in control room area or three (03) outlets, whichever is higher
- At least one (01) telephone outlet for every ten (10) meter in all other area.
- One (01) outlet in each switchgear and panel area

The design and construction of the telephone network and that of Public address and communication system shall be finalized during detailed engineering stage.

c) Terminal Equipment Design

The control equipment and telephone sockets shall comply with the standards that are currently used in the country and shall bear a Conformity Mark. The standards selected for the system shall be mentioned by the contractor during detailed engineering stage.

In the offices and facilities, the equipment shall either be embedded, or mounted directly on the wire way.

17.2.7. CABLES

Cables for use in communication shall be of FRLS PVC sheathed cables and shall conform to latest edition of Indian / International standards.

Cables shall be suitable for installation as follows:

- Above ground in open air location (tray / ducts) in tropical, humid and corrosive atmosphere prevalent in power plant
- Direct buried in underground trenches conduits with uncontrolled back fill and possibility of flooding by water and chemicals
- Laid underground in RCC lined cable trenches with possibility of flooding by water

17.3. SUPERVISION AND SURVEILLANCE SYSTEM

17.3.1. GENERAL REQUIREMENTS

The whole system shall be installed in such a way that all the plant area especially the machines and panel area in the power house as well as transformer yard which may cause fire or may heavily be damaged due to any hazard that may occur during plant operation, control room in the power house complex, boundary, plant entry are covered.

The system shall be monitored from the control room of the power house. Necessary arrangements for the same shall be within the scope of this Contract.

Design and selection of the equipment should be such that it should meet the requirements of long term trouble free operation with highest degree of reliability and performance. All the equipment shall be constructed to operate safely without overheating, vibration, wear and tear, corrosion, electromagnetic interference or any kind of similar problems. If any special precaution is to be taken in order to avoid these, the same has to be considered by the contractor during detailed design.

The CCTV system network design, equipment election and system implementation should also concentrate on flexibility of future expansion and maintainability without much hassle.

17.3.2. TECHNICAL SPECIFICATION FOR CCTV ITEMS

a) PTZ High-Speed Camera 35X

The cameras shall have pan, tilt and zoom (PTZ) feature suitable for indoor and outdoor surveillance. The cameras shall have 360 degree PAN coverage and 35x or more optical zoom capability. The cameras shall work on 230 V AC voltage / DC / Power over Ethernet (PoE). The camera shall have options for privacy zone masking, auto flip, day / night functionality.

Sl. No.	Parameter	Specification
1	Make	SONY, Bosch, Pelco, Infinova, Honeywell, Panasonic
2	Pick-up device	¼ "format CCD / CMOS image sensor Camera
3	Zoom	35X optical 12X digital zoom
4	Active Pixels	752 x 582
5	Shutter Speed	½ s to 1/10000 s
6	Backlight compensation	Required
7	White balance	Automatic with manual override
8	Pan angle	360 degree
9	Pan speed	0.3°/s-100°/s or above (proportional zoom ratio)
10	Tilt angle	- 90 to 0 degree
11	Compression	H .264
12	Compression frame rate	25/30 fps for H .264
13	Interface	10 Base-T / 100 Base-Tx (RJ-45)
14	Operating temperature	0 to 50° Celsius
15	Clear Visibility /Distance	200 Meters Both Side
16	ZOOM SPEED	Approx. 4.0 sec. (Optical WIDETELE)
17	Lens type	Auto focus zoom lens
18	Focal length	F = 3.4 to 119 mm
19	Protocols	TCP /I P, HTTP, ARP, ICMP, RTP/RTCP
20	Ethernet	10 Base-T / 100 Base-TX (RJ-45)

Sl. No.	Parameter	Specification
21	Minimum Illumination (at F 1.6, AGC ON and 50 IRE)	Color: 1.4 lux and for B/W: 0.15 lux
22	Presets	16
23	Approvals	CE, FCC, UL, IP-66 standards
24	Image setting	Wide dynamic range contrast , image stabilization, Text & Image overlay

b) Integral Network Box Camera

High resolution color camera shall be of day / night fixed box type suitable for indoor & outdoor surveillance. The camera shall work on 230 V AC voltage / DC/ Power over Ethernet (PoE).

Sl. No.	Parameter	Specification
1	Make	SONY, Bosch, Pelco, Infinova, Honeywell, Panasonic
2	Pick-up device	1/3 inch type CCD / CMOS Camera
3	Sensitivity	Color 0.5Lux @ F1.2 30 IRE B/W:- 0.01 Lux @F1.2 30 IRE
4	Active Pixels	1280 X 800
5	Interface	10 Base-T / 100 Base-Tx (RJ-45)
6	Video Standard	PAL / NTSC
7	Lens mounting	C / CS
8	Operating Temperature	0 °C to +50 °C
9	Shutter speed	1/25 s to 1/8000 s
10	Inbuilt web server	Required
11	Automatic Gain Control	Required
12	Automatic White Balance	Required
13	Back light Compensation	Required
14	Lens type	Vari-focal zoom lens
15	Horizontal view angle	32 - 74 degree
16	Focal length	F = 9 to 50.0 mm
17	Compression	H.264
18	Compression frame rate	25 / 30 fps
19	Audio compression	G.726/G.711
20	Protocols	TCP/IP, HTTP, ARP, ICMP, RTP/RTCP
21	Approval	CE, FCC; UL

Sl. No.	Parameter	Specification
22	Image setting	Wide dynamic range contrast , Image stabilization, Text & Image overlay
23	Housing	As per specs. of camera housing given separately

c) Housing Arrangement for Camera

Housing arrangement shall be designed for both outdoor and indoor use. It shall protect camera and lens combination. The housing arrangement shall have the following minimum technical specifications and features.

Sl. No.	Parameter	Specification
1	Window	3 mm (0.12 inch) glass
2	Camera Mounting	Removable camera / lens tray, mounted with two screws.
3	Construction	Aluminum housing casing, neoprene gaskets, UV resistant polymer end caps, and all stainless steel hardware.
4	Tamper resistance	Tamper-resistant screws for locking clasps shall be provided.
5	Enclosure Protection	IP-66, NEMA-4 or better
6	Approvals	UL or EN and FCC

d) Server

Sl. No.	Parameter	Specification
1	Make	IBM/ DELL/ HP
2	Chassis	Rack Mountable (1U)
3	CPU	2 X Eight Core Intel Xeon processor E5 Series with minimum 2.0 GHz speed or higher.
4	Motherboard	Intel Chipset with Intel E5-2600 Processor Family
5	Memory	64 GB DDR3 Registered (RDIMM) memory @1333 MHz or more and scalable up to 384 GB.
6	Bays	Upto 8 Hot Plug 2.5" hard drive bays / 6 Hot Plug 3.5" hard Disk Bays + CD ROM / DVD Bay
7	Hard disk drive	2 X 500 GB NL-SAS or SATA Hot plug 2.5" HDDs
8	Controller	SAS/SATA Raid Controller with RAID 0/1/1+0/5
9	Networking features	4 Nos. of Multifunction Gigabit Ethernet Ports with TCP/IP offload engine and iSCSI feature
10	Ports	USB 3.0 support With 5 total ports
11	Optical drive	DVD / CD-RW combo drive

Sl. No.	Parameter	Specification
12	Power Supply	n + 1 Hot swappable Power Supplies for redundancy
13	OS Support	Microsoft Windows Server2012 Microsoft Windows Server 2008 R2 SP1, x64 (includes Hyper-V v2) Microsoft Windows Small Business Server 2011 Novell® SUSE Linux Enterprise Server Red Hat Enterprise Linux

e) Network Attached Storage (NAS) / RAID Storage Device

The system shall equip with 16 TB of NAS / RAID based storage device.

Sl. No.	Parameter	Specification
1	Make	IBM / DELL / HP
2	Controllers	Should have min single controller in active/active configuration with min 6GB memory per controller.
3	Operating System	Should have Operating System dedicated for serving data efficiently with high availability. Support for scale out architecture is preferred.
4	Protocol Support	Should support: CIFS, NFS, SNMP, Telnet, NTP, HTTP, FTP, iSCSI, (optional NDMP support or other mechanism for LAN free Backup). All required licenses should be provided.
5	Disk Type	Should support 10K & 15K RPM 6Gbps SAS, 7200 RPM NL- SAS. Optional support for flash drives.
6	Storage Capacity	Should consist of usable 16 TB disk space with single volume / name space in RAID6 with 2TB NL-SAS drives. Should support 3TB and higher capacity NL-SAS drives in future. Should clearly specify total disks considered and global hot spare disks considered.

f) Video Management Software (VMS)

The video management software with license shall enable management and control of live and recorded video. The system shall be easy to install, configure, maintain and provide all levels of security with intuitive and reliable control. This shall enable fast detection of potential threats and emergency event management and shall comply with the following requirements.

- Video Management Software shall be a highly scalable, enterprise level software solution. It shall allow for seamless integration of third party security infrastructure where possible. The system shall be capable of working on Windows OS and Windows Server platforms.

- The SOFTWARE shall allow for video to be streamed on a video mosaic wall.
- The Software shall have client licenses for at least four (04) users.
- The system shall allow operation with a PC keyboard and mouse.
- The SOFTWARE shall provide the following:
  - Automatic search and registration of cameras of proposed system on the network.
  - The system shall allow for live view, playback and system configuration of the IP video system.
  - The system shall allow for creation of multiple users and user groups and assign privileges to each user.
  - Several simultaneous live picture connections of camera in network.
  - It shall be capable of showing video pane layouts including 2x2, 3x3, and 4x4 up to min. 5x5.
  - It shall be possible to show text On Screen Display (OSD) when video is displayed on a Receiver. The OSD shall detail the camera name, number, date and time (in the time zone of the VIDEO Encoder)
  - User actions logged by time, locations, cameras
  - Administrator changes to the system settings logged
- The Software shall allow the following:
  - Live display of cameras
  - Live display of camera sequences
  - Control of PTZ cameras
  - Playback of archived Video at speeds of x1 – x16
  - Retrieval of archived Video using normal playback
  - Instant Replay of Live Video
  - Configuration of system settings
- PTZ Operations:
  - Each Camera and SOFTWARE shall be able to operate with PTZ protocols of the offered cameras.
  - Named presets (up to 16) shall be supported per camera, invoked from SOFTWARE.
- The software shall be capable of monitoring the status of camera in the network and shall indicate when a device goes offline by suitable red cross across the camera.
- The SOFTWARE shall have the following facilities:
  - Shall support 25 Video streams concurrently on a work station
  - Shall allow 25 cameras to be replayed simultaneously from one NVR
  - Shall have facilities for play, forward, rewind, pause along with fast forward and rewind for reviewing the recorded videos
  - Shall be capable of 5 X 5 viewing panes
- Video export: Video clips shall be exportable in standard formats like AVI / WMV / MP4 etc.

g) Floor Mount Networking Rack

Floor mount networking rack (Width: 600 mm & Depth: 1000 mm, Make – APW President, Valrack, Rittal) with following accessories shall be provided.

- Front Glass Door with lock
- Rear Steel Door with venting option & lock
- 1U Fan tray with 4 Fans
- AC Mains Channel – 15 amp*4 & 5 amp*8 (IS Type).With power indicator and fuse / MCB
- Castors with foot-operated breaks
- Hardware Front Panel
- Cable Manager
- 24 port RJ 45 patch panel (CAT-6)
- Equipment Tray – five (05) nos.

h) PC Work Station / Monitoring Console (Without Monitor)

Sl. No.	Parameter	Specification
1	Make	IBM / DELL / HP
2	Form factor	Small form factor or Desktop or Tower
3	CPU	1 * 3rd gen Intel Core processor i3, 3 GHz, 8 MB cache, 1333 MHz memory, Quad-Core, HT, Turbo or higher
4	Chipset	Intel® Q67 Express or higher
5	Memory	2 GB DDR3-1333 ECC memory scalable up to 32 GB
6	Memory Protection	ECC available on data, parity on address and command
7	Hard disk	1 * 2 TB SATA 7200 rpm 3Gb/s 3.5" HDD
8	Graphics	NVIDIA Quadro FX 380 LP 1GB PCIe Graphics Card with dual display port
9	Networking	Integrated Gigabit Ethernet Card with Management capabilities
10	Ports	4 USB 3.0 (2 in Front and 2 in Rear)
11	Other	Keyboard & optical scroll mouse
12	Optical drive	Internal DVD / CD-RW combo drive
13	Operating System	Windows7 64 bit OS with original CD / DVD media

i) Full HD LED Monitor

Sl. No.	Parameter	Required Feature
1	Make	Sony / Samsung / LG / Panasonic
2	Screen size	50"
3	Resolution	1920 x 1080
4	Contrast ratio	5000 : 1

Sl. No.	Parameter	Required Feature
5	Brightness	Min. 350 nits
6	Video Inputs	CVBS / Component / HDMI
7	Temperature	0 Deg to 40 Deg Celsius
8	Humidity	10 – 80 %
9	Other Features	This LED monitor will be used as monitor for PC workstation and shall have features to meet specified functional requirement of CCTV system

j) 12 Core Armoured OFC cable

Sl. No.	Parameter	Specification
1	Make	D-link / Molex / HFCL / Birla Ericson / Aksh Fibre
2	Type	Gel filled 12 fiber corrugated steel tape armored direct burrial cable for outdoor installation. The fiber type is a matched cladding Single mode Fiber dual coated with acrylate coating with gel filled The fiber is optimized for operation at 1310 nm and 1550 nm ITU-T Recommendation G.652D Low water peak
3	Geometrical Properties	
	Nominal Mode Field Diameter	9 um
	Mode Field Diameter Tolerance	+/- 10%
	Cladding Diameter	125 um
	Cladding diameter tolerance	+/- 1 um
	Diameter of outer coating layer	245 um (without coloring layer)
	Tolerance of coating layer diameter	+/- 10 um
4	Materials	
	Core	Germanium doped core with no phosphorous i.e. reduced tendency for hydrogen degradation
	Coating	UV-Curable dual layer acrylate coating which ensures excellent micro bending and abrasion resistance.
	Coating Strip Force	0.3 - 2.0 lbf

Sl. No.	Parameter	Specification
5	Optical Properties	
	Attenuation at 1310 nm	<= 0.36 db/km
	Attenuation at 1550 nm	<= 0.22db/km
	Cut-off wave length	<= 1265nm

k) Other Items

- 24 port managed layer 3 switch With 12 SFP Port & 12 Fiber Port with Module
- 8 port, 10/100/1000 Layer 2 Managed Network Switch
- 8 Port Industrial Switch
- Cat-6 -STP Cable Box
- Power Cable
- Splicing machine (Portable)
- Optical Time Domain Reflectometer (OTDR – Portable) -OFC testing instrument
- Cable laying
- Any other item / equipment requirement for completeness of the system

17.4. COMMISSIONING CHECKS / SITE TESTS

The contractor shall provide a comprehensive quality assurance plan (QAP) to cover the acceptance test as proposed to be conducted. The intent of the acceptance test shall be to demonstrate that the communication system and the supervision and surveillance system are performing all the requisite functions correctly and reliably as indicated in this specification. The QAP for acceptance test shall be subjected to employer's approval.

On completion of installation of the communication system and the supervision and surveillance system by the contractor, each item of the systems as well as the integrated network as a whole shall be thoroughly inspected and tested by the employer's representative for the correctness and completeness of the installation. For this contractor shall be required to submit all the test report that may be asked for and demonstrate any feature or configuration as per the specification. This test shall include testing of all sub-systems individually for the acceptance level of various parameters for system reliability, availability and maintainability.

The acceptance test shall include all reasonable exercises which the combination of the equipment, the software and different configuration that can be expected to perform in actual uses. The communication system and the supervision and surveillance system shall be rejected if any portion of the system or sub system is not functioning satisfactorily. The Employer shall have the right to reject the system and ask for replacement if the communication system and the supervision and surveillance system fails this tests.

17.5. DOCUMENTS TO BE SUBMITTED AFTER PLACEMENT OF LOA

- Name of manufacturer proposed by the contractor for each item / equipment as per **Cl. No. 17.7**.
- Performance certificates of proposed manufacturers as per **Cl. No. 17.8.**
- All Type test reports of each similar rated products of the proposed manufacturer.

17.6. DOCUMENTS TO BE SUBMITTED DURING DETAILED ENGINEERING STAGE

Six (06) sets of data sheet, manual, leaflet, drawing and other documentation as mentioned below for Communication, Supervision & Surveillance System shall be submitted to the Controlling Officer of the employer for according approval during detailed engineering stage.

- Guaranteed Technical Particulars (GTP) as per **Chapter – 20 (Cl. No. 20.16)**.
- Detailed layout of the system and complete assembly drawings.
- Control and electric wiring diagrams.
- Technical Data of various equipment of the system.
- Calculation for echo sound generated in the powerhouse and design calculation for selecting number of loudspeaker with power output for communication system.
- Detailed time schedule indicating submission of drawings, delivery of items, installation, testing, trial run & commissioning.
- Detailed Bill of Material (BOM) which shall include the spare parts for five (05) years of trouble-free operation & maintenance of the above system as per **Cl. No. 19.14** and special tools, plants and equipment as per **Cl. No. 19.15.**
- Detailed Quality Assurance Plan (QAP) for field acceptance test.
- Manual for installation, operation and maintenance procedure.

After approval, six (06) sets of approved drawings and documents along with soft copies for Communication, Supervision & Surveillance System shall be submitted to the controlling officer of the employer.

17.7. MAKE OF COMPONENTS

The contractor shall submit proposed make of various bought out components of Communication, Supervision & Surveillance System after placement of LOA. Final make shall be approved by the employer during detailed engineering stage based on the performance certificates submitted by the contractor. For approved makers list of WBSEDCL for various components, the bidders are requested to go through **Chapter – 17** and **Chapter – 21** of this Technical Specifications.

17.8. CREDENTIALS AND PERFORMANCE CERTIFICATES

The contractor shall submit Performance Certificates issued to the proposed manufacturers by the respective employer for similar kind of job. The contractor shall also furnish documents in support of supply, delivery of similar equipment / system indicating thereon names of the organization, quantity ordered and quantity supplied along with their submission after placement of LOA. Non-submission of the same will be liable for rejection of the proposed manufacturers.

17.9. GUARANTEE

The Contractor shall guarantee the reliability and performance of individual equipment of the communication, supervision and surveillance system as well as of the complete system. Guarantee of the total equipment including any integral part of the equipment should be up to Defect Liability Period of the project.

17.10. COMPLETENESS OF EQUIPMENT / SYSTEM

All items, equipment, fittings and accessories etc. for any specified equipment / system that may not be specifically mentioned in the specification but necessary for completeness of the system shall be deemed to be covered under the scope of this contract. No extra charges will be paid to the contractor for the same.

