Bharat Heavy Electricals Ltd.,
Electronics Division,
Mysore Road, Bangalore – 560 026

Tender for VFD System for Barh -1, Barh -2, Mauda and North Karanpura projects

TENDER REFERENCE DOC	NKR0000346
TENDER DOCUMENT AVAILABLE FROM	Refer eprocurement system website
LAST DATE AND TIME FOR SUBMISSION OF TENDER	Refer eprocurement system website
DATE AND TIME FOR TENDER OPENING	Refer eprocurement system website
SUBMISSION OF TENDER	Bidder to submit tender in E-procurement site : **https://bhel.abcprocure.com** Refer instructions give in tender document for offer submission of bid in E-procurement site.

This Tender Document Contains documents as per below index:

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REQUEST FOR QUOTATION

BHARAT HEAVY ELECTRICALS LIMITED
Electronics Division
PB No. 2606, Mysore Road Bangalore - 560026
INDIA

RFQ NUMBER: NKR0000346
RFQ DATE: REFER EPROCUREMENT SYSTEM
RFQ DUE DATE: REFER EPROCUREMENT SYSTEM

(for all correspondence)
Purchase Executive : Nilmani Kumar
Phone :080- 26998663
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Sl No.	Material Code	Description	Qty	Unit	Project	Delivery	
1	PR0900009911	VFD FOR 1250KW, 3.3kV MOTOR	1	Set	Barh - 1	Dec-21	
2	PR0900009911A	REDUNDANT COOLINGFAN FOR VFD TRANSFORMER	1	Set	Barh - 1	Dec-21	
3	PR0900009937	LAPTOP LOADED WITH DRIVE SOFTWARE	1	No.	Barh - 1	Dec-21	
4	PR0900009101	CABLE ACCESSORIES FOR VFD	1	Set	Barh - 1	Dec-21	
5	PR0900009945	SUPERVISION OF ERECTION & COMMISSIONING	1	Set	Barh - 1	Dec-21	
6	PR0900009911	VFD FOR 1250KW, 3.3kV MOTOR	1	Set	Barh - 1	Jun-22	
7	PR0900009911A	REDUNDANT COOLINGFAN FOR VFD TRANSFORMER	1	Set	Barh - 1	Jun-22	
8	PR0900009945	SUPERVISION OF ERECTION & COMMISSIONING	1	Set	Barh - 1	Jun-22	
9	PR0900009911	VFD FOR 1250KW, 3.3kV MOTOR	1	Set	Barh - 1	Dec-22	
10	PR0900009911A	REDUNDANT COOLINGFAN FOR VFD TRANSFORMER	1	Set	Barh - 1	Dec-22	
11	PR0900009945	SUPERVISION OF ERECTION & COMMISSIONING	1	Set	Barh - 1	Dec-22	
12	PR0900005100	MANDATORY SPARES FOR VFD	1	Set	Barh - 1	Dec-22	Package - 1
13	PR0900009911	3.3kV 1250kW VFD as per PS/445/2636	1	Set	North Karanpura U#1	Sep-21	
14	PR0900009911A	Redundant CoolingFan for VFD Transformer	1	Set	North Karanpura U#1	Sep-21	
15	PR0900009911	3.3kV 1250kW VFD as per PS/445/2636	1	Set	North Karanpura U#2	Dec-21	
16	PR0900009911A	Redundant CoolingFan for VFD Transformer	1	Set	North Karanpura U#2	Dec-21	
17	PR0900009911	3.3kV 1250kW VFD as per PS/445/2636	1	Set	North Karanpura U#3	Mar-22	
18	PR0900009911A	Redundant CoolingFan for VFD Transformer	1	Set	North Karanpura U#3	Mar-22	
19	PR0900009937	Laptop for VFD	1	No.	North Karanpura Common	Sep-21	
20	PR0900009101	CABLE ACCESSORIES FOR VFD	1	Set	North Karanpura Common	Sep-21	
21	PR0900005100	MANDATORY SPARES FOR VFD	1	Set	North Karanpura Common	Mar-22	
22	PR0900009945	Erection Supervision & Commsng. for VFD	1	Set	North Karanpura U#1	Sep-21	
23	PR0900009945	Erection Supervision & Commsng. for VFD	1	Set	North Karanpura U#2	Dec-21	
24	PR0900009945	Erection Supervision & Commsng. for VFD	1	Set	North Karanpura U#3	Mar-22	
25	PR0900009929	VFD FOR 900KW, 3.3KV MOTOR	1	Set	Barh - 2	Dec-21	
26	PR0900009911A	REDUNDANT COOLINGFAN FOR VFD TRANSFORMER	1	Set	Barh - 2	Dec-21	
27	PR0900009937	LAPTOP LOADED WITH DRIVE SOFTWARE	1	No.	Barh - 2	Dec-21	
28	PR0900009101	CABLE ACCESSORIES FOR VFD	1	Set	Barh - 2	Dec-21	
29	PR0900009945	SUPERVISION OF ERECTION & COMMISSIONING	1	Set	Barh - 2	Dec-21	
30	PR0900009929	VFD FOR 900KW, 3.3KV MOTOR	1	Set	Barh - 2	Jun-22	
31	PR0900009911A	REDUNDANT COOLINGFAN FOR VFD TRANSFORMER	1	Set	Barh - 2	Jun-22	
32	PR0900009945	SUPERVISION OF ERECTION & COMMISSIONING	1	Set	Barh - 2	Jun-22	
33	PR0900005100	MANDATORY SPARES FOR VFD	1	Set	Barh - 2	Jun-22	
34	PR0900009929	3.3kV 900kW VFD as per PS/445/2636	1	Set	Mauda U#1	Jun-21	Package - 2
35	PR0900009911A	Redundant CoolingFan for VFD Transformer	1	Set	Mauda U#1	Jun-21	
36	PR0900009929	3.3kV 900kW VFD as per PS/445/2636	1	Set	Mauda U#2	Dec-21	
37	PR0900009911A	Redundant CoolingFan for VFD Transformer	1	Set	Mauda U#2	Dec-21	
38	PR0900009937	Laptop for VFD	1	No.	Mauda Common	Jun-21	
39	PR0900009101	CABLE ACCESSORIES FOR VFD	1	Set	Mauda Common	Jun-21	
40	PR0900005100	MANDATORY SPARES FOR VFD	1	Set	Mauda Common	Dec-21	
41	PR0900009945	Erection Supervision & Commsng. for VFD	1	Set	Mauda U#1	Jun-21	
42	PR0900009945	Erection Supervision & Commsng. for VFD	1	Set	Mauda U#2	Dec-21	

i). This is only RFQ not an order.
ii). In all correspondence quote RFQ No. & due date.
iii). Quotation should remain valid for a minimum peiod of 90 days from due date.
iv). Delivery date is tentative. Delivery will be required strictly as per project requirement

ಭಾರತ್ ಹೆವಿ ಎಲೆಕ್ಟ್ರಿಕಲ್ಸ್ ಲಿಮಿಟೆಡ್
भारत हेवी इलेक्ट्रिकल्स लिमिटेड
Bharat Heavy Electricals Ltd.,
(A Government of India undertaking)
Electronics Division
PB 2606 , Mysore Road Bangalore , 560026 INDIA

CE: PR: 002- Rev 02

GENERAL COMMERCIAL CONDITIONS FOR CONTRACT

These 'General Commercial Conditions for Contract for Purchase' herein after referred to as GCC apply to all enquiries, tenders, requests for quotations, orders, contracts and agreements concerning the supply of goods and the rendering of related services (hereinafter referred to as "deliveries") to Bharat Heavy Electricals Limited and any of its units, regions or divisions (hereinafter referred to as "BHEL" or the Purchaser) or its projects/ customers.

Any deviations from or additions to these GCC require BHEL's express written consent. The general terms of business or sale of the vendor shall not apply to BHEL. Acceptance, receipt of shipments or services or effecting payment shall not mean that the general terms of business or sale of the vendor have been accepted.

Orders, agreements and amendments thereto shall be binding if made or confirmed by BHEL in writing. Only the Purchasing department of BHEL is authorized to issue the Purchase Order or any amendment thereof.

Definitions: Throughout these conditions and in the specifications, the following terms shall have the meanings assigned to them, unless the subject matter or the context requires otherwise.

a) 'The Purchaser' means Bharat Heavy Electricals Limited, Electronics division, Mysore road, Bangalore 560 026, a Unit of Bharat Heavy Electricals Limited (A Govt. of India Undertaking) incorporated under the Companies Act having its registered office at BHEL House, Siri Fort, New Delhi-110049, India and shall be deemed to include its successors and assigns. It may also be referred to as BHEL.
b) 'The vendor' means the person, firm, company or organization on whom the Purchase Order is placed and shall be deemed to include the vendor's successors, representative heirs, executors and administrator as the case may be. It may also be referred to as Seller, Contractor or Supplier.
c) 'Contract' shall mean and include the Purchase Order incorporating various agreements, viz. tender/ RFQ, offer, letter of intent/acceptance/ award, the General Conditions of Contract and Special Conditions of Contract for Purchase, Specifications, Inspection/ Quality Plan, Schedule of Prices and Quantities, Drawings, if any enclosed or to be provided by BHEL or his authorized nominee and the samples or patterns if any to be provided under the provisions of the contract.
d) 'Parties to the Contract' shall mean the 'The Vendor' and the Purchaser as named in the main body of the Purchase Order.