17.11. SCHEDULE OF REQUIREMENTS

Sl. No.	Description	Quantity
A	**Communication System**	
A.1	Complete public address system	As required
A.2	Complete microprocessor based (digital) EPABX system	As required
B	**Supervision and Surveillance System**	
B.1	Complete supervision & surveillance system as mentioned in this specification	As required
B.2	Special tools, plants and equipment as per **Cl. No. 19.15**	As required
B.3	Spare parts as per **Cl. No. 19.14**	As required
B.4	Completeness of the system as per **Cl. No. 17.10**	As required

Minimum Requirements of CCTV Cameras			
Sl. No.	**Location**	**Camera Type**	**Quantity**
1	Machine hall floor & service bay	PTZ	Six (06) Nos.
2	Transformer yard	PTZ	Two (02) Nos.
3	Entry of the plant	PTZ	One (01) No.
4	Control room	Box	One (01) No.
5	Switchgear room	Box	One (01) No.
6	Office room	Box	One (01) No.
7	DG & Station Auxiliary Transformer room	Box	One (01) No.
8	Battery Room	Box	One (01) No.
9	Store room	Box	One (01) No.
10	Workshop	Box	One (01) No.

18. WORKSHOP

18.1. STANDARDS

The system and equipment shall be designed, built, tested and installed following the latest version of the applicable standards. In the event of other standards being applicable, those shall be compared for specific requirement and approved during detailed engineering for the purpose.

18.2. RATING AND FUNCTIONAL CHARACTERISTICS

Unless otherwise stated, rating, characteristics, test and test procedures, etc. of the workshop equipment shall comply with the provisions and requirements of the latest applicable International / Indian Standards.

18.3. SPECIFIC PARAMETERS AND LAYOUT CONDITIONS

An workshop has been proposed adjacent to the service bay within the power house to meet the requirements of power house operation and maintenance works. This workshop shall be equipped with measuring and testing tools and devices as elaborated below.

The scope of work shall also include store room which shall also be located adjacent to the service bay area as indicated in the plant general arrangement drawing to safely store the mandatory spare parts to be delivered under this scope of contract.

Necessary electrical connections with protections shall be provided in both rooms.

18.4. ELECTRICAL WORKSHOP

18.4.1. SCOPE OF WORK

Brief scope of work under this system is mentioned below:

a. Measuring devices as defined in **Cl. No. 18.4.2**
b. Testing devices as defined in **Cl. No. 18.4.3**
c. Workbenches, lockers and instruments as defined in **Cl. No. 18.4.4**
d. Any other item(s) not mentioned specifically but necessary for the satisfactory completion of the scope of work as defined above.

18.4.2. MEASURING DEVICES

Following items shall be supplied with all accessories, carrying cases, connecting leads, power supply unit / cells etc. necessary for operation.

A. One (01) no. of **5 kV Insulation Resistance Testers** having following ratings:

- Accuracy: ± 5 %
- Range: 100 kΩ to 15 TΩ at variable test voltage from 50 V to 5 kV
- Digital display
- Automatic IR & PI display
- RS 232 & USB interface facility, Memory for storage of results

- Battery rechargeable with 230 V, 50 Hz AC supply

B. Two (02) nos. of **Digital Multi-meter** for AC and DC having following ratings:

- Accuracy:
  a) DC : ± 1%,
  b) AC : ± 1.5%
  c) Ohm : ± 1%.
- Ranges:
  a) Voltage : 60 mV to 1000 V in several steps,
  b) Current : 1.5 mA to 30 A in several steps,
  c) Resistance : upto 50 kΩ
- Continuity audible test
- Diode test, capacitance measurement, frequency measurement
- Hold display features
- Overload protection

C. Laboratory Connection Leads, suitable for all specified instruments, with vulcanized banana plugs on both ends, high-flexible, 1.1 kV, 1.5 mm^2 Cu and having following ratings:

- Five (05) leads of each black, green, red, yellow and blue having length 0.5 m
- Five (05) leads of each black, green, red, yellow and blue having length 1.5 m
- One (01) ring (100 m) laboratory cable 1 x 1.5 mm^2 Cu
- Twenty (20) banana plugs.
- Twenty (20) test clips fitting to banana plugs

D. Two (02) nos. **Phase Sequence Indicators** having following ratings:

- Voltage : 100 to 500 V
- Terminals marked with : L1, L2, L3
- Frequency : 15 to 400 Hz

E. Two (02) nos. portable **Digital Frequency Meters** having following ratings:

- Accuracy Class : 0.5,
- Rated voltages : 5 V to 550 V,
- Ranges : 40 to 60 Hz,

F. One (01) no. contact type portable **Temperature Measuring Instrument** with sensor and batteries, having following ratings:

- Accuracy : ± 0.5 % reading,
- Range : – 50°C to + 210°C in several steps,
- Setting time : maximum 3 seconds,
- Necessary interface for PC communication

G. One (01) no. of **Stopwatch**

18.4.3. TESTING DEVICES

A. Transformer Oil Testing Devices

- One (01) no. **High Voltage Insulation Oil Testing Device**, which shall be an automatic testing device, freely programmable, for execution of test specifications according to IEC / VDE or other international test standards, complete with all accessories, suitable for:

  Test voltage : 0 to 100 kV AC,

  Connection voltage : 230 V, 50 Hz.

B. Tools and Devices

- One (01) no. of hydraulic crimping machine for crimping all sizes of power cables used for this plant
- Three (03) sets of tools, screw driver, drillers, wrenches and pliers
- Two (02) nos. of short filled nylon headed mallets
- One (01) no. of silica gel drying oven of stainless steel, temperature range 60°C to 240°C
- One (01) no. of motor winding drying oven for drying the windings of the motors having ratings up to 50 kW
- Two (02) vacuum cleaners of 1000 W
- One (01) trolley mounted vacuum cleaner of 2500 W
- Three (03) sets of electric nut tighteners for all sizes
- Two (02) sets of portable type silt measuring instruments
- Two (02) Hot Air Blowers having following ratings:

  Power input : 1500 W

  Temperature control : 15^0 / 560^0C

  Air flow : 400 to 450 litre / min
- One (01) no. of pressure transmitter
- One (01) no. of differential pressure transmitter
- One (01) no. of resistance measurement instruments (bridge principle) for Pt 100
- Three (03) nos. of portable Hygrometers
- One (01) set of DC shunt for measurement of DC current

18.4.4. WORK BENCHES, LOCKERS AND INSTRUMENTS

A sufficient number of workbenches, tool lockers, racks, shelves and dust proof instrument boards shall be delivered and installed to allow executing all works in the electrical and electronic workshop and to store the tools, measuring and testing devices. The following minimum equipment shall be provided with this scope of contract:

i. One (01) no. of **Universal Laboratory Workbench**

The universal laboratory steel workbench with a stainless steel table top and four drawers (lockable) shall be equipped with a top mounted instrument and current supplying board. The metal enclosure of the instrument board shall be composed of sheet steel with a minimum thickness of 2.5 mm. The board shall be dust and vermin

proof. It shall be completely equipped, wired and painted and shall have a rated insulation level in accordance with the applicable IEC / VDE standards.

The power supply units shall be provided with:

- Four (04) nos. double sockets, 230 V, 50 Hz, each equipped with MCB and signal lamp
- One (01) no. power socket, 3 x 415 / 240 V, 50 Hz, with MCB and signal lamp
- One (01) bushing connection, 3 x 415 / 240 V, 50 Hz (L1/L2/L3/N) with three (03) signal lamps, three (03) voltmeters and three (03) ammeters and MCB
- One (01) bushing connection, 240 V, 50 Hz, 5 A, with voltmeter, ammeter, signal lamp and MCB
- One (01) bushing connection +24 V / 0 V / -24 V DC, 2 A, with two (02) voltmeters, two (02) ammeters, two (02) signal lamps and MCB
- One (01) bushing connection, 0 to 30 V DC, 0 to 1.5 A, voltage and current controlled, with voltmeter, ammeter, signal lamp and MCB
- One (01) bushing connection, 0 to 240 V, 50 Hz, steep less adjustable by means of a handle with scale, with voltmeter, ammeter signal lamp and MCB
- One (01) main power MCCB, three-pole, hand operated, 100 A

ii. Four (04) nos. of **Storage Locker** cabinets of appropriate size each having six (06) lockers of at least 305 mm x 380 mm x 457 mm size

iii. Five (05) nos. of **Tool Storage Cabinets** of sheet steel construction each with at least six (06) numbers full extension lockable drawers. The overall size of each unit shall not be less than 1000(H) mm x 710(W) mm x 700(D)mm

iv. Four (04) nos. of **Chairs** suitable for workshops

v. Five (05) nos. of **Racks** each with six nos. shelves having overall 2500 mm (min.) height and 2000 mm length (min.)

18.5. MECHANICAL WORKSHOP

18.5.1. SCOPE OF WORK

Brief scope of work under this system is mentioned below. If any item(s) not mentioned specifically but necessary for the satisfactory completion of maintenance work, as per accepted standard(s) / best international practices, shall be deemed to be a part of this scope of work. The bidder shall consider minimum basic requirements of instruments for carrying out successful operation and maintenance of the plant and shall quote their price accordingly.

18.5.2. MECHANICAL WORKSHOP EQUIPMENT

a. One (01) no. of electrical hand drilling machine
b. One (01) no. of portable electrical drilling machines with magnetic base
c. One (01) no. of rectifier type welding machine
d. One (01) lot of hand tools and instruments
e. Workbenches, lockers and instrument etc.

18.5.3. ELECTRICAL HAND DRILLING MACHINE

Each drilling machine shall have drilling capacity of maximum 23 mm in steel. The drilling shall have overload protection and two (02) speeds electronic speed control. Each drilling machine shall be supplied with following.

- One (01) set HSS drills of best quality covering the whole drilling range
- One (01) spare drill jar socket
- One (01) spare key for drill jar socket

Weight of the machine shall not be more than 5 kg

18.5.4. PORTABLE MAGNETIC BASE ELECTRICAL DRILLING MACHINE

Portable magnetic electrical drill machines with variable speed shall be suitable for upto 32 mm diameter drilling capacity complete with all accessories.

Each drilling machine shall at least be supplied with:

- One(01) drill chuck of adequate size
- One (01) set of Morse Taper covering the drilling range of 2 - 32 mm
- One (01) set of drill bits of best quality covering the whole drilling range of 2 - 32 mm

18.5.5. RECTIFIER TYPE WELDING MACHINE

Thyristorised Welding machines with smoke eater each suitable for operation on 415V ± 10 %, 50 Hz ± 5 % power supply confirming to relevant standard with following specifications:

Rated welding current:	40 – 600 A
Rated Duty cycle:	60%
Class of insulation:	H

Each welding machine shall be provided with the following accessories / items:

- One (01) no. of twenty (20) meters, of extra flexible rubber covered electrode, copper cable with electrode holder attached
- One (01) set of gouging attachment for use with carbon gouging electrodes
- Two (02) nos. welding goggle
- Two (02) pair of hand gloves
- One (01) no. of head shield
- Twenty (20) nos. each spare lenses, plain and dark

18.5.6. HAND TOOLS AND INSTRUMENTS

Following hand tools of approved make shall be supplied:

- Two (02) sets of heavy duty alloy steel Ring-headed spanners of size M6 to M64 mounted on a wrench board or tool box
- Two (02) sets of heavy duty alloy steel open-headed spanners of size M6 to M64 mounted on a wrench board or tool box
- Two (02) sets of heavy duty alloy steel socket wrench (12 sides) of appropriate drive of the size M6 to M64 mounted in a wrench board or in a toolbox

- Two (02) sets of heavy duty alloy steel single headed ring spanner of size M24 to M64 mounted in a wrench board or in a tool box
- Two (02) sets of heavy duty alloy steel open ended slogging spanner of size M24 to M110 in a wrench board or in a tool box
- Two (02) sets of double acting wrench handles having drive sizes 1/4", 1/2", 3/4", 1" and 1½"
- Two (02) sets of heavy duty alloy steel sockets of various size for each of above drive sizes in a tool box
- Two (02) sets of universal joints and extensions of the size 100 mm, 200 mm, 300 mm of the drive sizes similar to above ratchets handles
- Two (02) sets of torque wrenches with adjustable torque setting for the above drive sizes
- Two (02) sets of torque multipliers with input of above drive sizes and output of corresponding next higher drive size
- Two (02) nos. of pneumatic wrench with torque adjustment for above drive sizes
- Four (04) Spirit levels (coarse and bubble type) (Accuracy min. 0.5 mm / meter)
- Two (02) nos. of digital thermometers
- Two (02) nos. of mechanical tachometer
- Outside micrometer (least count 0.01 mm)

Size (mm)	Mechanical
0 – 25	04
0 – 100	02
100 – 200	02
200 – 1000	01 no. each

(covering all the ranges in step of 100)

- Inside (stick) micrometer (least count 0.01 mm)

Size (mm)	Mechanical
10 – 100	02
50 – 200	02
50 – 1000	01
1000 – 5000	01

- Digital Vernier Calliper (least count 0.02 mm or better)

Size (mm)	Nos.
150	02
300	02

- One (01) set of mechanical height gauge for measurement upto 600 mm (accuracy +/- 0.05mm)
- Depth gauge (accuracy of +/- 0.04 mm or better)

Size (mm)	Mechanical
150	02
300	01

- Two (02) nos. of master level 200 mm (least count 0.02 mm/m)
- One (01) no. of square level 200 mm (lease count 0.02 mm/m)
- One (01) set of slip gauge (set of 87)

- Two (02) sets of 500 x 500 mm master surface plate
- One (01) set of 1000 x 1000 mm master surface plate
- One (01) set of roughness measuring instruments
- One (01) set of Straight Edge Camel Back 3000 mm
- Two (02) sets of filler gauge
- Hydraulic dead weight tester – for calibration of pressure measurement devices like pressure transmitters, pressure gauges & hydro testing of pipelines; overall range 1 – 2000 bar
- Suitable nos. of spares for EOT Crane and Hydraulic Jack, as approved

18.5.7. WORKBENCHES, LOCKERS AND INSTRUMENT

Workbenches, tool lockers, racks, shelves and dust proof instrument boards shall be delivered and installed, to allow executing all work in the mechanical workshop and to store the tools, the measuring and testing devices. As a minimum the following equipment shall be provided:

i. One (01) **Universal Laboratory Workbench** with a stainless steel table top and four drawers (lockable) shall be equipped with a top mounted instrument and current supplying board. The metal enclosure of the instrument board shall be composed of sheet-steel with a minimum thickness of 2.5 mm. The board shall be dust and vermin proof. It shall be completely equipped, wired and painted and shall have a rated insulation level in accordance with the applicable IEC / VDE standards. It shall have the following:
   - One (01) hydraulic hand pump
   - One (01) service water connection
   - One (01) service air connection
   - One (01) electric 240 V AC outlet
   - One (01) bench vice.

ii. Four (04) **Storage Locker Cabinets** of appropriate size each having six (06) lockers of at least 305 mm x 380 mm x 457 mm size,

iii. Four (04) **Tools Storage Cabinets** of sheet steel construction each with at least six (06) numbers full extension lockable drawers. The overall size of each unit shall not be less than 1000 (H) mm x 710 (W) mm x 700 (D) mm.

iv. Six (06) **Racks** each with six nos. shelves having overall 2500 mm (min.) height and 2000 mm length (min.)

v. Four (04) **Machine Tool Cabinets** with full extension lockable drawers and doors in sheet steel construction. The overall size of each unit shall not be less than 1600 (H) mm x 710 (W) mm x 770 (D) mm.

18.6. DOCUMENTS TO BE SUBMITTED DURING DETAILED ENGINEERING STAGE

The Contractor shall submit all the drawings, documents,

- Guaranteed Technical Particulars (GTP) as per **Chapter – 20 (Cl. No. 20.17)**.
- Name of manufacturer proposed by the contractor for each item / equipment as per **Cl. No. 18.7**.
- Performance certificates of proposed manufacturers as per **Cl. No. 18.8.**

- All Type test reports of each similar rated products of the proposed manufacturer.
- Detailed time schedule indicating submission of drawings, delivery of items, installation, testing, trial run & commissioning.
- Detailed Bill of Material (BOM) which shall include the spare parts for five (05) years of trouble-free operation & maintenance of the above system as per **Chapter – 19** and special tools, plants and equipment as per **Cl. No. 19.15.**
- Detailed Quality Assurance Plan (QAP) for field acceptance test.
- Operation guideline, safety precautions, drawings, guarantee of individual equipment of approved make
- Any other documents as desired by WBSEDCL.

18.7. MAKE OF COMPONENTS

The contractor shall submit proposed make of various bought out components of Electrical and Mechanical Workshop after placement of LOA. Final make shall be approved by the employer during detailed engineering stage based on the performance certificates submitted by the contractor.

18.8. CREDENTIALS AND PERFORMANCE CERTIFICATES

The contractor shall furnish documents in support of supply, delivery of similar equipment / system indicating thereon names of the organization, quantity ordered and quantity supplied along with their submission after placement of LOA. Non-submission of the same will be liable for rejection of the proposed manufacturers.

18.9. DELIVERY, INSTALLATION, DEMONSTRATION AND TRAINING

The contractor shall deliver, safely store / install individual equipment as mentioned in this specification and demonstrate the operations of the equipment. The contractor shall also train employer's personnel for the operations and safety precautions.

18.10. GUARANTEE

The electrical and mechanical workshop equipment along with all auxiliaries and accessories shall be capable of performing intended duties under specified conditions. The Contractor shall guarantee the reliability and performance of the individual equipment as well as of the complete system. Guarantee of the total equipment including any integral part of the equipment should be up to Defect Liability Period of the project.

18.11. SCHEDULE OF REQUIREMENTS

Sl. No.	Description	Quantity
1	Electrical Workshop equipment as per **Cl. No. 18.1**	As required
2	Mechanical Workshop equipment as per **Cl. No. 18.1**	As required
3	Special tools, plants and equipment as per **Cl. No. 19.15**	As required
B.3	Spare parts as per **Chapter – 19**	As required

19. MANDATORY SPARE PARTS

19.1. GENERAL

All spare parts shall be suitably packed so as to protect against corrosion and degradation The supplied spare parts shall be marked with identification labels in the English Language. The identification shall be in accordance with the agreed Plant Identification System.

A list of minimum requirement of mandatory spare parts for the item(s) / equipment / system(s) for five (05) years of trouble-free operation & maintenance of the plant is provided in this chapter. The scope of supply under this contract shall include all spare parts, even though these are not individually or specifically stated in this specification but recommended by the respective manufacturers.