Order of Precedence:

In case of any inconsistency or contradiction between any of the documents, the order of precedence shall be Purchase Order, LOI / LOA, Special Conditions of Contract and General Conditions of Contract for commercial conditions; and specific agreement on technical conditions, RFQ/offer and specification for Technical Conditions.

Interpretation:

In the contract, except where the context requires otherwise:

a) words indicating one gender include all genders;
b) words indicating the singular also include the plural and words indicating the plural also include the singular;

c) provisions including the word "agree", "agreed" or "agreement" require the agreement to be recorded in writing, and
d) "Written" or "in writing" means hand-written, type-written, printed or electronically made, and resulting in a permanent record.

Applicable Conditions:

1. Price Basis: All prices shall be firm until the purchase order is executed / completed in all respects. No price variations / escalation shall be permitted.

2. Ordering and confirmation of Order:Vendor shall send the order acceptance on their company letter head/ through e-mail within a week from the date of receipt of Purchase Order or such other period as specified/ agreed by BHEL. BHEL reserves the right to revoke the order placed if the order confirmation differs from the original order placed. The acceptance of goods/services/supplies by BHEL as well as payments made in this regard shall not imply acceptance of any deviations.
   The purchase order will be deemed to have been accepted if no communication to the contrary is received within one week (or the time limit as specified/agreed by BHEL) from the date of receipt of the purchase order.

3. Documentation:After receipt of Purchase Order, vendor should submit necessary documents(if & as applicable) like drawings specified, bill of materials, datasheets, catalogues, quality plan, test procedure, type test report , O & M Manuals and/or any other relevant documents as per Specification/Purchase Order, as and when required by BHEL/Customer.
   At any stage within the contract period, the vendor shall notify of any error, fault or other defect found in BHEL's documents /specifications or any other items for reference. If and to the extent that (taking account of cost and time) any vendor exercising due care would have discovered the error, fault or other defect when examining the documents/specifications before submitting the tender, the time for completion shall not be extended. However if errors, omissions, ambiguities, inconsistencies, inadequacies or other defects are found in the vendor's documents, they shall be corrected at his cost, notwithstanding any consent or approval.

4. Penalty:
   a. For delay in documentation: In the event of delay in submission of complete set of specified documents ((like drawings, bill of materials, datasheets, catalogues, quality plan etc. as called in tender specifications including soft copies wherever applicable) in required sets beyond two(02) weeks (or as agreed/indicated in the SCC/Purchase Order) from the date of receipt of Purchase Order(by email), penalty at 0.5% (half percent) per week or part thereof, limited to a maximum of 5% (five percent) of the basic material value of the Purchase Order will be applicable.

      Penalty for delayed documentation if applicable, shall be deducted at the time of first supply payment. If penalty is applicable for duration of less than a week, penalty @ 0.5% (half percent) of the basic material value will be deducted. GST as applicable will be recovered along with penalty amount.

   b. For delay in delivery: In the event of delay in agreed contractual delivery as per Purchase Order, penalty @ 0.5 % (half percent) per week or part thereof but limited to a max of 10% (ten percent) value of undelivered portion (basic material cost) will be applicable. Delivery will commence from the date of issue of Manufacturing clearance along with approved document. The date for which Inspection call is issued by vendor along with test certificates / test reports /Certificate of Conformance / calibration reports, as proof of completion of manufacturing will be treated as date of deemed delivery for penalty calculation. In the absence of furnishing such document indicated above as proof of completion of manufacturing along with inspection call, actual date of inspection will be considered as date of deemed delivery and BHEL will not be responsible for delay in actual date of inspection.

Penalty for delayed delivery if applicable, shall be deducted at the time of first supply payment. If penalty is applicable for duration of less than a week, penalty @ 0.5% (half percent) of the basic material value will be deducted. GST as applicable will be recovered along with penalty amount.

5. Contract variations (Increase or decrease in the scope of supply): BHEL may vary the contracted scope as per requirements at site. If vendor is of the opinion that the variation has an effect on the agreed price or delivery period, BHEL shall be informed of this immediately in writing along with technical details. Where unit rates are available in the Contract, the same shall be the basis for such additional work. Vendor shall not perform additional work before BHEL has issued written instructions/ amendment to the Purchase Order to that effect. The work which the vendor should have or could have anticipated in terms of delivering the service(s) and functionality (i.e.) as described in this agreement, or which is considered to be the result of an attributable error on the vendor's part, shall not be considered additional work.

6. Inspection: Prior written notice of at least 10 days shall be given along with internal test certificates/COC and applicable test certificates. Materials will be inspected by BHEL-EDN-QS/CQS or BHEL nominated Third Party Inspection Agency (TPIA) or BHEL authorized Inspection Agency or Customer / Consultant or jointly by BHEL & Customer / consultant. All tests have to be conducted as applicable in line with approved Quality plan or QA Checklist or Purchase specification and original reports shall be furnished to BHEL-EDN, Bangalore for verification/acceptance for issue of dispatch clearance. BHEL reserves the right for conducting repeat test, if required.
   All costs related to inspections & re-inspections shall be borne by vendor. Whether the Contract provides for tests on the premises of the vendor or any of his Sub-contractor/s, vendor shall be responsible to provide such assistance, labour, materials, electricity, fuels, stores, apparatus, instruments as may be required and as may be reasonably demanded to carry out such tests efficiently. Cost of any type test or such other special tests shall be borne by BHEL only if specifically agreed to in the purchase order.

7. Transit Insurance: Transit insurance coverage between vendor's works and project site shall be to the account of BHEL, unless specifically agreed otherwise. However, vendor shall send intimation directly to insurance agency (as mentioned in dispatch instructions issued by BHEL) through fax/courier/e-mail, immediately on dispatch of goods for covering insurance. A copy of such intimation sent by vendor to insurance agency shall be given to BHEL along with dispatch documents. Dispatch documents will be treated as incomplete without such intimation copy. BHEL shall not be responsible for sending intimations to insurance agency on behalf of the vendor.

8. Mode of dispatch:
   Indigenous Scope: By road on Door Delivery Consignee Copy attached basis through your approved transporter (unless otherwise indicated in Dispatch Instructions), only on receipt of Despatch Clearance from BHEL.
   Imported Scope: By Air/Sea through BHEL approved Freight Forwarder/supplier approved Consolidator respectively as per agreed contractual terms, only on receipt of Dispatch Clearance from BHEL.

9. Changes in Statutory levies:
   If any rates of Tax are increased or decreased, a new Tax is introduced, an existing Tax is abolished, or any change in interpretation or application of any Tax occurs in the course of the execution of Contract, which was or will be assessed on the bidder in connection with performance of the Contract, an equitable adjustment of the Contract Price shall be made to fully take into account any such change by addition to the Contract Price or deduction there from, as the case may be. However, these adjustments would be restricted to direct transactions between BHEL and the bidder /agent of foreign bidder (if applicable). These adjustments shall not be applicable on procurement of raw materials, intermediary components etc. by the bidder /agent.

10. Availing duty/tax exemption benefits by bidder, wherever applicable: BHEL shall issue the required Certificate/s, as per relevant policies of the Govt. of India, to facilitate the bidders to avail any such benefits under the Contract. In case of failure of the bidders to receive the benefits partly or fully from the Govt. of India and/or in case of any delay in receipt of such benefits, BHEL shall neither be liable nor responsible in any manner whatsoever.

11. Taxes against sub-vendor dispatches: All taxes/levies, as applicable in respect of all components, equipments and material to be despatched directly from the sub-vendor's works to Site irrespective of the fact whether such taxes and levies are assessable and chargeable on Vendor or the BHEL, shall be to the vendor's account and no separate claim in this regard will be entertained by BHEL.

12. High Sea Sales (HSS): Customs clearance of the consignment landed on Indian Sea/Air ports will be done by BHEL based on the original HSS documents provided by vendors.
    Any delay in submission of complete/correct HSS documents to BHEL may incur demurrage charges. All demurrage charges on account of incomplete /incorrect HSS documents submission by vendor will be to vendor's account and all such charges will be recovered from any of the available vendor bills with BHEL.

13. Packaging and dispatch:The Seller shall package the goods safely and carefully and pack them suitably in all respects considering the peculiarity of the material for normal safe transport by Sea/ Air / Rail/ Road to its destination suitably protected against loss, damage, corrosion in transit and the effect of tropical salt laden atmosphere. The packages shall be provided with fixtures/ hooks and sling marks as may be required for easy and safe handling. If any consignment needs special handling instruction, the same shall be clearly marked with standard symbols / instructions. Hazardous material should be notified as such and their packing, transportation and other protection must conform to relevant regulations.
    The packing, shipping, storage and processing of the goods must comply with the prevailing legislation and regulations concerning safety, the environment and working conditions. Any Imported/Physical Exports items packed with raw/ solid wood packing material should be treated as per ISPM – 15 (fumigation) and accompanied by Phytosanitory/ Fumigation certificate. If safety information sheets (MSDS – Material Safety Data Sheet) exist for an item or the packaging, vendor must provide this information without fail along with the consignment.
    Each package must be marked with Consignee name, Purchase order number, Package number, Gross weight and net weight, dimensions (LxBxH) and Seller's name. Packing list of goods inside each package with PO item number and quantity must also be fixed securely outside the box to indicate the contents of each box. Total number of packages in the consignment must also be indicated in the packing list.
    Separate packing & identification of items should be as follows.
    1. Main Scope - All items must be tagged with part no. & item description.
    2. Commissioning accessories/spares - All items must be tagged with part no. & item description.
    3. Mandatory spares - All items must be tagged with part no. & item description.
    Nevertheless, vendor shall adhere to dispatch & packing instructions issued by BHEL at the time of dispatch.

14. Assignment of Rights & Obligations; Subcontracting: Vendor is not permitted to subcontract the delivery or any part thereof to third party or to assign the rights and obligations resulting from this agreement in whole or in part to third parties without prior written permission from BHEL. Any permission or approval given by the BHEL shall, however, not absolve the vendor of the responsibility of his obligations under the Contract.

15. Progress report: Vendor shall render such report as to the progress of work and in such form as may be called for by the concerned purchase officer from time to time. The submission and acceptance of such reports shall not prejudice the rights of BHEL in any manner.

16. Non-disclosure and Information Obligations: Vendor shall provide with all necessary information pertaining to the goods as it could be of importance to BHEL. Vendor shall not reveal any specified confidential information that may be divulged by BHEL to Vendor's employees not involved with the tender/ contract & its execution and delivery or to third parties, unless BHEL has agreed to this in writing beforehand. Vendor shall not be entitled to use the BHEL name in advertisements and other commercial publications without prior written permission from BHEL.

17. Cancellation /Termination of contract: BHEL shall have the right to completely or partially terminate the agreement by means of written notice to that effect. Termination of the Contract, for whatever reason, shall be without prejudice to the rights of the parties accrued under the Contract up to the time of termination.
    BHEL shall have the right to cancel/foreclose the Order/ Contract, wholly or in part, in case it is constrained to do so on account of any decline, diminution, curtailment or stoppage of the business.

18. Risk Purchase Clause: In case of failure of supplier, BHEL at its discretion may make purchase of the materials / services not supplied / rendered in time at the RISK & COST of the supplier. Under such situation, the supplier who fails to supply the goods in time shall be wholly liable to make good to BHEL any loss due to risk purchase.
    In case of items demanding services at site like erection and commissioning, vendor should send his servicemen/representatives within 7 days from the service call. In case a vendor fails to attend to the service call, BHEL at its discretion may also make arrangements to attend such service by other parties at the **RISK & COST** of the supplier. Under such situation the supplier who fails to attend the service shall be wholly liable to make good to BHEL any loss due to risk purchase/service including additional handling charges due to the change.

19. Shortages: In the event of shortage on receipt of goods and/or on opening of packages at site, all such shortages, caused by supplier's act or omission, shall be made good at free of cost within a reasonable time that BHEL may allow from such intimation.
    Transit Damages: In the event of receipt of goods in damaged condition or having found them so upon opening of packages at site, supplier shall make good of all such damages within a reasonable time from such intimation by BHEL. In case BHEL raises an insurance claim, the cost of material limited to insurance settled amount less handling charges will be reimbursed to supplier.

20. Remedial work: Notwithstanding any previous test or certification, BHEL may instruct the vendor to remove and replace materials/goods or remove and re-execute works/services which are not in accordance with the purchase order. Similarly BHEL may ask the vendor to supply materials or to execute any services which are urgently required for any safety reasons, whether arising out of or because of an accident, unforeseeable event or otherwise. In such an event, Vendor shall provide such services within a reasonable time as specified by BHEL.

21. Indemnity Clause: Vendor shall comply with all applicable safety regulations and take care for the safety of all persons involved. Vendor is fully responsible for the safety of its personnel or that of his subcontractor's men / property, during execution of the Purchase Order and related services. All statutory payments including PF, ESI or other related charges have to be borne by the vendor. Vendor is fully responsible for ensuring that all legal compliances are followed in course of such employment.

22. Product Information, Drawings and Documents: All specified drawings, technical documents or other technical information received by Vendor from BHEL or vice versa shall not, without the consent of the other party, be used for any other purpose than that for which they were provided. They may not, without the consent of the Disclosing party, otherwise be used or copied, reproduced, transmitted or communicated to third parties. All information and data contained in general product documentation, whether in electronic or any other form, are binding only to the extent that they are by reference expressly included in the contract.
    Vendor, as per agreed date/s but not later than the date of delivery, provide free of charge information and drawings which are necessary to permit and enable BHEL to erect, commission, operate and maintain the product. Such information and drawings shall be supplied in as many numbers of copies as may be agreed upon.
    All intellectual properties, including designs, drawings and product information etc. exchanged during the formation and execution of the Contract shall continue to be the property of the disclosing party.

23. Intellectual Property Rights, Licenses: If any Patent, design, Trade mark or any other intellectual property rights apply to the delivery (goods/related service) or accompanying documentation shall be the exclusive property of the Vendor and BHEL shall be entitled to the legal use thereof free of charge by means of a non-exclusive, worldwide, perpetual license. All intellectual property rights that arise during the execution of the Purchase Order/ contract for delivery by vendor and/or by its employees or third parties involved by the vendor for performance of the agreement shall belong to BHEL. Vendor shall perform everything necessary to obtain or establish the above mentioned rights. The Vendor guarantees that the delivery does not infringe on any of the intellectual property rights of third parties. The Vendor shall do everything necessary to obtain or establish the alternate acceptable arrangement pending resolution of any (alleged)

claims by third parties. The Vendor shall indemnify BHEL against any (alleged) claims by third parties in this regard and shall reimburse BHEL for any damages suffered as a result thereof.

24. Force Majeure: Notwithstanding anything contained in the purchase order or any other document relevant thereto, neither party shall be liable for any failure or delay in performance to the extent said failures or delays are caused by the "Act of God" and occurring without its fault or negligence, provided that, force majeure will apply only if the failure to perform could not be avoided by the exercise of due care and vendor doing everything reasonably possible to resume its performance.
    A party affected by an event of force majeure which may include fire, tempest, floods, earthquake, riot, war, damage by aircraft etc., shall give the other party written notice, with full details as soon as possible and in any event not later than seven (7) calendar days of the occurrence of the cause relied upon. If force majeure applies, dates by which performance obligations are scheduled to be met will be extended for a period of time equal to the time lost due to any delay so caused.

    Notwithstanding above provisions, in an event of Force Majeure, BHEL reserves for itself the right to cancel the order/ contract, wholly or partly, in order to meet the overall project schedule and make alternative arrangements for completion of deliveries and other schedules.

25. Warranty:
    Wherever required, and so provided in the specifications/ Purchaser Order, the Seller shall ensure that the goods supplied shall comply with the specifications laid down, for materials, workmanship and performance.
    Unless otherwise specified in SCC, warranty period shall be applicable for a period of 24 months from the date of delivery of goods or 18 months from the date of commissioning of goods, whichever is earlier.
    The warranty period as described above shall apply afresh to replaced, repaired or re-executed parts of a delivery. Unless otherwise specifically provided in the Purchase Order, Vendor's liability shall be co terminus with the expiration of the applicable warranty period.

26. Limitation of Liability: Vendor's liability towards this contract is limited to a maximum of 100% of the contract value and consequential damages are excluded. However the limits of liability will have no effect in cases of criminal negligence or wilful misconduct.
    The total liability of Vendor for all claims arising out of or relating to the performance or breach of the Contract or use of any Products or Services or any order shall not exceed the total Contract price.

27. Liability during warranty: Vendor shall arrange replacement / repair of all the defective materials / services under its obligation during the warranty period. The rejected goods shall be taken away by vendor and replaced / repaired. In the event of the vendor's failure to comply, BHEL may take appropriate action including disposal of rejections and replenishment by any other sources at the cost and risk of the vendor.
    In case, defects attributable to vendor are detected during Warranty period or where the commissioning call is issued within the warranty period, vendor shall be responsible for replacement/ repair of the goods as required by BHEL at vendor's cost even after expiry of warranty period.
    Further if the equipment or any part thereof cannot be used by reason of such defect and/or making good of such defect, the warranty period of the equipment or such part, as the case may be, shall be extended by a period equal to the period during which the equipment or such part cannot be used by BHEL because of any of the aforesaid reasons. Upon correction of the defects in the facilities or any part thereof by repair/replacement, such repair/replacement shall have the warranty period for a period of twelve (12) months from the time such replacement/repair of the equipment or any part thereof has been completed.

28. Liability after warranty period: At the end of the warranty, the Vendor's liability ceases except for latent defects. For the purpose of this clause, latent defects shall be the defects inherently lying within the material or arising out of design deficiency which do not manifest themselves during the warranty Period, but later. The Contractor's liability for latent defects warranty for the equipment including spares shall be limited to a period of six months from the end of the warranty period of the respective equipment including spares or first time commissioning, whichever is later but not later than one (01) year from the date of expiry of warranty period.

29. Compliance with Laws: Vendor shall, in performing the contract, comply with all applicable laws. The vendor shall make all remittances, give all notices, pay all taxes, duties and fees, and obtain all permits, licences and approvals, as required by the laws in relation to the execution and completion of the contract and for remedying of any defects; and the Contractor shall indemnify and hold BHEL harmless against and from the consequences of any failure to do so.

30. Settlement of Disputes:Except as otherwise specifically provided in the Purchase Order, decision of BHEL shall be binding on the vendor with respect to all questions relating to the interpretation or meaning of the terms and conditions and instructions herein before mentioned and as to the completion of supplies/work/services, other questions, claim, right, matter or things whatsoever in any way arising out of or relating to the contract, instructions, orders or these conditions or otherwise concerning the supply or the execution or failure to execute the order, whether arising during the schedule of supply/work or after the completion or abandonment thereof. Any disputes or differences among the parties shall to the extent possible be settled amicably between the parties thereto, failing which the disputed issues shall be settled through arbitration. Vendor shall continue to perform the contract, pending settlement of dispute(s).