List of any additional spare parts, specifically not mentioned in the list but recommended by the manufacturer(s) of the respective item(s) / equipment / system(s) for five (05) years of trouble-free operation & maintenance, shall be submitted by the contractor during detailed engineering stage.

If the contractor uses any spare part during installation of the item(s) / equipment / system(s), the same shall be supplied by him at his own cost and risk to the employer prior to the final commissioning of the plant.

The spares shall be delivered along with the unit. Corresponding components of all the equipment and the spares shall be of the same material, dimensions and finish and shall be interchangeable.

19.2. HYDRO TURBINE AND ASSOCIATED AUXILIARY & ANCILLARY EQUIPMENT

Sl. No.	Description	Quantity
A	**Turbine (Horizontal Pelton)**	
1.	Runner coupling bolts, nuts & Washer	One (01) set
2.	Bucket template	One (01) set
3.	Turbine casing bolt	One (01) set
4.	Turbine bearing (each type)	One (01) set
5.	Shell and thrust pad	One (01) set
6.	Ferrocare filter machine	One (01) set
7.	Filter paper	Two (02) sets
8.	Alpha Laval machine (centrifuge separator)	One (01) set
9.	Bearing oil cooler	One (01) set
10.	Bearing oil pump motor	One (01) set
11.	Bearing oil filter element (for duplex filter)	Two (02) nos.
12.	Needle Stem	One (01) set
13.	Spear	Two (02) sets
14.	Nozzle tip liner	Two (02) sets
15.	Needle valve, non-return valve, angle valve	One (01) no. each
16.	Nozzle packing	Two (02) sets
17.	Deflector servo motor packing	Two (02) sets

Sl. No.	Description	Quantity
18.	Bearing oil for one (01) time replacement	As required
19.	Dial type thermometer (bearing)	One (01) set
20.	Steel wire rope sling	One (01) set
21.	Chain pulley	One (01) set
B	**Governing Equipment**	
1.	Servo valve for governor (if any)	One (01) set
2.	Hydraulic valves for governor	One (01) set
3.	Pressure Gauge	Six (06) nos.
4.	Pressure switch	Six (06) nos.
5.	Governor oil for one (01) time replacement	As required
C	**Oil Pressure Unit and Pumps**	
1.	Oil screw pump with motor for pressure oil supply	One (01) set
2.	Twin filter for oil	One (01) set
3.	Safety relief valve together with pump un-loader valve	One (01) set
E	**Main Inlet Valve (Spherical Type)**	
1.	Operating seal	Two (02) sets
2.	Maintenance seal	Two (02) sets
3.	MIV cup seal	Ten (10) nos.
4.	O rings of MIV	Two (02) sets
5.	Hydraulic hose pipe of MIV	Two (02) sets
6.	All rubber seal and gasket	One (01) set
7.	Oil flow meter	One (01) set
F	**Compressed Air System**	
1.	Fan Blade	One (01) no.
2.	Gasket	Two (02) sets
3.	Connecting rod and crank shaft assembly	One (01) set
4.	Piston & cylinder	One (01) set
5.	Delivery unloader	One (01) no.
6.	Solenoid valve assembly	One (01) no.
7.	Non return valve	One (01) no.
8.	Ring set	One (01) set
9.	Valve plate	Two (02) sets
10.	Valve flat	Two (02) sets
11.	Compressor oil	One (01) liter
12.	Starter	One (01) set
13.	Valves for compressed air piping	One (01) set
14.	Direction control valve, if any	One (01) set
G	**Cooling Water and Dewatering Pump**	
1.	Cooling water pump motor set	One (01) set
2.	Dewatering pump motor set	One (01) set
3.	Top bearing and bottom bearing	One (01) set
4.	Shaft	One (01) set

Sl. No.	Description	Quantity
5.	Shaft couplings	One (01) set`
6.	Contactor	One (01) set
7.	Duplex filter element / wire mesh assembly	Two (02) sets
8.	Thermal overload relay	One (01) set
9.	Cooling water valves	One (01) set

19.3. GENERATOR AND AUXILIARIES

Sl. No.	Description	Quantity
A	**Generator**	
1.	Stator coil	One (01) coil
2.	Rotor pole (wound)	Two (02) nos.
3.	Field pole	Three (03) nos.
4.	Stator temperature recorder	One (01) set
5.	Brake pad	Two (02) sets
6.	Brake control panel	One (01) no.
7.	Carbon brushes	Fifty (50) nos.
8.	Carbon brush holder	Ten (10) nos.
9.	Bearing pads – for driving end and non-driven end each	One (01) set
10.	Bearing Liners	Two (02) sets
11.	HRC fuses of each type	Twelve (12) nos.
12.	Generator hot air inlet temperature thermometer	One (01) set
13.	RTD	One (01) set
14.	Relays (each type)	One (01) set
15.	Indicating lamps (AC / DC)	One (01) set
B	**Excitation System**	
1.	Fuses for Thyristor	Two (02) sets
2.	Thyristor bridges	Two (02) sets

19.4. 11 KV INDOOR SWITCHGEARS AND STATION AUXILIARY TRANSFORMER

Sl. No.	Items	Quantity
A	**11 kV Indoor Switchgear**	
1.	Arc quenching chamber (each type)	Three (03) sets
2.	Closing and Tripping coils of each type	One (01) set
3.	Spring mechanism of each type	One (01) set
4.	Relays (each type)	One (01) set
5.	CT (each type)	One (01) set
6.	PT (each type)	One (01) set
7.	Surge arrestors (each type)	One (01) set
8.	Push Button (each type)	One (01) set

Sl. No.	Items	Quantity
9.	Bus Bar Insulators	Three (03) sets
B	**Station Auxiliary Transformer**	
1.	HV Bushing with gasket	One (01) set
2.	LV Bushing with gasket	One (01) set

19.5. MAIN TRANSFORMER

Sl. No.	Items	Quantity
1.	11 kV LV bushing with gaskets	One (01) set
2.	33 kV HV bushing with gaskets	One (01) set
3.	Neutral bushing CT	One (01) set
4.	Temperature detector (WTI and OTI)	One (01) set each

19.6. 33 KV POWER EVACUATION SYSTEM

Sl. No.	Items	Quantity
1.	Arc quenching chamber	Three (03) sets
2.	Closing and Tripping coils of each type	One (01) set
3.	Spring mechanism of each type	One (01) set
4.	Relays (each type)	One (01) set
5.	CT (each type)	One (01) set
6.	PT (each type)	One (01) set
7.	Bus Bar Insulators	Three (03) sets
8.	Fixed and moving contacts of Isolator	Two (02) sets
9.	33 kV Pin Insulator	Six (06) sets
10.	11 kV Disc Insulator	Six (06) sets
11.	Post Insulator	One (01) set

19.7. LT SWITCHGEAR

Sl. No.	Description	Quantity
1.	Closing coil (each type)	One (01) set
2.	Tripping coil (each type)	One (01) set
3.	MCCBs (each type)	One (01) set

19.8. DC SYSTEM

Sl. No.	Description	Quantity
A	**Battery**	
1.	2 V Cells	Ten (10) nos.
2.	Electrolyte	10% of total quantity

Sl. No.	Description	Quantity
B	**Battery Charger**	
1.	SCR	Two (02) nos.
2.	Blocking diode	One (01) no.
3.	Control card	One (01) set
4.	HRC fuses	One (01) set
5.	Semiconductor fuses	One (01) set
6.	Filter capacitor	One (01) set
C	**DC Distribution Board**	
1.	Circuit Breakers (each type)	One (01) set
2.	Control fuses	One (01) set

19.9. SUPERVISOTY CONTROL AND DATA ACQUISITION SYSTEM (SCADA)

Sl. No.	Description	Quantity
1.	Power supply modules and cards (each type)	One (01) set
2.	Network Interface cards (each type)	One (01) set
3.	Data storage drives (each type)	One (01) set
4.	Modem (each type)	One (01) set
5.	HMI panel (each type)	One (01) set
6.	Measuring transmitter (each type)	One (01) set
7.	Sensors / transducers (each type)	One (01) set
8.	Router / gateway (each type)	One (01) set

19.10. POWER CONTROL & INSTRUMENTATION CABLES, CABLE RACKS & TRAYS

For various cables, at least 20 % of total quantity used for the plant shall be provided as spares. For other equipment to be supplied within this scope of contract, spares shall be provided as recommended by the manufacturer for five (05) years of trouble free operation.

19.11. EOT CRANE FOR POWER HOUSE

Sl. No.	Description	Quantity
1.	**Brake lining with rivets for electro-magnetic brake**	
a)	For long travel motion	Two (02) sets
b)	For cross traverse motion	Two (02) sets
c)	For main hoist	Two (02) sets
d)	For auxiliary hoist	Two (02) sets
2.	Current collectors	One (01) set
3.	Limit switches of each type	One (01) set

19.12. ILLUMINATION SYSTEM

Sl. No.	Description	Quantity
1.	MCCB (each type)	One (01) set
2.	MCB (each type)	One (01) set
3.	Lamp (each type)	Two (01) sets
4.	Lamp holder (each type)	One (01) set
5.	Igniter	Two (02) nos.

19.13. FIRE PROTECTION SYSTEM

Sl. No.	Description	Quantity
1.	Sensors for fire protection system	One (01) set

19.14. COMMUNICATION, SUPERVISION AND SURVEILLANCE SYSTEM

Sl. No.	Description	Quantity
A	**Supervision & Surveillance System**	
1.	PTZ high speed camera with all accessories	One (01) set
2.	Integral Box Camera with all accessories	One (01) set
3.	8 port,10/100/1000-Base T layer 2 managed switch	One (01) set
4.	8 port Industrial Ethernet Switch	One (01) set

19.15. SPECIAL TOOLS, PLANTS AND EQUIPMENT

All special tools, plants & equipment required for assembly, erection, dismantling of various item(s) / equipment / system(s) under the scope of the supply shall be deemed to be included in the scope of supply under this contract. The contractor shall submit a list of the above special tools, plants & equipment during detailed engineering stage.

20. GUARANTEED TECHNICAL PARTICULARS

The contractor shall furnish the Guaranteed Technical Particular (GTP) for various item(s) / equipment / system(s) under the scope of the supply as per the format provided hereunder after placement of LOA. Particulars which are subject to guarantee shall be clearly highlighted. The contractor shall start manufacturing / procurement of the respective item(s) / equipment / system(s) after receiving approval of the GTP from the employer.

20.1. HYDRO TURBINE AND ASSOCIATED AUXILIARY & ANCILLARY EQUIPMENT

1. Make of Turbine:
2. Type of Turbine:
3. Guaranteed Performance:

Sl. No.	Parameters	Discharge m^3/sec	% of Nozzle Opening	Turbine Output	Efficiency
1)	**At rated / design Head**				
	110 % rated output				
	100 % rated output				
	80 % rated output				
	60 % rated output				
	Weighted Average Efficiency at rated Head				
2)	**At maximum Head**				
	110 % rated output				
	100 % rated output				
	80 % rated output				
	60 % rated output				
3)	**At minimum Head**				
	100 % rated output				
	80 % rated output				
	60 % rated output				

Sl. No.	Parameters	Description
4)	The limit of minimum and maximum net heads for satisfactory operation of turbine	
5)	Point of best efficiency output at rated and minimum net heads and discharge corresponding to best efficiency point	
6)	Performance curve of turbine discharge, output and efficiency for various needle opening combinations	
7)	Rotational speed	
8)	Specific speed	
	Specific speed of unit	
	Direction of rotation as viewed from the non-driving end	
	Maximum runaway speed	
	Critical speed for combined turbine & generator	

9)	Maximum output corresponding to 100 % nozzle opening at minimum net head	
10)	Minimum load at which turbine can safely operate	
11)	Momentary rise in speed on suddenly reducing load to zero from	
a)	Maximum load (110 %)	
b)	Full load	
c)	¾ full load	
d)	½ full load	
e)	¼ full load	
12)	Time of needle operation for regulation	
a)	Maximum load rejection	
b)	Full load rejection	
c)	¾ full load rejection	
d)	½ full load	
e)	¼ full load	
13)	Momentary drop in speed (in % of rated speed) on increasing load from zero to	
1.	110 % load	
2.	Full load	
3.	¾ full load	
4.	½ full load	
5.	¼ full load	
14)	Maximum water hammer pressure when all the units simultaneously reject maximum load	
15)	Flywheel effect	
	Required for the entire generating unit	
	Available from turbine rotating parts	
	Available From generator rotating parts	
	Available from separate fly wheel	
16)	Recommended setting of turbine (center line of runner with respect to the tail race level)	
17)	Cavitation Guarantee	
18)	Maximum noise level at 1 m from turbine	
19)	Factor of safety	
a)	Guaranteed minimum factor of safety under worst condition based on yield point of the material	
b)	Name & location of the part having the factor of safety in 19.a above	
20)	Turbine Runner	
a)	Material composition and conforming standard	
b)	Pitch circle diameter	
c)	Outer diameter	
d)	Weight of turbine runner excluding shaft	
e)	Peripheral velocity	
f)	Whether statically & dynamically balanced in shop	

g)	Runner forged fabricated	
h)	Source of runner casting	
i)	Number of runner buckets	
j)	Length of Bucket	
k)	Width of Bucket	
l)	Depth of Bucket	
m)	Opening of bucket ending	
21)	Shaft	
a)	Material composition and conforming standard	
b)	Diameter of shaft & bore	
c)	Length	
d)	Weight	
e)	Whether hollow or solid	
f)	Method of coupling to generator shaft and runner	
g)	Flange diameter	
h)	Flange thickness	
i)	Method of matching and alignment of shaft with generator	
22)	Turbine bearing	
a)	Type	
b)	Location	
c)	No. of pads & size	
d)	Bearing area	
e)	Material of bearing pads	
f)	Type, No. & location of	
	- Embedded temperature detectors	
	- Dial type thermometers	
	- Thermostats	
g)	Cooling water requirement	
	- Quantity	
	- Pressure range	
h)	Cooling coils	
	- Number	
	- Maximum safe working pressure	
	- Bursting pressure	
	- Pressure drop of water through the coils	
i)	Normal working temperature of bearing	
j)	Maximum permissible temperature of bearing	
k)	Temp. rise by RTDs with cooling water supply at 28^0 c at maximum and rated loads	
	- Pads	
	- Oil	
l)	Operation capability of guide bearing in minutes for the following condition.	
	- At rated speed without cooling water supply	
	- At runaway speed with cooling water supply	

	- At runaway speed without cooling water supply	
23)	Nozzle Apparatus	
	- Number of nozzles / jets	
	- Material of needle	
	- Nozzle opening diameter	
	- Jet diameter at rated head and discharge	
24)	Jet Deflector	
	Material	
	Shape	
	Thickness	
25)	Elevation of centre line of Turbine	
26)	Needle servo motors	
	Number of servomotors	
	Material of servo motor body and piston	
	Rating	
	Range of oil pressure of satisfactory operation.	
27)	Turbine flow meter	
	Type	
	Range of flow measurement	
	Brief description	
28)	Centralized grease lubrication system, (if provided)	
	No. of pumps	
	Rating of each grease pump	
	Type and make of pump	
	Capacity of grease distributors	
	No. of grease distributors	
	No. of points to be lubricated	
	Frequency of lubrication	
	Recommended type and grade of lubrication Grease	
	Piping material	
29)	Governing system	
a.	Governor	
	Make	
	Type	
	Description and method of operation	
	Range of adjustment of permanent speed drop	
	Sensitivity	
	Range of adjustment of speed setting level	
	Governor opening and closing time	
	Range of adjustment of governor closing and opening times	
	Speed dead band	
	Items for mounted in control room	
b.	Speed Signal Generator / Permanent Magnet Generator	

	Type	
	Rated capacity	
	Rated line voltage	
	Rated frequency	
	No of Phases	
	No of speed switches	
c.	Governor oil pumps	
	No of oil pumps for each unit	
	Type	
	Capacity	
	Type of operation (continuous or intermittent)	
	Capacity and speed of pump motor	
	Class of insulation of pump motor	
d.	Sump tank	
	Dimensions of sump tank	
	Total / effective volume	
	Total volume of oil in governing system	
	Normal volume of oil in each vessel	
	Normal working pressure	
	Minimum working pressure for safe operation	
	Weight of each oil pressure vessel (without oil)	
	Grade of oil recommended	
	No of operations of needle & deflector and inlet valve possible at minimum working pressure and pumps out of service	
30)	Dewatering and drainage system	
a.	Name of manufacturer	
b.	No. of pumps	
c.	Type of pumps	
d.	Stages	
	- No. of stages	
	- Head / stage	
e.	Head	
	- Dynamic head	
	- Effective head	
	- Range of head	
f.	Method of lubrication	
g.	Diameter of impeller	
	Material of impeller	
h.	Size of dewatering sump	
i.	Type of motor	
	Rating of each motor	
	Total time for dewatering	
31)	Air Compressor Unit	

A.	Air Compressors	
a.	Type	
b.	Number of units	
c.	Nominal discharge pressure	
d.	Unit discharge rate	
e.	Free air delivery (FAD)	
f.	Max. pressure for operation of safety device	
g.	Duty of the compressor motor	
h.	Insulation and protection class of the motor	
B.	Air Receivers	
a.	Number of receivers	
b.	Volume per receiver	
C.	Air Dryer	
a.	Type	
b.	Number of dryers	
c.	Unit Discharge Rate	
32)	Heaviest package for shipment	
	Name	
	Weight	
	Dimensions (L x W x H)	
33)	Largest package for shipment	
	Name	
	Weight	
	Dimensions (L x W x H)	
34)	Guarantee	

20.2. GENERATOR AND AUXILIARIES

1. Make of Generator:
2. Type of Generator:
3. Guaranteed Performance:

Sl. No.	Parameters	Description
1	Shaft orientation	
2	Rated speed and direction of rotation	
3	Normal voltage between phases	
4	Voltage variation	
5	Frequency	
6	Frequency variation	
7.a	Guaranteed rated output at specified conditions with generator temperature rise limited to Class B insulation temperature rise limit (kW)	
7.b	Guaranteed maximum output at specified conditions with generator temperature rise limited to Class B insulation temperature rise limit (kW)	

8	Rated power factor	
9	Guaranteed maximum temperature rise for rated output guaranteed in item 7 above over ambient temperature not exceeding 40^0C	
(a)	Stator winding by ETD	
(b)	Rotor winding by RTDs / Resistance	
(c)	Bearing by ETD	
(d)	Other parts by thermometer	
10	Guaranteed maximum temperature rise for maximum output guaranteed in item 7 above over ambient temperature not exceeding 40^0C	
(a)	Stator winding by ETD	
(b)	Rotor winding by RTDs / Resistance	
(c)	Bearing by ETD	
(d)	Other parts by thermometer	
11	Guaranteed overall efficiency of generator at rated voltage, power factor (pf = 0.85 (lag) (adjustable with excitation), frequency and 75^0 C winding temperature computed by the summation of losses method in accordance with IS: 4889 subject to tolerance in IS: 4722	
(a)	110 % rated output	
(b)	100 % rated output (Full Load)	
(c)	80 % rated output	
(d)	60 % rated output	
12	Guaranteed Weighted Average efficiency	
13	Inherent Regulation, i.e., increase in voltage at constant speed and excitation on taking off	
(a)	110% full load	
(b)	Full Load	
(c)	80% full load	
(d)	60% full load	
14	Generator Reactance	
(a)	Synchronous reactance (saturated)	
(i)	Direct axis	
(ii)	Quadrature axis	
(b)	Transient reactance	
(i)	Saturated	
(ii)	Quadrature axis	
(c)	Sub transient reactance	
(i)	Direct axis	
(ii)	Quadrature axis	
(d)	Momentary speed rise the generator can take	
(e)	Negative phase sequence reactance	
(f)	Zero phase sequence reactance	
15	Resistance of armature winding per phase	
16	Resistance of field winding	
17	Generator time constants	

(a)	Direct axis transient open circuit	
(b)	Direct axis transient short circuit	
18	Generator characteristic curves	
(a)	Open circuit saturation curve	
(b)	Short circuit saturation curve	
(c)	Full Load saturation curve at rated power factor	
19	Short Circuit Conditions	
(a)	Max. value of 3 phase symmetrical short circuit current (RMS) when the machine is delivering rated output at 0.85 pf under voltage regulator control.	
(b)	Max. value of single phase short circuit current (RMS) under 19.a above	
(c)	Sustained three phase short circuit current with exciter circuit for full load and voltage regulator control	
(d)	Sustained 1 phase short circuit current under 19.c above	
(e)	Max duration of short circuit which the generator can withstand without injury	
20	Short Circuit Ratio	
21	Synchronizing Power at full load, 50 Hz, power factor (pf.= 0.85 lag) (adjustable with excitation)	
22	Flywheel effect	
(a)	Rotating parts of the generator (self weight effect)	
(b)	Flywheel (if any)	
23	Duration for which all parts are guaranteed to withstand safely maximum runaway speed	
24	Guaranteed minimum factor of safety based on yield point stress of material under runaway / short circuit conditions and name and location of part having the minimum factor of safety.	
25	Maximum I^2R value	
26	Inertia constant	
27	Maximum runaway speed of all parts guaranteed to withstand for 15 (fifteen) minutes of duration	
28	Embedded temperature detectors	
(a)	Number	
(b)	Type	
29	Excitation Equipment	
(a)	Name of the manufacturer	
(b)	Type of excitation system	
(c)	Rated output	
(d)	Max. voltage	
(e)	Rated voltage	
(f)	Max current	
(g)	Rated current	
(h)	Accuracy of voltage regulation	

(i)	Range of voltage level setting	
(j)	Range of compounding / reactance drop compensation	
(k)	Range of control in auto mode	
(l)	Range of control in manual mode	
(m)	Frequency range of operation	
(n)	Excitation power speed	
(o)	Response ratio	
(p)	Max. continuous rating	
(q)	Nominal / ceiling voltage	
®	Excitation transformer rating	
(s)	Excitation transformer type	
30	Field current for full load on rated pf and terminal voltage	
31	Schedule of losses at rated voltage , p.f. and frequency at 110%, 100%, 80% & 60% Load	
i)	Friction and windage losses	
ii)	Core Losses	
iii)	Armature I^2R losses at 75°C	
iv)	Stray losses	
v)	Field I^2R losses at 75°C	
vi)	Excitation system losses	
vii)	Total Losses	
32	Stator	
(a)	Material of stator core	
(b)	Insulation of laminations	
(c)	Insulation of winding	
(d)	Max. temperature rise	
(e)	No. of sections in which stator is divided	
(f)	Specific losses in core material	
(g)	Gross length of core	
(h)	Net length of core	
(i)	Stator core particulars	
	Inside dia	
	Outside dia	
	Weight	
(j)	Flux density at rated voltage on no load in	
	Air gap	
	Stator core	
	Teeth	
	Pole body	
(k)	Current density in stator winding	
(l)	No. of stator winding parallel paths and type of winding	
(m)	Calculated capacitance of stator winding	
(n)	Resistance of stator winding per phase at 20°C	

33	Rotor	
(a)	Rotor material	
(b)	Rotor construction	
(c)	Air gap	
(d)	Diameter of assembled rotor	
(e)	Factor of safety at maximum runaway speed based on yield point stress of material	
(f)	Construction of field poles	
(g)	Method of attaching field poles	
(h)	Field winding construction	
(i)	Insulation of field winding	
(j)	Construction of Damper winding	
(k)	Resistance of rotor field winding at 20°C	
(l)	Max current density in rotor winding	
(m)	Total weight of rotor	
34	Bearings (DE)	
(a)	Type	
(b)	Number of bearings	
(c)	Lubrication	
(d)	Material of pads	
(e)	Bearing oil/grease specification	
(f)	Quantity required for first filling	
(g)	Cooling water requirements	
35	Bearings (NDE)	
(a)	Type	
(b)	Number of bearings	
(c)	Lubrication	
(d)	Material of pads	
(e)	Bearing oil/grease specification	
(f)	Quantity required for first filling	
(g)	Cooling water requirements	
36	Generator Brakes	
(a)	Speed at which brakes are applied	
(b)	Air pressure for satisfactory operation	
(c)	Brake shoe material	
37	Main Shaft	
(a)	Material	
(b)	Details of coupling flange	
(c)	Diameter	
(d)	Length	
(e)	Weight	
38	Generator Ventilation System	
(a)	Cooling system air cooled / water cooled	

(b)	If air cooled, system details	
(c)	If water cooled, details of pumps	
(d)	Quantity of water required for cooling	
(e)	Pressure of cooling water	
39	Cooling water System	
(a)	Cooling water requirements of generator bearing	
(b)	Cooling water requirements for any other equipment	
(c)	No. of pumps and capacity	
(d)	Pressure requirement	
40	Neutral Isolating Switch	
(a)	Type	
(b)	Name and address of manufacturer	
(c)	Voltage rating, frequency	
(d)	Normal current	
(e)	Short time rating	
(f)	Impulse level (1.2/50 micro second wave)	
(g)	Power frequency dry withstand voltage (one minute)	
(h)	Dimensions	
(i)	Weight	
41	Weight of assembled stator	
42	Weight of generator rotor without shaft	
43	Weight of other rotating parts	
44	Weight of complete generator	
45	Heaviest package for shipment	
(a)	Name	
(b)	Weight	
(c)	Dimensions (L x B x H)	
46	Largest package for shipment	
(a)	Name	
(b)	Weight	
(c)	Dimensions (L x B x H)	
47	Heaviest assembly to be lifted by power house crane	
(a)	Name	
(b)	Weight	
(c)	Dimensions (L x B x H)	
48	Guarantee	

20.3. 11 KV INDOOR SWITCHGEARS AND STATION AUXILIARY TRANSFORMER

Sl. No.	Parameters	Description

1	**General**	
1.1	Name of the Company	
1.2	Office address	
1.3	Factory address	
2	**Panel**	
2.1	Make	
2.2	Type & Designation	
2.3	Application Standard	
2.4	Rated Voltage	
2.5	Highest Voltage	
2.6	Rated Current at bus bar	
2.7	Frequency	
2.8	STC for 3 Sec.	
2.9	Breaking Capacity	
2.10	Making Capacity	
2.11	Power frequency withstand voltage	
2.12	Impulse withstand voltage	
2.13	AC Aux. Voltage	
2.14	DC Aux. Voltage	
2.15	Degree of Protection for HV & LV Compartment	
2.16	Thickness of metal sheet (mm)	
	- For load-bearing member	
	- For Doors & covers	
2.17	Dimension of Whole Panel in mm (H x W x D)	
2.18	Dimension of Bus Coupler & Trunk Panel in mm (H x W x D)	
2.19	Dimension of Panel Compartments in mm (H x W x D)	
	- Compartment 1	
	- Compartment 2	
	- Compartment 3	
	- Compartment 4	
	- Compartment 5	
	- Compartment 6	
	- Compartment 7	
	- Compartment 8	
2.20	Single feeder panels to be supplied with bus bar for connection with adjacent Incomer / Bus Coupler / Feeder [Yes / No]	
2.21	HV Cable termination height in the cable compartment	
3	**Bus Bar**	
3.1	Material	
3.2	Shape	
3.3	Cross sectional area of main Bus	
3.4	Cross sectional area of Riser	
3.5	Type of plating	

3.6	Normal Current currying capacity	
3.7	STC for 3 Sec.	
3.8	Temp. Rise over ambient temperature at rated current	
3.9	Current density for main Bus & Riser	
3.10	Phase to Phase clearance	
3.11	Phase to ground clearance	
3.12	Type of insulation	
3.13	Colour Identification	
4	**Bus support insulator**	
4.1	Reference Standard	
4.2	Make	
4.3	Material	
4.4	Dry Power frequency Withstand Voltage for one minute	
4.5	Wet Power frequency Withstand Voltage for one minute	
4.6	Impulse Withstand voltage	
4.7	Creepage distance	
5	**Vacuum Circuit Breaker (each type to be provided separately)**	
5.1	Make	
5.2	Type	
5.3	Reference Standard	
5.4	Rated voltage	
5.5	Highest voltage	
5.6	Frequency	
5.7	Normal Current	
5.8	Breaking capacity	
5.9	Making capacity	
5.10	STC for 3 Sec.	
5.11	Temp. Rise over ambient temperature at rated current	
5.12	No of break per phase	
5.13	Operating duty cycle	
5.14	Single Phase Capacitor Breaking capacity	
5.15	Three Phase Capacitor Breaking capacity	
5.16	Line Charging Breaking capacity	
5.17	Cable Charging Breaking capacity	
5.18	Closing time	
5.19	Opening time	
5.20	Mechanical endurance capacity	
5.21	Electrical endurance capacity	
5.22	Operating mechanism	
5.23	Type of isolation & draw out	
5.24	Details of mechanical interlock provided	
5.25	DC wattage of trip coil	
5.26	DC voltage range for trip operation	

5.27	DC wattage of closing coil	
5.28	DC voltage range for closing operation	
5.29	Details of electrical interlock	
6	**Vacuum Bottle (each type to be provided separately)**	
6.1	Make	
6.2	Rated voltage	
6.3	Type and model no.	
6.4	Normal current	
6.5	Breaking capacity	
6.6	Making capacity	
6.7	STC for 3 Sec.	
6.8	Maximum contact separation length	
6.9	Minimum mechanical life in no. of operation	
6.10	Minimum electrical life in no. of operation at rated current	
6.11	Minimum electrical life in no. of operation at rated full short circuit current	
6.12	Power frequency withstand voltage (dry)	
6.13	Impulse withstand voltage	
6.14	Contact material	
6.15	Type of plating	
6.16	Contact pressure	
7	**Current Transformer (each type to be provided separately)**	
7.1	Make	
7.2	Reference Standard	
7.3	Type	
7.4	Voltage	
7.5	Frequency	
7.6	Insulation level	
7.7	Class of insulation	
7.8	No. of secondary	
7.9	Ratio	
7.10	Class of accuracy	
7.11	Burden	
7.12	STC for 1 Sec	
7.13	ALF for Protection Core	
7.14	ISF of Metering Core at lower ratio	
7.15	V_k & Magnetising Current (at lower ratio)	
7.16	Fixing Arrangement	
8	**Neutral Grounding Equipment**	
8.a	Distribution Transformer	
8.a.1	Type	
8.a.2	Name and address of manufacturer	
8.a.3	Voltage ratio	

8.a.4	Continuous current rating	
8.a.5	One minute power frequency withstand voltage	
8.b	Resistor / secondary load resistor	
8.b.1	Current rating of resistor	
8.b.2	Duty cycle of resistor and cooling medium	
8.b.3	Overall dimensions and weight	
9	**LAVT Cubicle**	
9.1	Size of the cubicle	
9.2	Thickness of the sheet	
9.3	Weight	
9.4	Lightning Arrestor / Surge Arrestors	
9.4.1	Make	
9.4.2	Type	
9.4.3	Applicable Standard	
9.4.4	Rated Voltage (U_n)	
9.4.5	Maximum continuous operating Voltage	
9.4.6	Nominal discharge current (8 / 20 µS)	
9.4.7	Pressure relief rated current	
9.4.8	High Current short duration test valve	
9.4.9	Residual voltage with 8/20 µS at discharge current 5 kA	
9.4.10	Line discharge class	
9.4.11	Power frequency withstand voltage (one minute)	
9.4.12	Max. residual voltage at 10 kA	
9.4.13	Overall weight	
9.4.14	Mounting details	
9.5	Protective Capacitors	
9.5.1	Type	
9.5.2	Name and address of manufacturer	
9.5.3	Standard applicable	
9.5.4	Voltage Rating	
9.5.5	Capacitance Micro farad	
9.5.6	Weight	
9.5.7	Mounting details	
9.6	Potential Transformer	
9.6.1	Make	
9.6.2	Reference standard	
9.6.3	Insulation level	
9.6.4	Class of insulation	
9.6.5	Type	
9.6.6	Frequency	
9.6.7	Winding connection	
9.6.8	Type of core connection	
9.6.9	Ratio	

9.6.10	Class of accuracy	
9.6.11	Burden per Phase	
9.6.12	Over voltage factor for 8 hrs	
9.6.13	Fixing position	
9.6.14	Fixing arrangement	
9.6.15	Primary fuse rating	
9.6.16	Temperature rise 1.1 times rated voltage with rated burden & frequency	
9.6.17	Power frequency withstand voltage (one minute)	
10	**Auxiliary Relay (each type to be provided separately)**	
10.1	Make	
10.2	Type	
10.3	Rated current / voltage and permissible variation	
10.4	Rated burden	
10.5	No. and type of contacts (whether 'NO' or 'NC')	
10.6	Rating of contacts	
10.7	Total operating time or relays	
10.8	One minute power frequency withstand voltage	
10.9	Detailed literature furnished with reference	
10.10	Details of testing facilities provided	
10.11	Undertaking form as per Cl. No. 4.19 attached [Yes / No]	
11	**Indicating Lamp**	
11.1	Make	
11.2	Type	
11.3	Rated voltage	
11.4	Rated power consumption (watts)	
11.5	Series resistor provided	
12	**Indicating Meter (each type to be provided separately)**	
12.1	Make	
12.2	Type of Movement	
12.3	Size (square mm)	
12.4	Scale size in degree	
12.5	Accuracy	
12.6	Range offered in line with specification	
12.7	VA burden	
12.8	Applicable standard	
12.9	Undertaking form as per Cl. No. 4.20 attached [Yes / No]	
13	**Energy Meter**	
13.1	Make	
13.2	Type	
13.3	Range	
13.4	Detailed literature furnished	
13.5	Standard to which it conform to	

13.6	Rated current	
13.7	Rated Voltage and frequency	
13.8	Draw out / non draw out	
13.9	Class of accuracy	
13.10	Rated VA burden for current coil and voltage coil	
13.11	Test plug / test blocks / testing terminal with links	
13.11	Undertaking form as per Cl. No. 4.20 attached [Yes / No]	
14	**MCB / MCCB**	
14.1	Make	
14.2	Rated voltage	
14.3	Rated current	
14.4	Rupturing capacity	
14.5	Setting for short circuit	
14.6	Setting range for over load	
14.7	Operating time	
14.8	No. of auxiliaries contacts	
14.9	Rating for auxiliary contacts	
14.10	Operating characteristics furnished	
15	**Terminal connector**	
15.1	Make	
15.2	Type	
15.3	Size	
16	**Control Switch**	
16.1	Make	
16.2	Type	
16.3	Contact configuration	
16.4	No of spare contact (NO + NC)	
16.5	AC & DC current rating	
16.6	AC voltage rating	
17	**Spring Charge Limit Switch**	
17.1	Make	
17.2	Type	
17.3	No of contact (NO + NC)	
17.4	No of spare contact (NO + NC)	
17.5	AC & DC Current rating	
17.6	AC Voltage rating	
18	**Local Remote Switch**	
18.1	Make	
18.2	Type	
18.3	Contact configuration	
18.4	AC & DC Current rating	
18.5	AC Voltage rating	
19	**Spring Charging Motor**	

19.1	Make	
19.2	Type	
19.3	Rated AC Voltage	
19.4	Rated wattage	
19.5	AC Voltage variation for operation	
20	**Operation Counter**	
20.1	Make	
20.2	Type	
20.3	Operation count range	
21	**Space Heater**	
21.1	Make	
21.2	Type	
21.3	Rated AC Voltage	
21.4	Wattage	
22	**Thermostat**	
23.1	Make	
23.2	Setting range	
23	**Annunciator**	
23.1	Make	
23.2	No of window	
23.3	Aux voltage	
23.4	No of inbuilt push switch	
24	**Voltage Selector Switch**	
24.1	Make	
24.2	Type	
25	**Test Terminal Block**	
25.1	Make	
25.2	Type	
25.3	Size	
26	**Terminal Block**	
26.1	Make	
26.2	Type	
27	**Fuse & Link**	
27.1	Make	
27.2	Type	
28	**HRC Fuse**	
28.1	Make	
28.2	Type	
29	**Control Wiring**	
29.1	Make	
29.2	Type	
29.3	Material and size conductor for CT circuit	
29.4	Material and size conductor for other circuit	

29.5	Solid / standard conductor	
29.6	Tinned / untinned	
29.7	Material of insulation and sheath	
29.8	Voltage grade of control wiring	
30	**Colour Coding of Wires**	
a)	For AC metering circuit	
b)	For DC control circuit	
c)	AC auxiliary power circuit like panel space heater	
d)	Earthing	
e)	Numbered ferrules at both ends	
f)	Insulator sleeves provided at both ends	
31	**Terminals**	
a)	Make	
b)	Current rating	
c)	Clamp type or bolt type	
d)	Max. conductor size and no. of conductor which it can receive	
e)	Disconnecting type of CT circuit	
f)	Terminal marking facility provided	
g)	Crimp type connectors provided at the terminals	
h)	Spare terminals	
32	**Earth Bus**	
33.1	Material	
33.2	Shape	
33.3	Size	
33	**Painting details**	
34.1	Paint type	
34.2	Paint shade	
34.3	Paint thickness	
34	Shipping dimension of equipment (H x W x D)	
35	Total weight of the equipment	
36	Accessories	
	Spring Charging Handle	
	VCB Operating Handle	
37	Guarantee of the total equipment including any integral part of the equipment	
38	**Station Auxiliary Transformer**	
38.1	Name of the manufacturer	
38.2	Country of origin	
38.3	Applicable standards	
38.4	Maximum continuous rating in kVA	
38.5	No load voltage ratio (In kV/kV)	
38.6	Rated frequency (in Hz)	
38.7	Number of phases	