31. Arbitration Clause in case of Contract with vendors other than Public Sector Enterprise (PSE) or a Government Department:

    ARBITRATION & CONCILIATION

    The parties shall attempt to settle any disputes or difference arising out of the formation, breach, termination, validity or execution of the Contract; or, the respective rights and liabilities of the parties; or, in relation to interpretation of any provision of the Contract; or, in any manner touching upon the Contract, or in connection with this contract through friendly discussions. In case no amicable settlement can be reached between the parties through such discussions, in respect of any dispute; then, either Party may, by a notice in writing to the other Party refer such dispute or difference to the sole arbitration of an arbitrator appointed by Head of the BHEL–EDN. Such Sole Arbitrator appointed, shall conduct the arbitration in English language.
    The Arbitrator shall pass a reasoned award and the award of the Arbitration shall be final and binding upon the Parties.
    Subject as aforesaid, the provisions of Arbitration and Conciliation Act 1996 (India) or statutory modifications or re-enactments thereof and the rules made thereunder and for the time being in force shall apply to the arbitration proceedings under this clause. The seat of arbitration shall be Bangalore.
    The cost of arbitration shall be borne as decided by the Arbitrator upon him entering the reference.
    Subject to the Arbitration Clause as above, the Courts at Bangalore alone shall have exclusive jurisdiction over any matter arising out of or in connection with this Contract.
    Notwithstanding the existence or any dispute or differences and/or reference for the arbitration, the parties shall proceed with and continue without hindrance the performance of its obligations under this Contract with due diligence and efficiency in a professional manner except where the Contract has been terminated by either Party in terms of this Contract.

    Arbitration Clause in case of Contract with a Public Sector Enterprise (PSE) or a Government Department:

    In the event of any dispute or difference relating to the interpretation and application of the provisions of the Contract, such dispute or difference shall be referred by either party for Arbitration to the Sole Arbitrator in the Department of Public Enterprises to be nominated by the Secretary to the Government of India in-charge of the Department of Public Enterprises. The Arbitration and Conciliation Act, 1996 shall not be applicable to arbitration under this clause. The award of the Arbitrator shall be binding upon the parties to the dispute, provided, however, any Party aggrieved by such Award may make further reference for setting aside or revision of the Award to the Law Secretary, Department of Legal Affairs, Ministry of Law and Justice, Government of India. Upon such reference the dispute shall be decided by the Law Secretary or the Special Secretary or Additional Secretary when so authorized by the Law Secretary, whose decision shall bind the Parties hereto finally and conclusively. The Parties to the dispute will share equally the cost of arbitration as intimated by the Arbitrator.'

32. Applicable Laws and Jurisdiction of Courts: Prevailing Indian laws both substantive and procedural, including modifications thereto, shall govern the Contract. Subject to the conditions as aforesaid, the competent courts in Bangalore alone shall have jurisdiction to consider over any matters touching upon this contract.

33. General Terms: That any non-exercise, forbearance or omission of any of the powers conferred on BHEL and /or any of its authorities will not in any manner constitute waiver of the conditions hereto contained in these presents.
    That the headings used in this agreement are for convenience of reference only.
    That all notices etc., to be given under the Purchase order shall be in writing, type script or printed and if sent by registered post or by courier service to the address given in this document shall be deemed to have been served on the date when in the ordinary course, they would have been delivered to the addressee.

ಭಾರತ್ ಹೆವಿ ಎಲೆಕ್ಟ್ರಿಕಲ್ಸ್ ಲಿಮಿಟೆಡ್
भारत हेवी इलेक्ट्रिकल्स लिमिटेड
Bharat Heavy Electricals Ltd.,
(A Government of India undertaking)
Electronics Division
PB 2606 , Mysore Road Bangalore , 560026 INDIA

CE:PR:001- Rev 03

INSTRUCTIONS TO BIDDERS

Bidder is requested to read the instructions carefully and submit their quotation taking into consideration of all the points:

A. GENERAL INSTRUCTIONS:

1. Any Purchase Order resulting from this enquiry shall be governed by the Instructions to Bidders (document reference: CE: PR: 001 – Rev 03), General Conditions of Contract (document reference: CE: PR: 002 - Rev 02) and Special Conditions of Contract, if any, of the enquiry.
2. Any deviations from or additions to the "General Conditions of Contract"or "Special Conditions of Contract" require BHEL's express written consent. The general terms of business or sale of the bidder shall not apply to this tender.
3. Regret letter (either through post or by mail or by EPS) indicating reasons for not quoting must be submitted without fail, in case of non-participation in this tender. Supplier shall be liable for removal as a registered vendor of BHEL when the supplier fails to quote against four consecutive tender enquiries for the same item or all enquiries in last two years for the same item, whichever is earlier.
4. Procurement directly from the manufacturers is preferred. However, if the OEM/ Principal insist on engaging the services of an agent, such agent shall not be allowed to represent more than one manufacturer/ supplier in the same tender. Moreover, either the agent could bid on behalf of the manufacturer/ supplier or the manufacturer/ supplier could bid directly but not both. Agent/Representative authorized by the OEM/Principal in turn cannot further sub authorize any other firm for submitting the offer or for placement of order.

   In case bids are received from the manufacturer/ supplier and his agent, bid received from the agent shall be ignored.
5. Consultant / firm (and any of its affiliates) shall not be eligible to participate in the tender/s for the related goods for the same project if they were engaged for consultancy services for the same project.
6. If an Indian representative/associate/liaison office quotes on behalf of a foreign based bidder, such representative shall furnish the following documents:
   a. Authorization letter to quote and negotiate on behalf of such foreign-based bidder.
   b. Undertaking from such foreign based bidder that such contract will be honored and executed according to agreed scope of supply and commercial terms and conditions.
   c. Undertaking shall be furnished by the Indian representative stating that the co-ordination and smooth execution of the contract and settlement of shortages/damages/replacement/repair of imported scope till the equipment is commissioned and handed over to customer will be the sole responsibility of the Indian representative/associates/agent/liaison office.
   d. Refer **Annexure I** on "Guidelines for Indian Agents".

7. In case of imported scope of supply, customs clearance & customs duty payment will be to BHEL account after the consignment is received at Indian Airport /Seaport. Bidders must provide all original documents required for completing the customs clearance along with the shipment. Warehousing charges due to incomplete or

missing documentation will be to supplier's account. All offers for imported scope of supply by air, must be made from any of the gateway ports (within the country) indicated **(Refer Annexure II).**

8. The offers of the bidders who are on the banned list and also the offers of the bidders, who engage the services of the banned firms, shall be rejected. The list of the banned firms is available on BHEL website: http://www.bhel.com/vender_registration/vender.php
9. Business dealings with bidders will be suspended if they are found to have indulged in any malpractices/misconduct which are contrary to business ethics like bribery, corruption, fraud, pilferage, cartel formation, submission of fake/false/forged documents, certificates, information to BHEL or if they tamper with tendering procedure affecting the ordering process or fail to execute a contract, or rejection of 3 consecutive supplies or if their firms / works are under strike/lockout for a long period. Bidder may refer "Guidelines for Suspension of Business Dealings with Suppliers/ Contractors" available on www.bhel.com for more details.
10. The bidder along with its associate/collaborators/sub-contractors/sub-vendors/consultants/service providers shall strictly adhere to BHEL Fraud Prevention Policy displayed on BHEL website http://www.bhel.com and shall immediately bring to the notice of BHEL Management about any fraud or suspected fraud as soon as it comes to your notice.
11. Offers to be submitted in English language only.
12. For this procurement, the local content to categorize a supplier as a Class-I local supplier/ Class-II local supplier/ Non-local supplier and purchase preference to Class-I local supplier, is as defined in Public procurement (Preference to Make in India), Order 2017 dated 04.06.2020 issued by DPIIT. In case of subsequent Orders issued by the Nodal Ministry, changing the definition of local content for the items of the NIT, the same shall be applicable even if issued after issue of this NIT, but before opening of price bid/s against this NIT.

    Any Indian Bidder intending to avail the benefits shall submit the requisite documents as per the aforesaid orders.
13. The Bidder shall mandatorily submit Declaration as mentioned below, under Rule 144(xi) of General Financial Rules, 2017 amendment dt 23.07.2020 issued by Ministry of Finance, Govt. of India. The declaration to be submitted on Company Letter head duly signed and sealed by authorised signatory, for ascertaining the eligibility of offer in the tender.

    "I have read the clause regarding restrictions on procurement from a bidder of a country which shares a land border with India; I certify that this bidder is not from such a country or, if from such a country, has been registered with the Competent Authority. I hereby certify that this bidder fulfils all requirements in this regard and is eligible to be considered."

    (Where applicable, evidence of valid registration by the Competent Authority shall be attached).

    The Competent Authority for the purpose of registration under this Order shall be the Registration Committee constituted by the Department for Promotion of Industry and Internal Trade (DPIIT).

    Refer Annexure-X for 'Restrictions under Rule 144(Xi) of General Financial Rules,2017 amendment dt: 23.07.2020'.

B. <u>GUIDELINES FOR PREPARATION OF OFFER:</u>

1. Quotation shall be submitted in Single Part Bid, Two Part Bid or Three Part Bid, as called for in the tender:

- **SINGLE PART BID**: Technical and Commercial Bid with prices along with price summary & filled in BHEL Standard Commercial terms and conditions in a single sealed envelope.

- **TWO PART BID**: Unpriced offer i.e. "Techno-commercial Bid" with filled in BHEL Standard Commercial terms and conditions in a sealed envelope **along with the copy of the "Price Bid"without the prices** should be enclosed in one cover and the cover must be super scribed **"Techno-commercial offer)** and Priced offer i.e. "Price Bid"containing price summary in a separate sealed envelope and must be super scribed **"Price Bid"**.Both these envelopes shall be enclosed in a single sealed envelope superscribed with enquiry number, due date of tender and any other details as called for in the tender document.

- **THREE PART BID**: Pre-qualification Bid (Part-I), Techno Commercial Bid with filled in BHEL Standard Commercial terms and conditions (Part-II), and Price Bid (Part-III). All three envelopes shall be enclosed in a single sealed envelope superscribed with enquiry number, due date of tender and any other details as called for in the tender document.

If any of the offers (Part I, Part II or Part III) are not submitted before the due date and time of submission (or) if any part of the offer is incomplete, the entire offer of the bidder is liable for rejection.

2. Supplier shall ensure to superscribe each envelope with RFQ number, RFQ Date, RFQ Due date and time, Item Description and Project clearly & boldly. Also mention on the envelope whether it is "Techno Commercial Bid" or "Price Bid" or "Pre-Qualification Bid". Please ensure complete address, department name and purchase executive name is mentioned on the envelope (before dropping in the tender box or handing over) so that the tender is available in time for bid opening.
3. BHEL standard Commercial Terms and Conditions (duly filled, signed & stamped) must accompany Technical-Commercial offer without fail and should be submitted in original only.

   The above indicated submission of Offers in "sealed envelope/hard copy" as mentioned in points B.1-B.3 is applicable for tenders that are not floated through E-Procurement System (EPS).

4. Validity: Unless otherwise specified in SCC (special commercial conditions of contract), the offer will be valid for a period of 90 days from the date of part-I bid opening and in case of Negotiation/Counter-offer/Reverse Auction, price validity will apply afresh for a period of _60_ days from the date of according final price by bidder (or) upto original validity period, whichever is later.

5. Any of the terms and conditions not acceptable to supplier, shall be explicitly mentioned in the Techno-Commercial Bid. If no deviations are brought out in the offer it will be treated as if all terms and conditions of this enquiry are accepted by the supplier without deviation.
6. Deviation to this specification/item description, if any, shall be brought out clearly indicating "DEVIATION TO BHEL SPECIFICATION" without fail, as a part of Techno-Commercial Bid. If no deviations are brought out in the offer it will be treated as if the entire specification of this enquiry is accepted without deviation.
7. Suppliers shall submit one set of original catalogue, datasheets, bill of materials, dimensional drawings, mounting details and/or any other relevant documents called in purchase specification as part of Technical Bid.
8. "Price Bid" shall be complete in all respects containing price break-up of all components along with all applicable taxes and duties, freight charges (if applicable) etc. Once submitted no modification / addition / deletion will be allowed in the "Price Bid." Bidders are advised to thoroughly check the unit price, total price to avoid any discrepancy.
9. In addition, bidder shall also quote for erection & commissioning charges/erection supervision & commissioning charges (E&C service charges), documentation charges, testing Charges (type & routine),

training charges etc. as applicable along with corresponding tax. The price summary must indicate all the elements clearly.

10. Wherever applicable, bidders should indicate "lumpsum" Erection and Commissioning (or) Erection Supervision and Commissioning charges, as applicable (including To & Fro Fare, Boarding, Lodging, Local Conveyance etc.) for carrying out E&C activity and further handing over to customer. The quotation shall clearly indicate scope of work, likely duration of commissioning, pre-commissioning checklist (if any).
11. Wherever bidders require PAC (Project Authority Certificate)/applicable certificates for import of raw materials, components required for DECC,EPCG Power Projects, Export Projects or other similar projects wherein supplies are eligible for customs duty benefits, lists and quantities of such items and their values (CIF) has to be mentioned in the offer. Prices must be quoted taking into account of such benefits.
12. Prices should be indicated in both figures & words**.** Bid should be free from correction/overwriting, using corrective fluid, etc. Any interlineation, cutting, erasure or overwriting shall be valid only if they are attested under full signature(s) of person(s) signing the bid else bid shall be liable for rejection. Any typographical error, totalling mistakes, currency mistake, multiplication mistake, summing mistakes etc. observed in the price bids will be evaluated as per **Annexure III** "Guidelines for dealing with Discrepancy in Words & Figures – quoted in price bid" and BHEL decision will be final.
13. Documents submitted with the offer shall be signed and stamped in each page by authorized representative of the bidder. However, this requirement is not mandatory for offers uploaded through E-Procurement System (EPS).

C. <u>GUIDELINES FOR OFFER SUBMISSION:</u>

The under-mentioned clauses 1, 2&3 will not be applicable for EPS tenders.

1. Offers / Quotations must be dropped in tender box before 13.00 Hrs. on or before due date mentioned in RFQ.The offers are to be dropped in the proper slot of the Tender Box kept in our reception area with caption "CE, SC&PV, DEFENCE". Tenders are opened on 3 days in a week (Monday/Wednesday/Friday). Tender must be deposited in the slot corresponding to the day (Monday - Box no.4/Wednesday - Box no. 6 /Friday - Box no.8) while depositing the offer.

2. E-Mail/ Internet/EDI offers received in time shall be considered only when such offers are complete in all respects. In case of offers received through E-mail, please send the offer to the email ID specified in the SCC document of the tender.

3. Offers of Vendors who already have a valid Technical/Commercial MOU with BHEL-EDN for the items of the RFQ shall mention the relevant MOU reference no. and give only such other details not covered in the MOU.

4. In cases where tender documents are bulky, or due to some reasons tender documents are required to be submitted by hand or through posts/couriers, the offers are to be handed over either of the two purchase officers whose names are mentioned in the SCC document of tender RFQ.
5. Tenders will be opened on due date, time and venue as indicated in the RFQ in the presence of bidders at the venue indicated in the RFQ. For EPS tenders, e-mail notifications will be automatically generated and forwarded to registered e-mail ID/s of bidders during opening of tenders.
6. Bidder will be solely responsible:
   a. For submission of offers before due date and time. Offers submitted after due date and time will be treated as "Late offers" and will be rejected.

   b. For submission of offers in the correct compartment of the tender box based on the day of due date (Monday/Wednesday/Friday). Please check before dropping your offer in the correct tender box.

c. For depositing offers in proper sealed condition in the tender box. If the bidder drops the tender in the wrong tender box (or) if the tender document is handed over to the wrong person, BHEL will not be responsible for any such delays.

d. For offers received through email etc., suppliers are fully responsible for lack of secrecy on information and ensuring timely receipt of such offers in the tender box before due date & time (This clause will not be applicable for EPS tenders).

The above indicated submission of Offers as mentioned in points 6.a-6.d is applicable for tenders that are not floated through EPS.

e. In case of e-tender, all required documents should be uploaded before due date and time. Availability of power, internet connections, system/software requirements etc. will be the sole responsibility of the bidder. Wherever assistance is needed for submission of e-tenders, help-line numbers as available in the web-site of service provider of BHEL may be contacted.

Purchase Executive/ BHEL shall not be responsible for any of the activities relating to submission of offer.

D. <u>PROCESSING OF OFFERS RECEIVED:</u>

1. Any discount/ revised offer submitted by the supplier on its own shall be accepted provided it is received on or before the due date and time of offer submission (i.e. Part-I bid). The discount shall be applied on pro-rata basis to all items unless specified otherwise by the bidder.
2. Changes in offers or Revised offers given after Part-I bid opening shall not be considered as a part of the original offer unless such changes/revisions are requested by BHEL. In case of withdrawal of any Technical/Commercial deviation(s) by the bidder before opening of price bids/conducting the Reverse Auction, revision of price/impact bid will not be accepted.
3. In case there is no change in the technical scope and/ or specifications and/ or commercial terms & conditions, the supplier will not be allowed to change any of their bids after Technical bids are opened (after the due date and time of tender opening).
4. In case of changes in scope and/ or technical specifications and/ or commercial terms & conditions by BHEL and it accounts for price implications from bidders, all techno-commercially acceptable bidders shall be asked by BHEL (after freezing the scope, technical specifications and commercial terms & conditions) to submit the impact of such changes on their price bid. Impact price will be applicable only for changes in technical specification / commercial conditions by BHEL. The impact price must be submitted on or before the cut-off date specified by BHEL and the original price bid and the price impact bid will be opened together at the time of price bid opening.
5. Un-opened bids (including price bids) will be returned to the respective bidders after release of Purchase order. Regarding Offers for EPS tenders that get rejected on PQC/ techno-commercial grounds, the bids for the subsequent parts will not be opened i.e., both technical bid and price bid (Parts-II & III)will not be opened in case of rejection on PQC ground and price bid (Part-II/Part-III, as applicable) will not be opened in case of rejection on techno-commercial ground.
6. After receipt of Purchase Order, supplier should submit required documents viz.,specified drawings, bill of materials, datasheets, catalogues, quality plan, test procedure, type test report , O & M Manuals and/or any other relevant documents as per Specification/Purchase Order, as and when required by BHEL/Customer.