38.8	Type of Cooling	
38.9	Connections	
38.9.1	HV Winding	
38.9.2	LV Winding	
38.10	Vector Symbol	
38.11	Temperature under normal operating condition above ambient temperature	
38.11.1	Top oil (in ^{0}C)	
38.11.2	Winding (in ^{0}C)	
38.11.3	Maximum hot spot temperature of winding (in ^{0}C)	
38.12	Magnetising current referred to HV at rated frequency	
(a)	At 90% rated voltage (in Amps)	
(b)	At 100% rated voltage (in Amps)	
(c)	At 112.5% rated voltage (in Amps)	
(d)	At 110% rated voltage (in Amps)	
38.13	Power factor of magnetizing current at 100 % rated voltage & frequency	
38.14	No load current at rated voltage and rated frequency (in Amp)	
38.15	Maximum No load loss in watt at rated frequency & voltage	
38.16.i	Maximum Load loss in Watt at 75^{0}C at rated output and frequency	
38.16.ii	Maximum Total loss in Watt at 75^{0}C at 50 % load and frequency	
38.17	Total Loss (including NLL & FLL) at 100% loading at 75^{0}C	
38.18	Percentage Regulation at full load at 75 ^{0}C	
(a)	At unity power factor	
(b)	At 0.8 power factor lagging	
38.19	Efficiency at 75 ^{0}C (in percentage) at full load	
(i)	At unity power factor	
(ii)	At 0.8 power factor lagging	
38.20	Efficiency at 75 ^{0}C (in percentage) at ¾ full load	
(i)	At unity power factor	
(ii)	At 0.8 power factor lagging	
38.21	Efficiency at 75 ^{0}C (in percentage) at ½ full load	
(i)	At unity power factor	
(ii)	At 0.8 power factor lagging	
38.22	Impedance voltage on rated kVA based on rated current and frequency at 75 ^{0}C (in percentage)	
38.23.i	Resistance voltage at rated current and freq. at 75^{0}C (in %)	
38.23.ii	Reactance voltage at rated current and freq. at 75^{0}C (in %)	
38.24.i	Resistance at HV base at 75 ^{0}C (ohms)	
38.24.ii	HV (between lines) (ohms)	
38.24.iii	LV (between lines) (ohms)	
38.25	Reactance at HV at 50 Hz	
38.26	Withstand time without injury for three phase dead short circuit at terminal (in seconds)	

38.27	Short time current rating for short circuit with duration		
38.27.1	HV Winding (in kA)		
38.27.2	LV Winding (in kA)		
38.27.3	Duration in seconds		
38.28	Permissible over loading time at maximum ambient temperature (hrs)		
38.28.1	125% load after running with 50% load with steady temp. rise		
38.28.2	120% load after running with 100% load with steady temp. rise		
38.29	Core		
38.29.i	Material Type		
38.29.ii	Whether stack core / wound core Type		
38.29.iii	Flux density of Core and yoke		
(a)	At rated voltage at 50 Hz (lines / sq. cm.)		
(b)	At 112.5 % rated voltage at 50 Hz (lines / sq. cm.)		
38.29.iv	Thickness of stampings (in mm)		
38.29.v	Type of Insulation between core lamination		
38.29.vi	Approximate area of cross section of core and yoke (in sq.mm)		
38.29.vii	Material of core clamping plate		
38.29.viii	Thickness of core clamping plate (in mm)		
38.29.ix	Insulation of core clamping plate		
38.29.x	Describe location / method of core grounding		
38.29.xi	Primary core material in the offered transformer		
38.29.xii	Whether the proof of use of prime core material is enclosed		
38.30	Terminal Arrangement		
(i)	High voltage		
(ii)	Low Voltage		
38.31	Positive Sequence Impedance between HV & LV winding on rated kVA at rated current and freq. at 75^0C winding temp. (%)		
38.32	Zero sequence Impedance at reference temp. of 75^0C (%)		
38.33	Details of windings	HV	LV
38.33.i	Type of Winding		
38.33.ii	Material of the winding conductor		
38.33.iii	Conductor area (in sq.mm)		
38.33.iv	Current density of winding at rated kVA (Amp per sq.cm)		
38.33.v	Insulating material used		
38.33.vi	Insulating material used between		
(a)	High voltage and low voltage winding		
(b)	Low Voltage winding and Core		
38.34	Insulation withstand Test Voltages		
(i)	Lightning Impulse withstand test voltage (kV Peak)		
(ii)	Power frequency withstand test voltage (in kV rms for 1 minute)		
(iii)	Induced over voltage withstand test voltage (in kV rms)		
38.35	Current in the winding at rated kVA		
(i)	Low voltage (in Amps)		

(ii)	High Voltage (in Amps)		
38.36	Voltage per turn (kV per turn)		
38.37	Ampere turn		
38.38	Number of turns		
(i)	Low Voltage		
(ii)	High Voltage		
38.39	Bushing	HV	LV
38.39.i	Make		
38.39.ii	Type		
38.39.iii	Applicable standard		
38.39.iv	Insulation withstand test voltage		
(a)	Lightning Impulse withstand test voltage (1.2 x 50 micro seconds in kV Peak)		
(b)	Power frequency withstand test voltage (in kV for 1 minute) • Dry • Wet		
38.39.v	Creepage distance in air		
(a)	Total (in mm)		
(b)	Protected (in mm)		
38.39.vi	Minimum height of the bushing		
38.40	Min. clearance (in mm) between live conductive parts and live conductive parts to earthed structure in Oil (between Phases)		
38.41	Min. clearance (in mm) between live conductive parts and live conductive parts to earthed structure in Oil (Phase to Ground)		
38.42	Min. clearance (in mm) between live conductive parts and live conductive parts to earthed structure in Air (between Phases)		
38.43	Min. clearance (in mm) between live conductive parts and live conductive parts to earthed structure in Air (Phase to Ground)		
38.44	Approximate weight of Transformer (in kg)		
(i)	Core with clamping		
(ii)	Coil with Insulation		
(iii)	Core and winding		
(iv)	Tank and fitting with accessories		
(v)	Untanking weight		
(vi)	Oil required for the transformer		
(vii)	Total weight with Core, Winding, oil and fittings		
38.45	Details of Tank		
(i)	Type of tank		
(ii)	Approximate thickness of sheet (in mm) • Sides • Bottom • Cover		
(iii)	Vacuum withstand capacity		
(iv)	Dimension of base channel (in mm x mm)		
38.46	Oil quality		

(i)	Applicable standard	
(ii)	Total quality of oil (in litre)	
38.47	Approximate overall Dimensions (in mm)	
(a)	Length	
(b)	Breadth	
(c)	Height	
(d)	Minimum height of bottom most portion bushing from bottom of base channel	
38.48	Minimum clearance height for lifting tank cover (in mm)	
38.49	Marking: whether agreeable to	
a)	Punching of transformer sl. no. on the yoke	
b)	Transformer Rating and Diagram plate along with Asset codification number shall be welded on the transformer Body	
38.50	Painting: Type of Painting of all steel surface	
38.51	List of Testing equipment available in the Testing Lab of Manufacturer	
38.52	Guarantee	

20.4. MAIN TRANSFORMER

Sl. No.	Parameters	Description
1	Name of manufacturer	
2	Applicable standard	
3	Installation	
4	Insulating medium	
5	Type of cooling	
6	Continuous rating (MVA)	
7	Rated voltage	
	HV winding (kV)	
	LV winding (kV)	
8	Rated frequency (Hz)	
9	No. of phase connections	
	HV winding	
	LV winding	
10	Reference ambient temperatures adopted for design	
11	Maximum ambient air temperature (^{0}C)	
12	Current at rated no-load voltage & on principal tap	
	HV side	
	LV side	
13	Temperature rise	
	Temperature rise of top oil above reference temp. (by thermometer) at rated output (^{0}C)	
	Temperature rise of winding above reference temp. of external cooling media (by resistance method) at rated output (^{0}C)	

14	Limit of hot spot temperature for which the transformer is designed (deg. C)	
15	Type of tap changing switch i.e. on-load / off-circuit	
16	Off Circuit Tap Changer	
	Range	
	No. of steps	
	Range for high voltage variation	
	Position of tapping	
17	No Load loss	
	at rated voltage and frequency at principal tap (kW)	
	at the voltage corresponding to the highest tap (kW)	
18	Load losses at rated and rated frequency for 75 ^{0}C winding temp. at:	
	Principal tap (kW)	
	Highest tap (kW)	
	Lowest tap (kW)	
19	Impedance voltage at rated current for the principal tapping: HV – LV percent	
20	Reactance at rated current and frequency: HV – LV	
21	Load current at rated voltage and rated frequency on	
	HV	
	LV	
22	Insulation Level	
22.i	Separate source power frequency voltage withstand	
	HV winding kV rms	
	LV winding kV rms	
22.ii	Induced over voltage withstand	
	HV winding kV rms	
	LV winding kV rms	
22.iii	Full wave lightning impulse withstand voltage	
	HV winding kV peak	
	LV winding kV peak	
23	Regulation at full load and 75 deg. C winding temp. Expressed as a percentage of normal rating:	
	At unity power factor (%)	
	At 0.9 power factor lagging (%)	
	At 0.8 power factor lagging (%)	
24	Efficiency at 75^{0}C winding temp. As derived from guaranteed loss figures at unity power factor and 0.9 power factor corresponding to:	
	Full load (%)	
	¾ full load (%)	
	½ full load (%)	
25	Maximum efficiency (%)	
26	Load at which maximum efficiency occurs (% of full load)	
27	Permissible short time over-loading	

28	Time in minutes for which the transformer can be run at full load without exceeding the max. permissible temperature	
29	Terminal arrangement	
	HV side	
	LV side	
	Neutral	
30	Noise level	
	When energized at normal voltage and freq. without load (db)	
	When fully loaded at rated voltage & freq. (db)	
31	External short circuit withstand capacity (MVA) and duration (seconds)	
32	Over-flux withstand capability of the transformer corresponding to:	
	Over voltage factor 1.1	
	Over voltage factor 1.25	
	Over voltage factor 1.4	
33	Cooling system	
34	Short time current rating for 1 second of	
	HV winding	
	LV winding	
35	Permissible over-loading	
	HV winding	
	LV winding	
36	Maximum expected over-all dimensions of assembled transformer:	
	Length (mm)	
	Breadth (mm)	
	Height (mm)	
37	Shipping details	
	Max. expected weight of heaviest package	
	Max. expected dimensions of largest package • Length (mm) • Breadth (mm) • Height (mm)	
38	Details of core	
38.i	Type of core construction	
38.ii	Flux density at rated voltage and frequency at principal tap	
38.iii	Magnetizing current at normal ratio and frequency at:	
	90 % of rated voltage	
	100 % of rated voltage	
	110 % of rated voltage	
38.iv	Power factor of magnetizing current at normal voltage ratio and frequency	
38.v	Material of core laminations	
38.vi	Thickness of core laminations (mm)	
38.vii	Insulation between core laminations	

38.viii	Insulation of core bolts	
38.ix	Insulation of core bolt washers	
38.x	Core bolt insulation withstand voltage for 1 minute (kV rms)	
38.xi	Are the core bolts grounded? If so, how?	
38.xii	Material of core clamping plate	
38.xiii	Thickness of core clamping plate.	
38.xiv	Insulation of core clamping plate	
38.xv	Location / method of core grounding.	
38.xvi	Details of oil ducts in core	
39	Details of windings	
39.i	Type of winding	
	HV winding	
	LV winding	
39.ii	Material of the winding conductor	
	HV winding	
	LV winding	
39.iii	Conductor area	
	HV winding	
	LV winding	
39.iv	Maximum current density for windings at rated current (A/cm^2)	
	HV winding	
	LV winding	
39.v	Insulating material used for:	
	HV winding	
	LV winding	
39.vi	Whether graded / un-graded insulation provided for:	
	HV winding	
	LV winding	
39.vii	Insulating material used between	
	HV and LV winding	
	LV winding and core	
39.viii	Type of axial coil supports	
	HV winding	
	LV winding	
39.viii	Type of radial coil supports	
	HV winding	
	LV winding	
40	Details of bushing	
40.i	Maximum allowable torque on coil clamping bolts bushing	
40.ii	Make and type	
40.iiii	Rated voltage class (kV)	
40.iv	Rated current (Amps)	
40.v	Lightning impulse withstand test voltage(KV peak)	

40.vi	Power frequency withstand test voltage:	
	Wet for 1 minute(KV rms)	
	Dry for 1 minute(KV rms)	
40.vii	Visible corona discharge voltage(KV rms)	
40.viii	Creepage distance in air(mm)	
40.ix	Creepage distance (protected)	
40.x	Whether test tap is provided	
40.xi	Quantity of oil (kg) in bushing and specification of oil used	
40.xii	Weight of assembled bushing (kg)	
40.xiii	Minimum clearance height for removal	
40.xiv	Minimum clearance (mm)	
	In oil (between phase and phase to ground) • HV • LV	
	In air (between phases and phase to ground • HV • LV	
41	Transformer Tank	
41.i	Type of tank	
41.ii	Approximate thickness of sheet	
	Sides (mm)	
	Bottom(mm)	
	Cover(mm)	
41.iii	Cooling tubes / radiators (mm)	
41.iv	Vacuum recommended for hot oil circulation (Torr)	
41.v	Vacuum to be maintained during oil filling in tank (Torr)	
41.vi	Vacuum to which the tank can be subjected without distortion (Torr)	
41.vii	No. of bi-directional wheels provided	
41.viii	Track gauge required for the wheels	
	Transverse axis	
	Longitudinal axis	
41.ix	Type of pressure relief device/ explosion vent and pressure at which it operates	
41.x	Volume of Conservator	
41.xi	Total volume (liter)	
41.xii	Volume between the highest and lowest visible oil levels (liter)	
42	Insulation oil	
42.i	Applicable Indian Standard	
42.ii	Specific resistance at 27^0C & 90^0C (ohm-cm)	
42.iii	Tan delta	
42.iv	Water content (ppm)	
42.v	Dielectric strength (break-down voltage kV)	
42.vi	Characteristic of oil after aging test	

42.vii	Sludge content	
42.viii	Neutralization number	
42.ix	Details of oil preserving equipment offered	
43	Gas and oil operated relay	
43.i	Type	
43.ii	Make	
44	Temperature indicators	
44.i	Oil temperature indicator	
	Make and type	
	Permissible setting ranges for alarm and trip	
	Number of contacts	
	Current rating of contracts	
44.ii	Winding temperature indicator	
	Make and type	
	Permissible setting ranges for alarm and trip	
	Number of contracts	
	Current rating of contracts	
44.iii	Whether remote indicators provided. If so, whether equipment required at Employer's control room is included.	
45	Bushing current transformers	
	Location (Phase / Neutral)	
	No. of cores	
	Ratio	
	Burden (VA)	
	Class of accuracy	
	Knee point voltage	
	Magnetizing current at knee point voltage	
	Secondary resistance	
46	Tap changing equipment	
46.i	Make	
46.ii	Type	
46.iii	Power flow-unidirectional / bi-directional / restricted bidirectional	
46.iv	Rated voltage to earth (kV)	
46.v	Rated current(Amps)	
46.vi	Step voltage(Volts)	
46.vii	No. of steps	
46.viii	Control	
46.ix	Parallel operation	
46.x	Protective devices	
46.xi	Auxiliary supply details	
46.xii	Time for complete tap change (one step) Sec	
46.xiii	Diverter selector switch transient time (cycles)	
46.xiv	Value of maximum short circuit current (Amps)	

46.xv	Maximum impulse withstand test voltage with 1/250 micro seconds full wave assembly and ground (kV peak).	
46.xvi	Maximum power frequency test voltage between switch assembly and earth. (kV rms)	
46.xvii	Approx. overall dimension of tap changer (in case of separate tank type) (mm)	
46.xviii	Approx. overall weight (in case of separate tank type) (kg)	
46.ix	Approximate mass of oil (in case of separate tank type) (kg)	
47	Driving mechanism box	
	Make & type	
	Details of apparatus proposed to be housed in the box	
48	Details of anti-earthquake device	
49	Details of gas replenishing arrangement during transportation of transformer	
50	Size of rail recommended for the transformer track.	
51	Method of protecting transformer winding during transportation.	
52	Lifting Jacks	
52.i	No. of jacks in one set	
52.ii	Type & make	
52.iii	Capacity	
52.iv	Pitch	
52.v	Lift	
52.vi	Height in closed position	
52.vii	Mean diameter of thread	
53	Marshalling Box	
	Make and Type	
	Details of apparatus proposed to be housed in the marshalling box.	
54	Approximate weight	
54.i	Core and coils (kg)	
54.ii	Tank and fittings (kg)	
54.iii	Oil (kg)	
54.iv	Total weight of transformer with oil and fittings (kg)	
54.v	Un-tanking weight (kg)	
54.vi	Weight of copper required to complete the transformer (kg)	
54.vii	Weight of steel required to complete the transformer (kg)	
54.viii	Weight of fittings and parts detached for transport (kg)	
55	Quantity of insulating oil (litres)	
56	Minimum clearance height from rail track for handling the bushings (mm)	
57	Crane lift above rail level required for un-tanking (mm)	
58	Minimum bay width required for installation of the transformer	
59	Any other particulars considered necessary / important by the	

	manufacturer	
60	Guarantee	

20.5. 33 KV POWER EVACUATION SYSTEM

20.5.1. VACCUM CIRCUIT BREAKER

Sl. No.	Parameters	Description
A	**Vacuum Circuit Breaker**	
A.1	Type	
A.2	Service (outdoor / indoor)	
A.3	Reference standard	
A.4	Date of last type test	
A.5	Arc quenching medium	
A.6	No. of break / phase	
A.7	Rated voltage	
A.8	Highest voltage	
A.9	Frequency	
A.10	Rated normal current	
A.11	Breaking capacity	
A.12	Making capacity	
A.13	STC for 3 Sec.	
A.14	Insulation level : 1.2/50 micro-sec. L.I. withstand voltage (kVp)	
	Between line terminals and ground parts (kVp)	
	Between terminals with breaker contacts open (kVp)	
A.15	One minute Power frequency withstand voltage (kVrms)	
	Between line terminals and ground parts (kVrms)	
	Between terminals with breaker contacts open (kVrms)	
A.16	Rated TRV for terminal fault	
A.17	Minimum creepage distance	
A.18	Temperature rise	
A.19	Operating duty cycle	
A.20	First pole to clear factor	
A.21	Single phase capacitor breaking capacity	
A.22	Cable charging breaking capacity	
A.23	Minimum Pole to Pole clearance	
A.24	Clearance between lower live part of VCB to ground level	
A.25	Clearance between lower live part of the VCB and upper surface of the metallic structure	
A.26	Closing time	
A.27	Opening time	
A.28	Mechanical endurance capacity	
A.29	Electrical endurance capacity	