7. Any deviation to the terms and conditions not mentioned in the quotation by supplier in response to this enquiry will not be considered, if put forth subsequently or after issue of Purchase Order, unless clarification is sought for by BHEL and agreed upon in the Purchase Order.
8. Evaluation shall be on the basis of delivered cost (i.e. "Total Cost to BHEL").
   "Total Cost to BHEL" shall include total basic cost, packing & forwarding charges, taxes and/or duties(as applicable), freight charges, taxes on Services, customs clearance charges for imported items, any other cost indicated by bidder for execution of the contract and loading factors (for non-compliance to BHEL Standard Commercial Terms & Conditions). Benefits arising out of Nil Import Duty on DEEC, EPCG, DFIA Projects, Physical Exports or such 100% exemptions (statutory benefits), project imports, customer reimbursements of statutory duties (like Basic Customs Duty and cess on customs duty), Input tax credits as applicable will also be taken into account for arriving at the Total cost to BHEL (wherever applicable and as indicated in SCC document of tender).

   For EPS tenders, it shall be noted that the prices (including discounts) vis-a-vis currency quoted in EPS portal only will be considered as Final for the purpose of evaluation of the lowest bidder. Bidder shall ensure to indicate the applicable taxes against each line item in online portal, failing to which the same will be considered as inclusive/NIL.

   In the course of evaluation, if more than one bidder happens to occupy L-1 status, effective L-1 will be decided by soliciting discounts from the respective L-1 bidders.
   Incase more than one bidder happens to occupy the L-1 status even after soliciting discounts, the L-1 bidder shall be decided by a toss/draw of lots, in the presence of the respective L-1 bidder(s) or their representative(s).
   Ranking will be done accordingly. BHEL's decision in such situations shall be final and binding.

9. For evaluation of offers in foreign currency, the exchange rate (TT selling rate of SBI) shall be taken as under:

Single part bids:	Date of tender opening
Two/three part bids:	Date of Part-I bid opening
Reverse Auction:	Date of Part-I bid opening

   In case of Performance Bank Guarantee (PBG) also, exchange rate will be considered as mentioned above for converting foreign currency to Indian currency and vice versa.

   If the relevant day happens to be a bank holiday, then the exchange rate as on the previous working day of the bank (SBI) shall be taken.
10. Ranking (L-1, L-2 etc.) shall be done only for the techno-commercially acceptable offers.

E. <u>INFORMATION ON PAYMENT TERMS:</u>

1. All payments will be through Electronic Fund transfer (EFT). Vendor has to furnish necessary details as per BHEL standard format **(Refer Annexure IV)** for receiving all payments through NEFT.(Applicable for Indian vendors only).
2. In case of High Sea Sales transaction, customs clearance of the consignment landed on Indian Sea/Air ports will be done by BHEL based on the original HSS documents provided by vendors. All warehousing charges due to delay in submission of complete and or correct HSS documents to BHEL will be to supplier's account only. Such recovery will be made out of any of the available bills **(Refer Annexure V)**.
3. Statutory deductions, if any, will be made and the deduction certificate shall be issued.
   A. In case vendor does not provide PAN details, the TDS deduction shall be at the maximum percentage stipulated as per the provisions of Income Tax Act.

In addition to the above, Foreign vendors shall also submit relevant details of their bankers like Swift Code, Banker's Name &Address etc.

B. TDS deduction as per section 51 of CGST Act,2017 shall be applicable as per Gazette Notification No. 50/2018-Central Tax, Dated: 13th September 2018 and subsequent notification/s, as and when released by Govt. authorities.

4. Incomplete documentation will not be accepted. Delayed submission of invoice / documents may result in corresponding delay in payment. In this connection, request to also refer clause: G about invoicing & payment formalities under GST regime. Applicable documents shall be submitted to the purchaser at the time of execution of supplies/services for availing GST input credits.

F. STANDARD PAYMENT TERMS OF BHEL-EDN:

PURCHASE ORDERS FOR:	**SUPPLY WITH SERVICE(S)**	**SUPPLY ONLY**
INDIGENOUS PROCUREMENT	a. 100% of basic value with taxes and freight will be paid in 45 days from the date of dispatch or 15 days from the date of submission of complete set of documentation, whichever is later. Note: In case PBG is not furnished, only 90% payment will be released against 100% claim without the consent of Vendor. This 10% basic amount withheld towards PBG will be paid either against submission of supplementary invoice & Original PBG (or) against supplementary invoice without PBG after expiry of Warranty period.	b. 100% of PO value with taxes and freight will be paid in 45 days from the date of dispatch or 15 days from the date of submission of complete set of documentation, whichever is later.
IMPORT PROCUREMENT	c. 100% of basic value will be paid against usance draft of 45 days from the date of AWB/BOL on submission of complete set of documents. Note: In case PBG is not furnished, only 90% payment will be released against 100% claim without the consent of Vendor. This 10% basic amount withheld towards PBG will be paid either against submission of supplementary invoice & Original PBG (or) against supplementary invoice without PBG after expiry of Warranty period.	d. 100% of PO value will be paid against usance draft of 45 days from the date of AWB/BOL on submission of complete set of documents.
HIGH-SEA SALES PROCUREMENT	e. 100% of basic value will be paid in 45 days from the date of signing of High Sea Sale agreement or 15 days from the date of submission of complete set of documentation, whichever is later Note: In case PBG is not furnished, only 90% payment will be released against 100% claim without the consent of Vendor. This 10% basic amount withheld towards PBG will be paid either against submission of supplementary invoice & Original PBG (or) against supplementary invoice without PBG after expiry of Warranty period.	f. 100% of basic value will be paid in 45 days from the date of signing of High Sea Sale agreement or 15 days from the date of submission of complete set of documentation, whichever is later.

g. Erection and Commissioning:

Evaluation methodology: Unless and otherwise specified in SCC, E&C charges should not be less than 10% of the main supply value. In case the quoted total E&C value is less than 10% of the main supply value, BHEL shall evaluate Bidders Price deducting differential amount from main supply price proportionally from all items and apportioning towards E&C charges.

Payment term: 100% E&C charges along with tax as applicable, will be paid in 15 days from the date of submission of supplementary invoice/documents against proof of completion of E&C.

h. Erection Supervision and Commissioning:

Evaluation methodology: Unless and otherwise specified in SCC, E&C charges should not be less than 5% of the main supply value. In case the quoted total E&C value is less than 5% of the main supply value, BHEL shall evaluate Bidders Price deducting differential amount from main supply price proportionally from all items and apportioning towards E&C charges.

Payment term: 100% E&C charges along with tax as applicable, will be paid in 15 days from the date of submission of supplementary invoice/documents against proof of completion of E&C.

i. Comprehensive Annual Maintenance Contract:

Evaluation methodology: Unless and otherwise specified in SCC, CAMC will be applicable for a period of 04 years from the date of expiry of warranty period (or) from the date of completion of commissioning of equipment, whichever is later and the total CAMC value should not be less than 20% of the main supply value. In case the quoted total CAMC value is less than 20% of the main supply value, BHEL shall evaluate Bidders Price deducting differential amount from main supply price proportionally from all items and apportioning towards CAMC charges.

Payment terms: 100% CAMC charges along with tax as applicable, will be paid in 15 days from the date of submission of supplementary invoice/documents against proof of completion of CAMC on yearly basis.

j. Terms of Payment for Training: 100% payment will be made in 45 days from the date of completion of Training or 15 days from the date of submission of complete set of invoice along with documentary evidence, whichever is later.

LOADING FACTORS FOR DEVIATION IN PAYMENT TERMS (APPLICABLE FOR IMPORT PROCUREMENT ONLY):

1) For offers received with Sight draft payment term in place of Usance draft, loading applicable will be 1.0% of basic value.

2) For offers received with Letter of Credit payment term with Usance of 45 days, loading applicable will be 2.5% of basic value.
   Additional loading of 2% will be applicable for payment term as Letter of Credit at Sight.

k. Any payment term with credit period of less than 45 days for indigenous supply/HSS and any other variation of payment terms are liable for rejection.

l. Standard payment terms indicated in Clauses: F (a), (b), (c), (d), (e), (f), (g), (h), (i) & (j) will not attract any loading.

Note 1: Basic value of Purchase Order mentioned above will include all components of the purchase order and will exclude only taxes, duties, freight, training charges, E&C and AMC charges (wherever applicable). Wherever the Purchase Order is split into import portion and indigenous portion of supply, minimum % to be quoted for Services, wherever mentioned, will be of both purchase order values put together.

Note 2: In case of multiple packages/units in a power plant, payment of E&C charges will be processed on pro-rata basis.

Note 3: No deviation will be permitted from the duration of Guarantee/Warranty and/or Comprehensive Annual Maintenance Contract period specified in SCC.

G. Terms & Conditions to be complied under GST regime:

1. All invoices to contain BHEL-EDN (buyer) GSTIN number: 29AAACB4146P1ZB. However for CGST +SGST/UGST billing outside the state of Karnataka, invoice has to be generated with BHEL's Nodal Agency GSTIN number. Address of Nodal Agency along with GSTIN number will be provided by BHEL at the time of issuing dispatch clearance.

2. The Bidder shall mention Bidder's GSTIN number in all quotations and Invoices submitted.

3. The Bidder shall also mention HSN (Harmonized System of Nomenclature) / SAC (Services Accounting Code) mandatorily in all quotations and invoices submitted.

4. Invoice submitted should be in the format as specified under GST Laws viz., all details as mentioned in Invoice Rules like GST registration number(GSTIN), invoice number with date of issue, quantity, rate, value, taxes with nomenclature – CGST, SGST, UGST,IGST mentioned separately, HSN Code / SAC Code etc. Invoice should be submitted in original for buyer plus duplicate for credit availment.

5. Payment of GST to Vendor will be made only if it is matching with data uploaded by the Vendor in GST portal.

6. For invoices paid on Reverse charge basis – "Tax payable on reverse charge basis" to be mentioned on the invoice.

7. In case GST credit is delayed/denied to BHEL due to non/delayed receipt of goods and/or tax invoice or expiry of timeline prescribed in GST law for availing such ITC, or any other reasons not attributable to BHEL, GST amount will be recoverable from vendor along with interest levied/ leviable on BHEL.

8. In case vendor delays declaring such invoice in his return and GST credit availed by BHEL is denied or reversed subsequently as per GST law, GST amount paid by BHEL towards such ITC reversal as per GST law will be recoverable from vendor/contractor along with interest levied/ leviable on BHEL.

9. Vendor should intimate BHEL immediately on the same date of invoicing without any delay.

10. In case of discrepancy in the data uploaded by supplier in the GSTN portal or in case of any shortages or rejection in the supply, then BHEL will not be able to avail the tax credit and will notify the supplier of the same. Supplier has to rectify the data discrepancy in the GSTN portal or issue credit note (details to be uploaded in GSTN portal) for the shortages or rejections in the supplies, within the calendar month notified by BHEL.

11. Bidders to note that Rules & Regulations pertaining to E-way bill system are to be strictly adhered to, as and when notified by Govt. authorities.

H. Performance bank guarantee (PBG):

Performance bank guarantee (PBG) will be applicable as called in the tender documents. Unless otherwise specified in the SCC, the PBG against performance of the contract shall be valid for a period of 24 months from the date of dispatch of goods + claim period of 03 months, for a value equal to 10 % of the basic value of the purchase order which will include all components of the purchase order and will exclude only taxes, duties, freight, training charges, E&C and AMC charges (wherever applicable).

1. The BG issued in Indian Rupees by Banks in India is to be executed on Non-Judicial Stamp paper/e-stamp paper of appropriate value as per Stamp Act prevailing in the State(s) where the BG is submitted or is to be acted upon or the rate prevailing in the State where the BG was executed, whichever is higher. The Stamp Paper/e-stamp paper shall be purchased in the name of Vendor/Bank issuing the guarantee.
2. No deviation for the duration and value of PBG will be permitted.
3. PBG shall be from any of the BHEL consortium of bankers **(refer Annexure VI)**.
4. PBGs from nationalized banks are also acceptable.
5. PBG should be sent directly by the bank to the dealing executive mentioned in the purchase order located at the address mentioned in the purchase order.
6. PBG should be in the format specified **(refer Annexure VII)**. No deviation to this format will be allowed. However in case BHEL changes the PBG format, bidder shall honor the same.
7. Bank Guarantee should be enforceable in Bangalore.
8. In Case of Bank Guarantees submitted by Foreign Vendors-
   a. From Nationalized/Public Sector / Private Sector/ Foreign Banks (BG issued by Branches in India) can be accepted subject to the condition that the Bank Guarantee should be enforceable in Bangalore.
   b. From Foreign Banks (wherein Foreign Vendors intend to provide BG from local branch of the Vendor country's Bank)

   b.1 Please note that Bank Guarantee issued by any of the Consortium Banks only will be accepted by BHEL. As such, Foreign Vendor needs to make necessary arrangements for issuance of Counter-Guarantee by Foreign Bank in favour of the Indian Bank's (BHEL's Consortium Bank) branch in India. It shall be noted that all charges for issuance of Bank Guarantee/ counter- Guarantee should be borne by the Foreign Vendor.
   b.2 In case, Foreign Vendors intend to provide BG from Overseas Branch of our Consortium Bank (e.g. if a BG is to be issued by SBI Frankfurt), the same is acceptable. However, the procedure at sl.no. b.1 is required to be followed.
   b.3 The BG issued may preferably be subject to Uniform Rules for Demand Guarantees (URDG) 758 (as amended from time to time).
9. Expired PBGs will be returned only after expiry of the claim period.
10. PBG shall not be applicable for spares.

I. PROVISONS APPLICABLE FOR MSE VENDORS (MICRO AND SMALL ENTERPRISES) :

Benefits/facilities as applicable for Micro and Small Enterprises (MSEs) shall be available to MSEs registered with Government designated authorities as per the Purchase & Price Preference Policy of the Government subject to them becoming eligible otherwise.

Vendors who qualify as MSE vendors are requested to submit applicable certificates (as specified by the Ministry of Micro, Small and Medium Enterprises) at the time of vendor registration. Vendors have to submit the Udyog Aadhaar/Udyam Registration certificate along with attested copy of a CA certificate (Annexure VIII) applicable for the relevant financial year (latest audited) along with the tender documents in the Part-I bid to avail the applicable benefits.

Date to be reckoned for determining the deemed validity will be the date of bid opening (Part-I in case of two-part bid and three-part bid).

Documents have to be notarized/attested by a Gazetted officer and must be valid as on the date of part I bid opening for the vendors to be eligible for the benefits applicable for MSE vendors. Please note that no benefit shall be applicable if any deficiency in the above required documents are not submitted before the price bid opening/Reverse Auction. If the tender is to be submitted through e-procurement portal, then the above required documents are to be uploaded on the portal.

Bidders to however note the documents that shall be furnished in order to establish credentials as MSE vendor should be as per the extant statutory requirements specified by the Ministry of Micro, Small and Medium Enterprises.

PURCHASE PREFERENCE FOR MSE VENDORS:

MSE vendors quoting within a price band of L1 + 15% shall be allowed to supply up to 25% of the requirement against this tender provided

1. The MSE vendor matches the L1 price.
2. L1 price is from a non MSE vendor.
3. L1 price will be offered to the vendor nearest to L1 in terms of price ranking (L2 - nearest to L1). In case of non-acceptance by the MSE vendor (L2), next ranking MSE vendor will be offered who is within the L1 + 15% band (if L3 is also within 15% band).
4. 3% of the 25% will be earmarked for women owned MSEs.
5. 25% of the 25% (i.e., 6.25% of the total enquired quantity) will be earmarked for SC/ST owned MSE firms provided conditions as mentioned in (1) & (2) are fulfilled.
6. In case where no SC/ST category firms are meeting the conditions mentioned in (1) and (2) or have not participated in the tender, the 6.25% of earmarked quantity for SC/ST owned MSE firms will be distributed among the other eligible MSE vendors who have participated in the tender.
7. In case after the bid opening it is seen that no MSE has become L1, then depending on the nature of the item, if it is not possible to split the tendered items/quantities on account of reasons like customer contract requirements of supplying one make for a given project or technical reasons like the tendered item being a system etc., then BHEL would not counter offer the L1 prices even though there may be MSE bidders within the +15% band of L1. Such information that tendered quantity will not be split shall be indicated in the SCC.

J. INTEGRITY COMMITMENT IN THE TENDER PROCESS, AND EXECUTION OF CONTRACTS:

1. Commitment by BHEL: BHEL commits to take all measures necessary to prevent corruption in connection with the Tender process and execution of the Contract. BHEL will, during the tender process, treat all bidder / suppliers in a transparent and fair manner, and with equity.

2. Commitment by Bidder(s)/ Contractor(s):

   a. The Bidder(s)/ Contractor(s) commit(s) to take all measures to prevent corruption and will not directly or indirectly try to influence any decision or benefit which he is not legally entitled to.
   b. The Bidder(s)/ Contractor(s) will not enter with other Bidder(s) into any undisclosed agreement or understanding or any actions to restrict competition.

c. The Bidder(s)/ Contractor(s) will not commit any offence under the relevant Acts. The Bidder(s)/ Contractor(s) will not use improperly, for purposes of competition or personal gain or pass on to others, any information or document provided by BHEL as part of business relationship.
d. The Bidder(s)/ Contractor(s) will, when presenting his bid, disclose any and all payments he has made, and is committed to or intends to make to agents, brokers or any other intermediaries in connection with the award of the contract and shall adhere to the relevant guidelines issued from time to time by Government of India/ BHEL.

If the Bidder(s) / Contractor(s), before award or during execution of the Contract commit(s) a transgression of the above or in any other manner such as to put his reliability or credibility in question, BHEL is entitled to disqualify the Bidder(s) / Contractor (s) from the tender process or terminate the contract and/ or take suitable action as deemed fit.

K. <u>Integrity Pact (IP):</u>

a) IP is a tool to ensure that activities and transactions between the Company and its Bidders/ Contractors are handled in a fair, transparent and corruption free manner.
A panel of independent External Monitors (IEMs) have been appointed to oversee implementation of IP in BHEL.
The IP as enclosed with the tender is to be submitted (duly signed by authorized signatory who signs in the offer) along with techno-commercial bid. Only those Bidders who have entered into such an IP with BHEL would be competent to participate in the bidding. In other words, entering into this Pact would be a preliminary qualification.
b) Please refer Section-8 of the IP for Role and Responsibilities of IEMs (Annexure IX). In case of any complaint arising out of the tendering process, the matter may be referred to the IEM mentioned in the tender.

Note: No routine correspondence shall be addressed to the IEM (phone/ post/ email) regarding the clarifications, time extensions or any other administrative queries, etc. on the tender issued. All such clarification/ issues shall be addressed directly to the tender issuing (procurement) department."