A.30	Operating mechanism	
A.31	Number of trip coil	
A.32	DC auxiliary voltage	
A.33	AC auxiliary voltage	
A.34	No. of spare contacts aux switch (NO & NC)	
A.35	No. of spare contacts in limit switch (NO & NC)	
A.36	Contact multiplier	
A.37	Space heater	
A.38	Illuminating lamp	
A.39	Anti pumping relay	
A.40	Breaker control switch	
A.41	Local remote switch	
A.42	Spring charging motor	
A.43	Degree of protection of control cubicle	
A.44	Sheet thickness of control cubicle	
A.45	Total height of the breaker from plinth level after erection	
A.46	Total weight of the breaker after erection	
B	**Vacuum Bottle**	
B.1	Make	
B.2	Model no. (supporting literature to be enclosed)	
B.3	Rated voltage	
B.4	Normal current	
B.5	Breaking capacity	
B.6	Making capacity	
B.7	STC for 3 sec	
B.8	Minimum mechanical life in no. of operations	
B.9	Minimum electrical life in no. of operations at rated current	
B.10	Minimum electrical life in no. of operations at 25 kA	
B.11	Dry frequency withstand voltage for 1 min.	
B.12	Impulse withstand voltage	
B.13	Contact material	
B.14	Type of plating	
C	**Low Voltage Terminal Connector**	
C.1	Make	
C.2	Type	
C.3	Size	
D	**Primary Terminal Connector**	
D.1	Material	
D.2	Size	
D.3	Continuous current rating	
D.4	Nuts, bolts & washers	
D.5	Reference Standard	
D.6	Number of connector per VCB	

E	**Trip & close coil**	
E.1	Voltage & wattage of closing coil	
E.2	Voltage & wattage of trip coil	
F	**Control wire**	
F.1	Make	
F.2	Voltage grade	
F.3	Size	
F.4	Colour	
G	**Earthing Terminal**	
G.1	Material	
G.2	Shape	
G.3	Size	
G.4	Current rating	
H	**Painting Details**	
H.1	Surface cleaning process	
H.2	Paint thickness	
H.3	Paint shade	
I	**Accessories**	
I.1	Spring charging handle	
I.2	VCB operating handle	
J	**Property Plate**	
K	**Guarantee**	

20.5.2. ISOLATOR / DISCONNECTING SWITCH

Sl. No.	Parameters	Description
A	**Isolator / Disconnecting Switch**	
A.1	Make	
A.2	Type	
A.3	Model	
A.4	Number of poles	
A.5	Voltage rating	
A.6	Maximum permissible continuous service voltage	
A.7	Current rating in Amps	
	Normal (continuous rating)	
	Maximum & short time current rating for 1 Sec	
	Maximum & short time current rating for 3 Sec	
A.8	Current density at minimum cross section of switch blade	
A.9	Type, material and contact pressure (in kg) of cu contacts and stainless steel spring	
	Moving contact	
	Fixed contact	
	Compression spring	
A.10	Whether contacts are silver faced or tin plated (thickness may	

	be indicated)	
A.11	Temperature rise obtained during type test as per Cl. No.11.1.7 of IS: 1818 of the following at the full rated current in ^{0}C over an ambient temp. of 50^{0}C	
	Contacts	
	Terminals	
	Compression springs	
A.12	Rerating factor for higher ambient temperature	
A.13	Measurement of the resistance of the main circuits (in mV drop) which was obtained during type test as specified in relevant Cl. of IS: 1818 and IS 9921	
	Contacts (fixed and moving)	
	Terminals	
A.14	Frequency	
A.15	Type and material of the terminal connector provided	
A.16	Diameter, wall thickness and length of GI operating pipe	
A.17	Size and length of base mounting MS Galvanised channel provided for the three phase	
A.18	Clearance between live parts of Phase in mm	
A.19	Clearance between live parts of Phase in mm	
A.20	Centre distance between the Insulators of the adjacent phases in mm. in the assembled position of the switch	
A.21	Mounting / fixing hole centre distance in the base channel and sizes	
A.22	Maximum charging current that can be safely interrupted by the switch	
A.23	Maximum capacitive current that can be safely interrupted by the switch	
A.24	Maximum transformer off load breaking capacity current that can be safely interrupted by the switch	
A.25	Maximum line charging breaking capacity	
A.26	Torque required to open the switch	
A.27	Clearance between fixed contact & blade in open condition	
A.28	Particulars of switch contacts	
A.28.i	Material	
A.28.ii	Type	
A.28.iii	Contact Area	
A.28.iv	Contact Pressure	
A.28.v	Whether silver plated or not?	
A.29	mV drop of isolator with 100A (DC)	
	Before operation of Isolator	
	Across Terminal	
	Across Contact	
	After carrying out mutually agreed no. of operations	
	Across terminal	
	Across contact	
A.30	Size of connecting bolts & nuts	

A.31	Whether connector is provided & if so indicate the type & materials used	
A.32	No. of operations that the switch withstand without deterioration of contact	
A.33	No. of times the switch can be operated without any need for inspection	
A.34	Type of mounting	
A.35	Net weight of one complete set	
A.36	Actual dimension of the isolating switch per phase	
A.37	Shipping dimension of the largest packages	
A.38	Guarantee	
B	**Support Insulator**	
B.1	Particulars of insulators	
B.2	Type of insulators	
B.3	Name of manufacturer of insulators	
B.4	Height of the Insulators	
B.5	Diameter of the largest shed	
B.6	No of units per stack	
B.7	Electrical characteristics (for one insulator)	
B.7.i	Flash over voltage • Dry power frequency voltage (kV_{rms}) • Wet power frequency voltage (kV_{rms}) • Impulse voltage of 1.2/50 micro sec.(+ve) (kV_{peak}) • Impulse voltage of 1.2/50 micro sec.(-ve) (kV_{peak})	
B.7.ii	Withstand voltage • Dry Power frequency voltage (kV_{rms}) • Wet Power frequency voltage (kV_{rms}) • Impulse voltage of 1.2/50 micro sec (+ve) (kV_{peak}) • Impulse voltage of 1.2/50 micro sec (-ve) (kV_{peak})	
B.7.iii	Visible discharge voltage (kV_{rms})	
B.7.iv	Power frequency puncture withstand voltage of unit	
B.7.v	Mechanical characteristics • Cantilever strength upright (kN) • Cantilever strength under hung (Inverted) (kN) • Torsional strength (Nm) • Tensile strength (kN) • Compression strength(kN)	
B.7.vi	General characteristics • Minimum creepage distance (mm) • Weight of complete unit (kg) • Weight of nonferrous parts (total) (kg) • Weight of ferrous parts(total) (kg)	
B.7.vii	Standard to which insulator conforms	

20.5.3. CURRENT TRANSFORMER

Sl. No.	Parameters	Description
1	Name of Manufacturer	
2	Type & model of the manufacturer	
3	Conforming standard	
4	Date of last type test	
5	Dead tank or live tank construction	
6	Total height of the CT	
7	Total weight of the CT	
8	Material used in primary winding	
9	Material used in secondary winding	
10	Rated voltage (kV)	
11	Insulation Level	
11.i	1.2/50 micro second Impulse withstand voltage (dry) on primary winding (kV_{peak})	
11.ii	One minute power frequency withstand voltage (Dry) on primary winding (kV_{rms})	
11.iii	One minute power frequency withstand voltage (Wet) on primary winding (kV_{rms})	
11.iv	One minute power frequency withstand test voltage in secondary winding (kV_{rms})	
12	Rated primary current (Amp)	
13	Rated secondary current (Amp)	
14	Extended current rating (Amp)	
15	Short time thermal rating of primary current for 1 sec and 3 sec	
16	Rated dynamic current of primary (kA_p)	
17	Rated continuous thermal current (kArms)	
18	Temperature rise at rated continuous thermal current over 50°C ambient Temp (°C)	
	Winding	
	Oil	
	Exposed current carrying part	
19	Bushing	
	Minimum creepage distance (mm)	
	Whether CT bushing is hermetically sealed or not	
	Cantilever strength (kgf)	
20	Whether nitrogen gas cushion is provided	
21	Whether pressure relief device provided	
22	Material & Size of Stud	
	Primary terminal	
	Secondary terminal	
23	Number of Secondary Winding	
24	Details of cores (to be mentioned for individual cores)	
24.i	Current ratio	
24.ii	Burden	

24.iii	Accuracy class	
24.iv	ALF	
24.v	ISF	
24.vi	Min. V_k at lower ratio	
24.vii	Max. I_e at $V_k/2$	
24.viii	R_{CT} at highest ratio	
25	Weight of oil (kg)	
26	Volume of oil (L)	
27	Fixing hole centre dimension in X & Y direction (mm)	
28	Mounting details	
29	Type of connector	
30	Painting details	
31	Fixing position of secondary terminal box	
32	Degree of protection of secondary terminal box	
33	Guarantee	

20.5.4. POTENTIAL TRANSFORMER

Sl. No.	Parameters	Description
1	Name of manufacturer	
2	Type & model	
3	Conforming standard	
4	Date of last type test	
5	Dead tank or live tank construction	
6	Total height of the PT	
7	Total weight of the PT	
8	Material used in primary winding	
9	Material used in secondary winding	
10	Rated voltage (kV)	
11	Highest Voltage (kV)	
12	Frequency	
13	Insulation Level	
	1.2/50 micro second Impulse withstand voltage (dry) on primary winding (kV_{peak})	
	One minute power frequency withstand voltage (Dry) on primary winding (kV_{rms})	
	One minute power frequency withstand voltage (Wet) on primary winding (kV_{rms})	
	One minute power frequency withstand test voltage in secondary winding (kV_{rms})	
14	Creepage distance	
15	Ratio	
16	Class of accuracy (to be mentioned for individual core)	

17	Burden (to be mentioned for individual core)	
18	Voltage factor	
19	Core identification (to be mentioned for individual core)	
20	Material & size of primary stud	
21	Material & size of secondary stud	
22	Primary terminal connector	
23	Fixing hole centre distance	
24	Painting process	
25	Paint shed	
26	IP of secondary terminal box	
27	Weight of oil	
28	Volume of oil	
29	Guarantee	

20.5.5. LIGHTNING ARRESTOR

Sl. No.	Parameters	Description
1	Name of manufacturer	
2	Type & model	
3	Conforming standard	
4	Date of last type test	
5	Diameter of primary stud (mm)	
6	Total height of the LA	
7	Total weight of the LA	
8	No. of units per arrestor	
9	Rated voltage of units	
10	MCOV	
11	Switching surge Impulse withstand voltage with 250/2500 micro sec. wave (kV_p)	
12	Lightning Impulse Residual voltage (kV_p) (8/20 microsecond wave)	
13	Temporary over voltage capability (kV_{rms})	
	0.1 seconds	
	1.0 seconds	
	10.0 seconds	
	100.00 seconds	
14	Residual voltage after passing a steep current (1 microsecond front time) with amplitude equal to nominal discharge current	
15	Residual voltage for switching impulse currents (front time of about 30 to 60 microseconds) in kV crest at 500/1000 Amps	
16	Maximum RIV at 1.1 U_r / √3 voltage at 1 MHz (micro volts)	
17	Nominal discharge current (kAp) (for 8/20 micro-sec. wave)	
18	High current Impulse withstand capacity (4/10 micro-sec.)(kAp)	
19	I_r at MCOV	

20	I_c at MCOV	
21	Minimum energy discharge capability (kJ/kV)	
22	Long duration discharge class	
23	Pressure relief class	
24	Protective ratio based on transformer / reactor BIL	
	5000 Amps	
	10,000 Amps	
25	Material of housing	
26	Insulator	
27	Total creepage distance of whole arrestor housing (mm)	
28	Cantilever strength of complete Arrestor (kgf)	
29	LA Housing Insulation Withstand (kV)	
30	Dry power frequency withstand voltage	
31	Wet power frequency withstand voltage	
32	Lightning Impulse (Dry)	
33	Partial discharge in pico-coulomb	
34	Corona extinction voltage (kV_{rms})	
35	Type of surge monitor	
36	Each ZNO block dimensions	
37	Guarantee	

20.5.6. ACSR DOG CONDUCTOR

Sl. No.	Parameters	Description
1	Code Word	
2	Maker's name and address	
	Aluminium rods	
	Steel rods	
	Complete conductor	
3	Stranding and wire diameter	
3.i	Aluminium	
	Nominal	
	Minimum	
	Maximum	
3.ii	Steel	
	Nominal	
	Minimum	
	Maximum	
4	Nominal aluminium area in mm^2	
5	Sectional area of aluminium in mm^2	
6	Total sectional area in mm^2	
7	Cross sectional area of nominal diameter wire in mm^2	
7.i	Aluminium	

7.ii	Steel	
7.iii	Overall diameter of conductor in mm	
8	Breaking load of conductor in kN	
9	Minimum breaking load for	
9.i	Aluminium wire	
	Before stranding	
	After stranding	
9.ii	Steel wire	
	Before stranding	
	After stranding	
10	Zinc coating of steel wire	
10.i	Uniformity of coating, number & duration of dips process test withstood, 1 Min x nos, ½ Min x nos	
	Before stranding	
	After stranding	
10.ii	Minimum weight of coating gm / m^2	
	Before stranding	
	After stranding	
11	Mass in kg per km	
	Aluminium	
	Steel	
	Conductor	
12	Resistance in ohm per km at 20^0C	
	Aluminium	
	Conductor	
13	Continuous maximum current rating of conductor (Amps. In still air at 45^0C ambient temperature)	
14	Modulus of elasticity of conductor	
15	Co-efficient of linear expansion per ^{0}C of	
	Aluminium wire	
	Steel Wire	
	Conductor	
16	Standard length of each piece in km	
17	Approximate dimensions of the drum in mm	
18	Weight of the conductor in one drum in kg	
19	Weight of the drum in kg	
20	Gross weight of the drum including weight of the conductor	
21	Standard according to which the conductor will be manufactured and tested	
22	Other particulars if any	
23	Guarantee	

20.5.7. INSULATOR

Sl. No.	Parameters	Description
A	**33 kV Pin Insulator**	
A.1	Name of the manufacturer	
A.2	Nominal system voltage (kV)	
A.3	Highest system voltage (kV)	
A.4	Height of the insulator (mm)	
A.5	Dia. of largest shed (mm)	
A.6	Weight per unit (kg)	
A.7	Conductor groove (mm)	
A.8	Creepage distance (mm)	
A.9	Minimum failing load (kN)	
A.10	Power frequency visible discharge voltage (kV_{rms})	
A.11	Minimum withstand test voltage	
A.11.i	Power Frequency One Minute Dry (kV_{rms})	
A.11.ii	Power Frequency One Minute Wet (kV_{rms})	
A.11.iii	1.2/50 micro-second wave Impulse Withstand Voltage	
	Positive Wave (kV_{peak})	
	Negative Wave (kV_{peak})	
A.12	Power frequency puncture withstand voltage (kV rms)	
A.13	Minimum flash over voltage	
A.13.i	Power frequency one minute dry (kV_{rms})	
A.13.ii	Power frequency one minute wet (kV_{rms})	
A.13.iii	1.2/50 micro-sec wave Impulse flashover voltage (kV_{peak})	
a)	Positive wave (kV_{peak})	
b)	Negative wave (kV_{peak})	
A.14	Colour of glaze	
A.15	Marking on Insulator (To be specified as per IS)	
B	**11 kV disc insulator**	
B.1	Name of the manufacturer	
B.2	Nominal system voltage (kV)	
B.3	Highest system voltage (kV)	
B.4	Minimum creepage distance	
B.5	Height of complete unit (mm)	
B.6	Weight of complete unit (kg)	
B.7	Weight of Insulator Portion (kg)	
B.8	Tension strength	
B.9	PF visible discharge voltage (kVrms)	
B.10	PF Minimum flash over voltage	
	a) One minute dry (kV_{rms})	
	b) One minute wet (kV_{rms})	
B.11	Impulse flashover voltage 1.2/50 micro second wave	
	a) Positive (kV_{peak})	
	b) Negative (kV_{peak})	

B.12	PF withstand voltage	
	a) One minute dry	
	b) One minute wet	
B.13	Impulse withstand voltage 1.2/50 micro-sec. wave (kV_{peak})	
B.14	PF puncture withstand voltage (kV_{rms})	
B.15	Nominal dia of ball, ball pin, socket & security clip	
B.16	Min. failing load (kN)	
B.17	Size of the disc	
	a) Diameter (mm)	
	b) Unit Spacing (mm)	
B.18	Other Dimension of the Ball & Socket (mm)	
B.19	Colour of Glaze	
B.20	Marking on Insulator (to specify as per IS)	
B.21	Grade of materials used and ref. to relevant standard	

20.6. LT SWITCHGEAR

Sl. No.	Parameters	Description
1	Name & Address of the manufacturer	
2	Basic parameters of the equipment	
a)	Rated continuous current	
b)	Short time current	
c)	Making current (momentary 1 second) withstand rating	
d)	Temp. rise at rated current above ambient temp. of 40^0C	
e)	Power frequency withstand test	
f)	Thickness of sheet steel used in • front side (mm) • rear side (mm) • bottom (mm)	
3	Circuit Breakers (ACB / MCCB) (each item to be mentioned separately)	
i)	Name of manufacturer	
ii)	Type, model and designation	
iii)	Applicable standard	
iv)	Number of poles	
v)	Continuous current rating	
vi)	Frequency	
vii)	Operating time	
viii)	Closing time	
ix)	Contact parting, cycles	
x)	Rated interrupting time, cycles	
xi)	Method of closing	
xii)	Type of main contacts	
xiii)	Closing coil voltage range %	

	Closing coil current	
xiv)	Tripping coil voltage range %	
	Tripping coil current	
xv)	Spring charging motor voltage range of operation%	
xvi)	Power required at rated voltage (110V DC) for, Closing coil (W) Tripping coil (W)	
xvii)	Number of auxiliary contacts NO + NC	
xviii)	Rated short time breaking current, one second (kA)	
xix)	Weight of the circuit breaker (kg)	
xx)	Are breakers completely interchange-able [Yes / No]	
4	Bus Bars	
i)	Applicable standard	
ii)	Material and cross section of each bus bar (mm^2)	
iii)	Number of bus bars per phase and their arrangement	
iv)	Voltage rating (V)	
v)	Continuous current rating (A)	
vi)	Short time rating for one second (kA)	
vii)	Clearance between phases (mm)	
viii)	Clearance between phase and ground (mm)	
ix)	Support insulator type	
x)	Support insulator material	
5	Current Transformers (each type to be mentioned separately)	
i)	Name of manufacturer	
ii)	Type, model and designation	
iii)	Transformation ratio	
iv)	One second thermal current (kA)	
v)	Rated dynamic current (kA)	
vi)	Accuracy class	
vii)	VA burden	
viii)	ISF / ALF, as per applicability	
ix)	Frequency	
x)	Applicable standard	
6	Potential Transformers(separate (each type to be mentioned separately)	
i)	Name of manufacturer	
ii)	Type, model and designation	
iii)	applicable Standard	
iv)	Transformation ratio	
v)	VA burden	
vi)	Accuracy class	
vii)	Rated voltage factor	
viii)	Winding connection	
7	MCB / MCCB	

i)	Name of manufacturer	
ii)	Type, model and designation	
iii)	Applicable Standard	
iv)	rated voltage	
v)	rated current	
vi)	Rupturing current at rated Voltage (kA)	
8	Instruments and Meters	
i)	Name of manufacturer	
ii)	Type, model and designation	
iii)	Applicable standard	
iv)	Size	
v)	VA burden	
vi)	Power consumption	
vii)	Temperature at which calibrated	
viii)	Maximum scale length	
ix)	Accuracy	
x)	Undertaking form as per Cl. No. 4.20 attached [Yes / No]	
9	Control and Selector Switch	
i)	Name of manufacturer	
ii)	Type, model and designation	
iii)	Applicable Standard	
iv)	Number of positions	
v)	Number of contacts (NO+NC) available in each position	
10	Relays (each type to be mentioned separately))	
i)	Name of manufacturer	
ii)	Type, model and designation	
iii)	Applicable Standard	
iv)	Draw out / non draw-out	
v)	VA Burden	
vi)	Type of mounting, flush or projecting	
vii)	Operating voltage	
viii)	Power consumption	
ix)	Contact dropout time (ms)	
x)	Number of NO + NC contacts	
xi)	Contact interrupting capacity (A)	
xii)	Undertaking form as per Cl. No. 4.19 attached [Yes / No]	
11	Timers	
i)	Name of manufacturer	
ii)	Applicable standard	
iii)	Type & Model	
iv)	Range	
12	Terminal Blocks	
i)	Standard	

ii)	For current transformer	
	Manufacturer	
	Type	
iii)	For Control Wiring	
	Manufacturer	
	Type	
iv)	For Potential Transformer	
	Manufacturer	
	Type	
13	Indicating Lights	
i)	Manufacturer	
ii)	Type	
iii)	Applicable standard	
14	415 V auxiliary switchboards (each type of panel to be furnished separately)	
i)	Name of manufacturer	
ii)	Type, model and designation	
iii)	Applicable standard	
iv)	Overall dimension of each switchboard / panel (mm)	
v)	Thickness of sheet steel used in • front side (mm) • rear side (mm) • bottom (mm)	
vi)	Enclosure protection	
vii)	Details of feeders with MCCB rating of each	
viii)	Dimension of block outs at the bottom for receiving power and control cables (L x W)	
ix)	Details of painting inside and outside	
15	Guarantee	

20.7. DC SYSTEM

Sl. No.	Parameters	Description
A	**DC Battery**	
A.1	General	
A.1.i	Name and address of the manufacturer	
A.1.ii	Location of factory	
A.1.iii	Conforming standards	
A.1.iv	Type model of the battery	
A.1.v	Date of last type test	
A.1.vi	Ampere-hour capacity at 10 hour rate of discharge (Ah)	
A.1.vii	No. of positive plates per battery	
A.1.viii	Total no. of plates per battery	
A.1.ix	Battery voltage before charging	

A.1.x	Battery voltage after full charging	
A.1.xi	No. of battery in each bank	
A.2	Capacity in ampere-hours of the battery for (AH / end voltage)	
A.2.i	1 hour load	
A.2.ii	5 hours load	
A.2.iii	10 hours load	
A.2.iv	Ampere hour efficiency	
A.2.v	Watt hour efficiency	
A.3	Electrical Parameters	
A.3.i	Short circuit current	
A.3.ii	Current: trickle charging	
A.3.iii	Voltage: trickle charging	
A.3.iv	Current: quick charging	
A.3.v	Voltage: quick charging	
A.3.vi	Recommended value of float charging voltage	
A.3.vii	Internal resistance of charged battery (milli ohms)	
A.3.viii	Total resistance of the bank including interconnection between the cells (ohms)	
A.4	Battery Container	
A.4.i	Materials of containers	
A.4.ii	Thickness, type and material of separators	
A.4.iii	Volume of Electrolytes required for first filling (including 10% extra) (liter)	
A.4.iv	Weight of electrolyte per battery	
A.4.v	Specific gravity of electrolyte at 27°C with all cells fully charged	
A.4.vi	Specific gravity of electrolyte at the end of discharge at 10 hour discharge rate	
A.4.vii	Construction details of positive plate	
A.4.viii	Construction details of negative plate	
A.4.ix	Surface area of plates mm^2	
A.4.x	Clearance between edges of plates and inner surface of container (mm)	
A.4.xi	Clearance between bottom of negative plates and bottom of container (mm)	
A.4.xii	Clearance between top of plates and top of container (mm)	
A.4.xiii	Sediment space (depth) (mm)	
A.4.xiv	Distance between centres of cells when erected (mm)	
A.4.xv	Dimensions of each battery (L x B x H) (mm)	
A.4.xvi	Thickness of container (mm)	
A.4.xvii	Net weight of the Battery, complete with Electrolyte (Kg)	
B	**Battery Charger**	
B.1	General	
B.1.i	Name of manufacturer	
B.1.ii	Location of the factory	

B.1.iii	Date of last type test done	
B.1.iv	Conforming standard	
B.1.v	Type & model of the charger as per manufacturer	
B.1.vi	Total dimension of float cum boost charger (L x B x H) in mm	
B.1.vii	Minimum thickness of sheet (mm)	
B.2	Charger Characteristics	
B.2.i	Capacity (min.) of battery charger in Ah	
B.2.ii	Float / trickle charging current (A)	
B.2.iii	Boost / quick charging current (A)	
B.2.iv	Voltage regulation of float charger (%)	
B.2.v	Ripple content (%)	
B.3	Component Parameters	
B.3.i	Type of thyristor with model	
B.3.ii	Manufacturer of thyristor	
B.3.iii	Rating of thyristor	
B.3.iv	Type of diode with model	
B.3.v	Manufacturer of diode	
B.3.vi	Rating of diode	
B.3.vii	Rating of three phase transformer (kVA)	
B.3.viii	Manufacturer of 3 phase transformer	
B.4	Relays & Contractors with range	
B.4.i	Input under voltage relay	
B.4.ii	Single phasing alarm relay	
B.4.iii	Phase reversal relay	
B.4.iv	DC output overvoltage relay	
B.4.v	DC output under-voltage relay	
B.4.vi	Charger failure relay	
B.4.vii	DC earth fault relay	
B.4.viii	AC input failure relay	
B.4.ix	Fuse failure relay	
B.4.x	Output contractor (load side)	
B.4.xi	Output contractor (battery side)	
B.4.xii	Tap cell contractor	
B.4.xiii	Confirmation of both auto & manual control (Yes / No)	
B.4.xiv	Confirmation of both local & remote alarm provision (Yes / No)	
B.4.xv	Undertaking form as per Cl. No. 4.19 attached [Yes / No]	
C	**DC Distribution Board**	
C.1	Manufacturer	
C.2	Type designation	
C.3	Applicable Standard	
C.4	Total number of feeders	
C.5	Rated voltage	
C.6	Rated current of feeders	

C.7	Power frequency withstand voltage for 1 min.	
C.8	Rated current of incoming feeder and bus-bar (A)	
C.9	Short-circuit withstand current for 1 s (kA)	
C.10	Protection class of cubicle	
C.11	Overall dimensions of complete distribution board (L x W x H)	
D	**DC MCCBs (each type of MCCBs to be furnished separately)**	
D.1	Rated current	
D.2	No of poles	
D.3	Short circuit current	
D.4	Short circuit braking current time	
D.5	Whether thermal overload provided	
D.6	Whether short circuit release provided	
D.7	No. of current settings and range of each setting	
E	**Guarantee**	

20.8. DIESEL GENERATOR SET

Sl. No.	Parameters	Description
1	Diesel engine	
1.1	Manufacturer	
1.2	Type designation	
1.3	Applicable standards	
1.4	Engine gross power (kW)	
1.5	Engine net power(rated continuous output) kW	
1.6	Engine overload capacity (output) for one hour (kW)	
1.7	Radiator capacity (kW)	
1.8	Lubrication oil consumption (max.) l/h	
1.9	Fuel consumption	
	- 100 % load l/kWh	
	- 75 % load l/kWh	
	- 50 % load l/kWh	
1.10	Air aspiration (m^3/min)	
1.11	Cooling air flow(m^3/min)	
1.12	Exhaust outlet diameter (mm)	
1.13	Exhaust flow (total) (m^3/min)	
1.14	Exhaust gas temperature (°C)	
1.15	Engine speed rpm	
1.16	Maximum starting time (from starting to full output) (sec)	
2	Generator	
2.1	Manufacturer	
2.2	Type designation	
2.3	Applicable standards	
2.4	Rated generator output (kVA)	

2.5	Rated power factor cosϕ	
2.6	Generator efficiency at rated output and power factor %	
2.7	Diesel generator set continuous output (kW)	
2.8	Rated voltage	
2.9	Rated frequency	
2.10	Rated speed	
2.11	Noise level (taking complete machine into account) db	
3	Starting battery	
3.1	Applicable standards	
3.2	Rated voltage	
3.3	Battery capacity at 27°C	
	- at 10 hours Ah	
	- at 1 hour Ah	
3.4	Type of battery	
4	Guarantee	
Informative Data		
1	Diesel engine	
1.1	Number of cylinders	
1.2	Cylinder arrangement	
1.3	Cylinder bore (mm)	
1.4	Cylinder stroke (mm)	
2	Generator	
2.1	Insulation class of winding	
2.2	Winding temperature rise at rated output	
2.3	Protection class of enclosure	
3	DG auxiliaries	
3.1	Power requirements	
	- cooling fan motor (kW)	
	- fuel oil transfer pump (kW)	
	- total power requirements for complete system (kW)	
3.2	Capacity of day tank (liter)	
3.3	Capacity of main oil storage tank l x 10^3	
4	Weight	
4.1	Weight of complete DG set including base frame (kg)	
4.2	Weight of	
	- engine (kg)	
	- generator (kg)	
5	Dimensions	
5.1	Complete diesel generator set including base frame	
	- length mm	
	- height mm	
	- width mm	
5.2	Radiator heat exchanger	

	- depth (mm)	
	- height (mm)	
	- width (mm)	
5.3	Main oil storage tank	
	- length (mm)	
	- height (mm)	
	- width (mm)	
5.4	Day tank	
	- length (mm)	
	- height (mm)	
	- width (mm)	

20.9. SUPERVISORY CONTROL AND DATA ACQUISITION SYSTEM (SCADA)

Sl. No.	Parameters	Description
1	Central control system	
1.1	Manufacturer	
1.2	Type	
1.3	Applicable standards	
1.4	System structure	
1.5	Number of system levels	
1.6	Number of communication levels	
1.7	Configuration of field levels	
1.8	Minimum / maximum system components	
1.9	Hardware - details	
1.10	Communication details	
1.11	Details of equipment / instruments to be supplied with number, size, weight, etc.	
2	Unit Control Boards	
2.1	Manufacturer	
2.2	Type	
2.3	Applicable standards	
2.4	Size (L x W x H) (mm)	
2.5	Weight (kg)	
2.6	Details of equipment / instruments to be supplied with number, size, weight, etc.	
3	Bus system (each type to be provided separately)	
3.1	Manufacturer	
3.2	Type	
3.3	Applicable standards	
3.4	Guaranteed response time	
3.4.1	Order response time (sec)	
3.4.2	Alarm response time (sec)	

3.4.3	Event response time (sec)	
3.5	Details of equipment / instruments to be supplied as per Particular Technical Specifications	
4	Position / pressure / level / temp. transmitter, temp. element, level, pressure, limit, flow switch, pressure gauges temp. control valves (each type to be provided separately)	
4.1	Manufacturer	
4.2	Type	
4.3	Applicable standards	
4.4	Accuracy %	
4.5	Protection class IP	
4.6	Response time (sec)	
4.7	Output signal (mA/V)	
4.8	Power supply voltage	
4.9	Ambient temperature	
4.10	Construction details with documentation	
4.11	Any other technical data	
5	Electrical indication, digital indication, alarm unit (to be given separately for each type/category)	
5.1	Manufacturer	
5.2	Type	
5.3	Applicable standards	
5.4	Dimensions (mm)	
5.5	Accuracy (%)	
5.6	Max. ambient temperature	
5.7	Type of indicated figures	
6	Interposing relays	
6.1	Manufacturer	
6.2	Type	
6.3	Applicable standards	
6.4	Power requirements (VA)	
6.5	Contacts permissible power (W)	
6.6	Undertaking form as per Cl. No. 4.19 attached [Yes / No]	
7	All recorders (each type to be provided separately)	
7.1	Manufacturer	
7.2	Type	
7.3	Applicable standards	
7.4	Accuracy	
7.5	Max. ambient temperature	
7.6	Dimensions	
7.7	Input signals	
7.8	Input requirements	
8	Printers (each type to be provided separately)	
8.1	Manufacturer	

8.2	Type	
8.3	Applicable standards	
8.4	Power requirement (W)	
8.5	Supply voltage	
8.6	Speed (Ch/s)	
8.7	Characters per line (Ch/line)	
9	Video Display Unit	
9.1	Manufacturer	
9.2	Type	
9.3	Applicable standards	
9.4	Number of units nos.	
9.5	Power requirement (W)	
9.6	Supply voltage	
9.7	Over all dimensions (mm)	
9.8	Screen dimensions (mm)	
9.9	Maximum resolution pixel at frequency Hz	
10	I/O station (each category to be provided separately)	
10.1	Manufacturer	
10.2	Type	
10.3	Applicable standards	
10.4	Max. no. of contact inputs nos.	
10.5	Max. no. of analogue inputs nos.	
10.6	Max. no. of common outputs nos.	
10.7	Power requirement	
10.8	Supply voltage	
11	System software	
11.1	Manufacturer	
11.2	Type	
12	Control room desk and panel (to be given separately)	
12.1	Manufacturer	
12.2	Type	
12.3	Applicable standards	
12.4	Mosaic tile mounting details with dimensions (for panels only)	
12.5	Over all dimensions (mm)	
12.6	Colour	
13	Any other details required	
14	Detailed bill of material (to be given in a separate sheet)	
15	Guarantee	

20.10. CABLES, CABLE RACKS & TRAYS

Sl. No.	Parameters	Description
1	11 kV Power cables	
1.1	Manufacturer	
1.2	Type designation	
1.3	Applicable standards	
1.4	Rated voltage (kV)	
1.5	Highest voltage for equipment U_m (kV)	
1.6	Power frequency withstand voltage (kV_{rms})	
1.7	Test voltage at factory for 1 minute (kV_{rms})	
1.8	Test voltage at site after laying (kV)	
1.9	Material of conductor	
1.10	Material of insulation	
1.11	Minimum thickness of insulation (mm)	
1.12	Type of screen	
1.13	Material of screen	
1.14	Max. conductor temperature at	
	- service conditions (°C)	
	- fault conditions	
1.15	Whether cables FRLS Type	
2	Low voltage Power Cables (to be filled in for each type)	
2.1	Manufacturer	
2.2	Type designation	
2.3	Applicable standards	
2.4	Rated voltage (kV)	
2.5	Test voltage at factory during minutes (kV_{rms})	
2.6	Material of conductor	
2.7	Material of insulation	
2.8	Minimum thickness of insulation (mm)	
2.9	Type of screen	
2.10	Material of screen	
2.11	Max. conductor temperature at	
	- service conditions (°C)	
	- fault conditions	
2.12	Whether cables FRLS type	
3	Control & Instrumentation cables (to be filled in for every type)	
3.1	Manufacturer	
3.2	Type	
3.3	Standards	
3.4	Voltage rating (V)	
3.5	Test voltage (V)	
3.6	Conductor material	
3.7	Conductor insulation material	
3.8	Screening / armouring	

3.9	Whether cables FRLS Type	
4	Cable trays	
4.1	Manufacturer	
4.2	Type	
4.3	Standards	
4.4	Material	
4.5	Corrosion protection	
4.6	Material of bolts, nuts, etc.	
4.7	Whether literature for cable trays enclosed	
5	Any other information as required	
6	Guarantee	

20.11. EARTHING SYSTEM

Sl. No.	Parameters	Description
A	**Grounding Conductor**	
A.1	Size of the conductor for earth mat	
A.2	Size of the conductor for riser	
A.3	Size of the conductor for equipment connection	
A.4	Material for earth mat, riser, equipment connection	
A.5	Fault current for calculation of size of the conductor	
A.6	Duration of fault	
A.7	Type of joints in the earth mat (welded / bolted)	
A.8	Corrosion allowance	
A.9	Maximum conductor temperature (assumed) during the fault	
B	**Grounding rods**	
B.1	Dia of the rod	
B.2	Length of the rod	
B.3	No of rods provided	
B.4	Arrangement of connection of rod to the mat	
C	**Earth Mat**	
C.1	Soil Resistivity	
C.2	Area of the mat	
C.3	Size of the grid	
C.4	Size of the conductor for the earth Mat	
C.5	Length of the conductor	
C.6	Resistance of the mat	
C.7	Calculated resistance of the ground Rods	
C.8	Combined resistance of Mat & Rods	
C.9	Effective Resistance of mat conductor & (rods) and penstocks (1 penstock, 2 penstocks)	
D	**Step & touch potential**	
D.1	Resistively of the concrete	

D.2	Fault clearing time for calculation of touch / step potential	
D.3	Fault current	
D.4	Grid current	
D.5	Allowable touch potential	
D.6	Actual potential of the mat during fault	
D.7	Whether Mat potential is safe / unsafe	
D.8	If unsafe, measures adopted for limiting the potential within safe value	
D.9	Whether penstocks included in the Mat calculations	

20.12. VENTILATION SYSTEM

Sl. No.	Parameters	Description
1	Fans (each type to be mentioned separately)	
1.1	Type of fan (centrifugal / axial flow / propeller)	
1.2	No. of each type	
1.3	Purpose	
1.4	Location to be installed	
1.5	Capacity (m^3/hr)	
1.6.	Size (mm)	
1.7	RPM	
1.8	Net power requirement of the fan assembly (kW)	
1.9	Outlet velocity (m/sec)	
1.10	Static pressure (mm of Hg)	
1.11	Whether Acid resistant coating provided	
1.12	Direction of rotation as viewed from drive end	
1.13	Blades	
	- No. of Blades	
	- Type of Blades (forward curved / backward curved / radial)	
1.14	Tip speed	
1.15	Type of fan shaft bearing	
1.16	Diameter of fan impeller	
1.17	Diameter of fan casing (mm)	
1.18	Type of drive with details (mm)	
1.19	Overall dimensions	
1.20	Type of guards with location	
1.21	Mounting details	
1.22	Fan efficiency	
1.23	Weight (kg)	
1.24	Material of construction of	
	- Fan casing	
	- Fan blades	
	- Structural base	

	- Shaft	
	- Dampers	
	- Resilient mounting	
2	Dampers	
2.1	Manufacturer	
2.2	Capacity (m^3/hr)	
2.3	Friction drip	
2.4	Material of construction	
2.5	Type of control (manual / automatic)	
2.6	Locations	
2.7	Overall dimensions and weight (mm x mm x mm)	
2.8	No. and gauge of leaves (mm)	
3	Motors	
3.1	Manufacturer	
3.2	Three phase / single phase	
3.3	Location	
3.4	Type	
3.5	RPM at rated output	
3.6	Rating (kW / HP)	
3.7	Type of enclosure	
3.8	Starting current	
3.9	Full load current	
3.10	Winding insulation	
3.11	Temperature rise	
3.12	Minimum voltage required at the motor terminal during starting period	
3.13	Details of starters and control gear	
3.14	Overall and mounting dimensions of starter (L x B)	
3.15	Gross weight of motor (kg)	
4	Air Conditioners	
4.1	Make	
4.2	Type	
4.3	Rating	
4.4	Number	
4.5	Location of installation	
4.6	Protection system provided	
5	Any other information not included above	
6	Guarantee	

20.13. EOT CRANE FOR POWER HOUSE

Sl. No.	Parameters	Description
1	Estimate weight	
1.1	Unladen weight of the hoist including structural portion	
1.2	Unladen weight of crane excluding hoist mentioned in 1.1 but including longitudinal travel mechanism	
2	General	
2.1	Rated capacity of the crane (tonne / tonne)	
2.2	Hoisting speed (m / min)	
2.3	Longitudinal travel (m / min)	
2.4	Section of rail track proposed	
3	Longitudinal Travel Mechanism	
a)	Wheels	
	– Wheel base	
	– No. of wheels on each side	
	– Diameter of wheels	
	– Maximum load on wheel excluding impact	
b)	Motor data	
	– Manufacturer	
	– Type	
	– Type of enclosures	
	– Rated output	
	– Voltage	
	– Number of phases	
	– Speed at rated output	
	– Full load current	
	– Maximum starting current	
	– Frame size	
	– Class of insulation	
	– Thermal protection	
	– Type of bearings	
	– Break down torque of motor	
c)	Electromagnetic brake	
	– size	
	– Torque capacity	
d)	Total gear reduction proposed	
4	Cross Travel Mechanism	
a)	Wheels	
	– Wheel base	
	– No. of wheels on each side	
	– Diameter of wheels	
	– Maximum load on wheel excluding impact	
b)	Motor data	
	– Manufacturer	

	– Type	
	– Type of enclosures	
	– Rated output	
	– Voltage	
	– Number of phases	
	– Speed at rated output	
	– Full load current	
	– Maximum starting current	
	– Frame size	
	– Class of insulation	
	– Thermal protection	
	– Type of bearings	
	– Break down torque of motor	
c)	Electromagnetic brake	
	– size	
	– Torque capacity	
d)	Total gear reduction proposed	
5	Hoist	
a)	Estimated weights etc.	
i)	Top connecting beam with counter weights, walkway, guard railing, stairway and ladders etc.	
ii)	Hoist	
b)	General	
i)	Estimated hoist capacity (indicating break-up of uplift forces, seal friction, bearing friction, resistance to silt tearing, guide friction, reserve capacity and any other factor considered)	
ii)	Manual operation arrangement	
iii)	Lift indicator arrangement	
iv)	Wall way arrangement (grating, chequered plates, removable hatch covers and ladders/rungs etc.)	
v)	Arrangement of wire rope reeling with details of wire rope attachments.	
c)	Motor Data	
	– Manufacturer	
	– Type	
	– Type of enclosures	
	– Rated output	
	– Voltage	
	– Number of phases	
	– Speed at rated output	
	– Full load current	
	– Maximum starting current	
	– Frame size	
	– Class of insulation	

	– Thermal protection	
	– Type of bearings	
	– Break down torque of motor	
d)	Total gear reduction proposed	
e)	Brake	
	– Size	
	– Torque capacity	
f)	Hook travel	
	– Upper limit of travel	
ix)	Indicate dimensions and weights of	
6	Largest package / component to be transported	
a)	Description	
b)	Weight	
c)	Dimensions	
	Length (m)	
	Width (m)	
	Height (m)	
7	Heaviest package/component to be transported	
a)	Description	
b)	Weight	
c)	Dimensions	
	Length (m)	
	Width (m)	
	Height (m)	
8	Bulkiest package/component to be transported	
a)	Description	
b)	Weight	
c)	Dimensions	
	Length (m)	
	Width (m)	
	Height (m)	
9	Guarantee	

20.14. ILLUMINATION SYSTEM

Sl. No.	Parameters	Description
1	Moulded Case Circuit Breaker (MCCB) (each type to be mentioned separately)	
i)	Make	
ii)	Type & designation	
iii)	Ratings	
iv)	Number of poles	
v)	Service voltage	
vi)	Continuous current rating	

vii)	Frequency	
viii)	Making capacity in peak (kA)	
ix)	Breaking current in (kA)	
x)	Short time current rating (1 sec.)	
xi)	Whether indoor or outdoor	
2	Miniature Circuit Breakers (MCB) (each type to be mentioned separately)	
i)	Make	
ii)	Type & designation	
iii)	Ratings	
iv)	Number of poles	
v)	Service voltage	
vi)	Continuous current rating	
vii)	Frequency	
viii)	Making capacity in peak (kA)	
ix)	Breaking current in (kA)	
x)	Short time current rating (1 sec)	
xi)	Whether indoor or outdoor	
3	Switches and other accessories (each type to be mentioned separately)	
i)	Make	
ii)	Type and designation	
iii)	Voltage grade	
iv)	Current Rating	
4	Distribution & Sub-distribution Boards (separate for 3 Pole & Neutral: TPN and Single Pole Neutral: SPN	
i)	Make	
ii)	Type and designation	
iii)	No. of ways	
iv)	Overall dimensions	
v)	No. & size of cable glands	
vi)	Size of bus bars	
vii)	Neutral bus & neutral arrangement	
viii)	Breaking capacity	
ix)	Sheet thickness	
x)	Type of finish	
5	Main Lighting Boards	
i)	Overall dimensions	
ii)	No. & rating of incoming feeders	
iii)	No. & rating of outgoing feeders.	
iv)	Bus bas rating & breaking capacity	
v)	Clearances	
	Phase to Phase	
	Phase to earth	
vi)	Sheet thickness	

vii)	No. & size of cable	
viii)	Type of finish	
6	Luminaries	
i)	Make	
ii)	Type and designation	
iii)	Overall dimensions	
iv)	Recommended locations	
v)	Lighting distribution curve	
7	Technical Particulars & Leaflets submitted [Yes / No]	
8	Design of Illumination Level	
i)	Lux. level provided for control room	
ii)	Lux. level provided for machine hall & service bay	
iii)	Lux. level provided for office room	
iv)	Lux. level provided for 33 kV outdoor switchyard	
v)	Lux. level provided for tail race & outside of power house	
vi)	Lux. level provided for access road to Power House, Switchyard	
9	Cables (each type to be provided separately)	
i)	Type of cables	
ii)	Size	
iii)	Current rating	
iv)	Wiring for illumination concealed or surface	
10	Details of supporting structure for outdoor lighting	
i)	Switchyard & Transformer yard	
ii)	Approach Roads	
iii)	PH outside area & Tail race	
11	Guarantee	

20.15. FIRE PROTECTION SYSTEM

Sl. No.	Parameters	Description
A	**Electrical control panel**	
A.1	Manufacturer	
A.2	Overall dimensions	
A.3	Details of protection & control provided	
A.4	Make, type and rating of starter	
B	**Temperature sensing elements**	
B.1	Manufacturer	
B.2	Type of element used and material used for sensing	
B.3	No of sensing elements used for each Generator Transformer	
B.4	Operating temperature of sensing elements	
B.5	Range of sensing	
B.6	Life of element	
B.7	Maximum mechanical force withstanding capacity	

B.8	Duration of sensing at rated temp. for actuation of the element	
C	**Fire Bucket**	
C.1	Capacity of each bucket	
C.2	No. of buckets per stand Litres	
C.3	Material of bucket	
C.4	Standard to which it conforms	
D	**Automatic smoke detectors Ionization / Optical (each type to be mentioned separately)**	
D.1	Type of Detectors	
D.2	Material used	
D.3	Effective zone of sensing	
D.4	Element dimension and No. of elements employed	
D.5	Life of elements	
D.6	Recommended setting	
D.7	Numbers to be used for each area	
E	**Portable Fire Extinguishers**	
E.a	**CO_2 type extinguishers (Separate for hand portable & wheeled portable)**	
E.a.1	Manufacturer	
E.a.2	Capacity (kg)	
E.a.3	Number to be installed	
E.a.4	Dimensional details	
E.a.5	Fixing / mounting details	
E.a.6	Details of operation	
E.a.7	Details of maintenance schedule	
E.a.8	Standard to which it conforms	
E.a.9	Safety measures to be adopted for operation	
E.b	**Foam type extinguishers**	
E.b.1	Manufacturer	
E.b.2	Capacity (kg)	
E.b.3	Number to be installed	
E.b.4	Dimensional details	
E.b.5	Fixing/mounting details	
E.b.6	Details of operation	
E.b.7	Details of maintenance schedule	
E.b.8	Standard to which it conforms	
E.b.9	Safety measures to be adopted for operation	
E.c	**Dry chemical type extinguishers**	
E.c.1	Manufacturer	
E.c.2	Capacity (kg)	
E.c.3	Number to be installed	
E.c.4.	Dimensional details	
E.c.5	Fixing/mounting details	
E.c.6	Details of operation	

E.c.7	Details of maintenance schedule	
E.c.8	Standard to which it conforms	
E.c.9	Safety measures to be adopted for operation	
P	**Guarantee**	

20.16. COMMUNICATION, SUPERVISION AND SURVEILLANCE SYSTEM

As per relevant Indian Standard and manufacturer's practice.

20.17. WORKSHOP

As per relevant Indian Standard and manufacturer's practice.

21. APPROVED MAKER'S LIST FOR VARIOUS EQUIPMENT

The list of approved manufacturers as mentioned below is provided for the information to the bidders. However, updated list will be provided to the contractor after placement of LOA. The contractor shall collect the updated list of approved manufacturers from WBSEDCL before procurement / manufacture of any item / equipment. Any item / equipment, not mentioned in the list shall be subjected to WBSEDCL's approval based on credentials, satisfactory performance certificates etc. as submitted by the contractor. WBSEDCL will have the right to reject any such manufacturer without showing any reason to the contractor.

1. 11 / 0.415 kV Distribution Transformers

i. M/s. ABB Ltd.
ii. M/s. Bijay Transformers
iii. M/s. Eastern Transformer& Equipment Pvt. Ltd.
iv. M/s. Marson's Ltd.
v. M/s. RTS Power Corporation
vi. M/s. Transmake Electricals Pvt. Ltd.
vii. M/s. Vijai Electricals Ltd.

2. 11 / 33 kV Power Transformers

i. M/s. ABB Ltd.
ii. M/s. Eastern Transformer & Equipment Pvt. Ltd.
iii. M/s. EMCO Ltd.
iv. M/s. Marson's Ltd.
v. M/s. Marson's Electrical Industries
vi. M/s. Vijai Electricals Ltd.

3. Composite Hardwire Fittings (CHF)

i. M/s. Susmita Electricals
ii. M/s. Rama Industries
iii. M/s. Bharat Electrical and Engineering Works
iv. M/s. Somnath Hardware Stores
v. M/s. Reliance Techno Corporation

4. Isolator

i. M/s. S.C. Ghosh Bros. Pvt. Ltd.
ii. M/s. Mohta Engineering Udyog
iii. M/s. Shaoo Engineering Works Private Ltd.
iv. M/s. J. D. Electricals
v. M/s. Friends's Engineering Works
vi. M/s. Panchkuri Kayal & Co.
vii. M/s. Subir Metal Industries
viii. M/s. G. Nandy & Co.
ix. M/s. Reliance Techno Corporation

5. Insulator

i. M/s. Mayur Electro Ceramic Pvt. Ltd.
ii. M/s. Birla Aditya Insulators Pvt. Ltd.
iii. M/s. Bihar Industrial Corporation

iv. M/s. Bikaner Ceramic Pvt. Ltd.
v. M/s. Ridhi Sidhi Insulator Pvt. Ltd.
vi. M/s. India Potteries Ltd.
vii. M/s. Allied Ceramics Pvt. Ltd.

6. G.I. Pin

i. M/s. Reliance Techno Corporation
ii. M/s. Susmita Electricals
iii. M/s. Bengal Galvanizing Works

7. G.I. Wire / G.I. Stay Wire

i. M/s. Nirmal Wires Pvt. Ltd.
ii. M/s. Ramsarup Industrial Corp.
iii. M/s. R. K. Wire Products Ltd.
iv. M/s. Kedernath Dhoot

8. Conductor AAAC / ACSR

i. M/s. B. S. Industries
ii. M/s. Anish Industrial Corporation
iii. M/s. Laser Cable Pvt. Ltd.
iv. M/s. Lumino Industries Ltd.
v. M/s. Aluminium Electricals Manufacturing Co. Pvt. Ltd.
vi. M/s. Power Cable Industries
vii. M/s. Prateek Wires Pvt. Ltd.
viii. M/s. Mehra Electric Co.
ix. M/s. Bindawala Electrical Industries
x. M/s Bindawala Cable and Conductors Ltd.
xi. M/s. Radhika Transmission Pvt. Ltd.
xii. M/s. Cabcn India Pvt. Ltd.
xiii. M/s. Alcon Employees Industrial Co- operative Society Ltd.

9. Transformer Oil

i. M/s. Apar Industries Ltd.
ii. M/s. Colnmbia Petro-Chem. Pvt. Ltd.
iii. M/s. Savita Chemicals Ltd.

10. Cable

i. M/s. Havell's India Ltd.
ii. M/s. Polycab Wires Pvt. Ltd.
iii. M/s. Torrent Cables Ltd.
iv. M/s. KEC International Ltd.

11. 1.1 kV Power Cable

i. M/s. KEI
ii. M/s. Polycab Wires Pvt. Ltd.
iii. M/s. NICCO
iv. M/s. Gloster
v. M/s. Cable Corporation of India
vi. M/s. Torrent
vii. M/s. Crystal Cable

12. Control Cable

i. M/s. KEI
ii. M/s. Polycab Wires Pvt. Ltd.
iii. M/s. NICCO
iv. M/s. Gloster
v. M/s. Torrent
vi. M/s. Cable Corporation of India

13. Lightning Arrestor

i. M/s. Crompton Greaves Ltd.
ii. M/s. Raychem RPG Ltd.
iii. M/s. Lamco Industries Pvt. Ltd.
iv. M/s. Oblum Electrical Industries Pvt. Ltd.
v. M/s. AREVA T&D India Ltd.
vi. M/s. ABB Ltd.
vii. M/s. Electrolites (Power) Pvt. Ltd.

14. 12 kV Shunt trip Switchgear

i. M/s. AREVA T&D India Ltd.
ii. M/s. BHEL
iii. M/s. BIECCO Lawrie Ltd.
iv. M/s. Crompton Greaves Ltd.
v. M/s. Vijai Electricals Ltd.
vi. M/s. ABB Ltd.

15. 33 kV CT

i. M/s. Crompton Greaves Ltd.
ii. M/s. Chowdhury Industries Corporation Pvt. Ltd.
iii. M/s. Vijai Electricals Ltd.
iv. M/s. Laxmi Engineering

16. 33 kV PT

i. M/s. BHEL
ii. M/s. Crompton Greaves Ltd.
iii. M/s. Vidyut Control Systems Pvt. Ltd.
iv. M/s. Laxmi Engineering

17. 36 kV VCB

i. M/s. BHEL
ii. M/s. AREVA T&D India Ltd.
iii. M/s. Crompton Greaves Ltd.
iv. M/s. Siemens Ltd.
v. M/s. ABB Ltd.
vi. M/s. Schneider Electric
vii. M/s. GE (T&D) (formerly M/s. Alstom)

18. Main Protective Relays (Numerical)

i. M/s. Siemens Ltd.
ii. M/s. ABB Ltd.
iii. M/s. GE (T&D) (formerly M/s. Alstom)

19. Auxiliary Relays

i. M/s. Siemens Ltd.
ii. M/s. ABB Ltd.
iii. M/s. GE (T&D) (formerly M/s. Alstom)

20. Battery

i. M/s. Exide / Chloride India

21. Battery Charger

i. M/s. Caldyne / Chloride India

22. ACDB & DCDB

i. M/s. Control and Switchgear
ii. M/s. Maktel System
iii. M/s. Electro Allied Product
iv. M/s. Unilec
v. M/s. Vikas Engg. Associates
vi. M/s. L&T
vii. M/s. Siemens Ltd.
viii. M/s. Schneider Electric
ix. M/s. Bose Corporation

23. Lighting Equipment

i. M/s. Philips
ii. M/s. Bajaj
iii. M/s. CGL
iv. M/s. Havells

Note:

1. Bidders are requested to go through the tender document for approved / preferred Maker's list for various equipment of 11 kV Indoor Switchgear **(Chapter – 4)**, 33 kV Indoor Switchgear **(Chapter – 6)**, Communication, Supervision & Surveillance System **(Chapter – 17)** also.
2. For any items / equipment, not specifically mentioned above or any other manufacturer for the above items / equipment, the contractor shall submit credentials, experience certificates and performance certificates of previous installations for according approval from WBSEDCL prior to manufacture / procurement.