Annexure I

Guidelines for Indian Agents

- **Definition of Indian Agent**: An Indian Agent of foreign prinicipal is an individual, a partnership, an association of persons, a private or pubile company, that carries our specific obligation(s) towards processing of BHEL tender or finalization or execution of BHEL's contract on behalf of the foreign supplier.

In case of yes, vendor to note the following and reply accordingly:

i. BHEL shall deal directly with foreign vendors, wherever required, for procurement of goods. However, if the foreign principal desires to avail of the services of an Indian agent, then the foreign principal should ensure compliance to regulatory guidelines - which require mandatory submission of an Agency Agreement.

ii. It shall be incumbent on the Indian agent and the foreign principal to adhere to the relevant guidelines of Government of India, issued from time to time.

iii. The Agency Agreement should specify the precise relationship between the foreign OEM / foreign principal and their Indian agent and their mutual interest in the business. All services to be rendered by agent/ associate, whether of general nature or in relation to the particular contract, must be clearly stated by the foreign supplier/ Indian agent. Any payment, which the agent or associate receives in India or abroad from the OEM, whether as commission or as a general retainer fee should be brought on record in the Agreement and be made explicit in order to ensure compliance to laws of the country.

iv. Any agency commission to be paid by BHEL to the Indian agent shall be in Indian currency only.

v. Tax deduction at source is applicable to the agency commission paid to the Indian agent as per the prevailing rules.

vi. In the absence of any agency agreement, BHEL shall not deal with any Indian agent (authorized representatives / associate / consultant, or by whatever name called) and shall deal directly with the foreign principal only for all correspondence and business purposes.

vii. The "Guidelines for Indian Agents of Foreign Suppliers" enclosed at annexure –'A' shall apply in all such cases.

viii. The supply and execution of the Purchase Order (including indigenous supplies/ service) shall be in the scope of the OEM/ foreign principal. The OEM/ foreign principal should submit their offer inclusive of all indigenous supplies/ services and evaluation will be based on 'total cost to BHEL'. In case OEM/ foreign principal recommends placement of order(s) towards indigenous portion of supplies/ services on Indian supplier(s)/ agent on their behalf, the credentials/ capacity/ capability of the Indian supplier(s)/ agent to make the supplies/ services shall be checked by BHEL as per the extant guidelines of Supplier Evaluation, Approval & Review Procedure (SEARP), before opening of price bids. In this regard, details may be checked as per Annexure-B (copy enclosed). It will be the responsibility of the OEM/ foreign principal to get acquainted with the evaluation requirements of Indian supplier/ agent as per SEARP available on www.bhel.com.

The responsibility for successful execution of the contract (including indigenous supplies/ services) lies with the OEM/ foreign principal. All bank guarantees to this effect shall be in the scope of the OEM/ foreign principal.

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Vendor's Signature with Seal

Annexure-A

Guidelines for Indian Agents of Foreign Suppliers

1.0 There shall be compulsory registration of agents for all Global (Open) Tender and Limited Tender. An agent who is not registered with BHEL shall apply for registration in the registration form in line with SEARP.

1.1 Registered agents will file an authenticated Photostat copy duly attested by a Notary Public/Original certificate of the Principal confirming the agency agreement and giving the status being enjoyed by the agent and the commission/ remuneration/ salary/ retainership being paid by the principal to the agent before the placement of order by BHEL.

1.2 Wherever the Indian representatives have communicated on behalf of their principals and the foreign parties have stated that they are not paying any commission to the Indian agents, and the Indian representative is working on the basis of salary or as retainer, a written declaration to this effect should be submitted by the party (i.e. Principal) before finalizing the order.

2.0 Disclosure of particulars of agents/ representatives in India, if any.

2.1 Tenderers of Foreign nationality shall furnish the following details in their offers:

2.1.1 The Bidder(s)/ Contractor(s) of foreign origin shall disclose the name and address of the agents/ representatives in India if any and the extent of authorization and authority given to commit the Principals. In case the agent/ representative be a foreign Company, it shall be confirmed whether it is existing Company and details of the same shall be furnished.

2.1.2 The amount of commission/ remuneration included in the quoted price(s) for such agents/ representatives in India.

2.1.3 Confirmation of the Tenderer that the commission/ remuneration, if any, payable to his agents/ representatives in India, may be paid by BHEL in Indian Rupees only.

2.2 Tenderers of Indian Nationality shall furnish the following details in their offers:

2.2.1 The Bidder(s)/ Contractor(s) of Indian Nationality shall furnish the name and address of the foreign principals, if any, indicating their nationality as well as their status, i.e. whether manufacturer or agents of manufacturer holding the Letter of Authority of the Principal specifically authorizing the agent to make an offer in India in response to tender either directly or through the agents/ representatives.

2.2.2 The amount of commission/ remuneration included in the price (s) quoted by the Tenderer for himself.

2.2.3 Confirmation of the foreign principals of the Tenderer that the commission/ remuneration, if any, reserved for the Tenderer in the quoted price(s), may be paid by BHEL in India in equivalent Indian Rupees on satisfactory completion of the Project or supplies of Stores and Spares in case of operation items.

2.3 In either case, in the event of contract materializing, the terms of payment will provide for payment of the commission/ remuneration, if any payable to the agents/ representatives in India in Indian Rupees on expiry of 90 days after the discharge of the obligations under the contract.

2.4 Failure to furnish correct and detailed information as called for in paragraph 2.0 above will render the concerned tender liable to rejection or in the event of a contract materializing, the same liable to termination by BHEL. Besides this there would be a penalty of banning business dealings with BHEL or damage or payment of a named sum.

—x—

ANNEXURE - II
LIST OF INTERNATIONAL GATEWAY AIRPORTS

For air based consignment, terms of delivery will be on FCA basis from following listed airports only. Vendors are requested to verify this list for use before submission of offer.

SCHEDULE NO	COUNTRY	CURRENCY CODE	AIRPORT
D01	UK	GBP	LONDON (HEATHROW)
D02	UK	GBP	NEW CASTLE
D03	UK	GBP	OXFORD. CHETLAM
D04	UK	GBP	BRISTOL. WELLINGBOROUGH
D05	UK	GBP	BIRMINGHAM
DO6	UK	GBP	EAST MIDLANDS
D07	UK	GBP	MANCHESTER
D08	UK	GBP	LEEDS
D09	UK	GBP	GLASGOW
D10	FRANCE	EURO	PARIS (ROISSY) & LYON
D11	SWEDEN	EURO	STOCKHOLM
D12	SWEDEN	EURO	GOTHENBERG & MALMO
D13	ITALY	EURO	ROMA, MILAN
D14	ITALY	EURO	TURIN, BOLOGNA, FLORENCE
D15	NETHERLANDS	EURO	AMSTERDAM, ROTTERDAM
D16	AUSTRIA	EURO	VIENNA, LINZ, GRAZ
D17	BELGIUM	EURO	ANTWERP, BRUSSELS
D18	DENMARK	DKK	COPENHAGEN
D19	JAPAN	JPY	TOKYO, OSAKA
D20	SINGAPORE	SGD	SINGAPORE
D21	CANADA	CAD	TORONTO
D22	CANADA	CAD	MONTREAL
D23	USA	USD	NEW YORK, BOSTON
D24	USA	USD	CHICAGO
D25	USA	USD	SAN FRANCISCO, LOS ANGELES
D26	USA	USD	ALANTA, HOUSTON
D27	GERMANY	EURO	MUNICH, KOLN, DUSSELDORF, HANNOVER, HAMBURG, STUTTGART, DAMSTADT, MANIHIEM, NURUMBERG
D28	GERMANY	EURO	FRANKFURT
D29	GERMANY	EURO	BERLIN
D30	SWITZERLAND	SFR	BASLE, ZURICH, GENEVA
D31	SPAIN	EURO	BARCELONA
D32	AUSTRALIA	AUD	SYDNEY
D33	AUSTRALIA	AUD	MELBOURNE
D34	AUSTRALIA	AUD	PERTH
D35	CZECH	EURO	PRAGUE
D36	HONG KONG	HKD	HONG KONG
D37	NEW ZELAND	NZD	AUCKLAND
D38	RUSSIA	USD	MOSCOW
D39	SOUTH KOREA	USD	KIMPO INTERNATIONAL, INCHEON
D40	FINLAND	EURO	HELSINKI
D41	ROMANIA	EURO	BUCHAREST
D42	NORWAY	EURO	OSLO
D43	IRELAND	EURO	DUBLIN
D44	ISRAEL	USD	TEL AVIV
D45	UAE	USD	DUBAI
D46	OMAN	USD	MUSCAT
D47	EGYPT	USD	CAIRO
D48	TAIWAN	USD	TAIPEI
D49	UKRAINE	USD	KIEV
D50	CHINA	USD	SHANGHAI, SHENZHEN
D51	PHILIPINES	USD	MANILA
D52	MALAYSIA	USD	KUALALUMPUR, PE NANG
D53	CYPRUS	USD	LARNACA
D54	SOUTH AFRICA	USD	JOHANNESBERG, DURBAN
D55	SLOVAKIA	EURO	BARTISLOVA
D56	SAUDI ARABIA	SAR	RIYADH
D57	TURKEY	EURO	ISTANBUL
D58	THAILAND	USD	BANGKOK
D59	BRAZIL	USD	SAO PAULO, RIO DE JANEIRO

ANNEXURE – III

DISCREPANCY IN WORDS & FIGURES – QUOTED IN PRICE BID

Following guidelines will be followed in case of discrepancy in words & figures-quoted in price bid:

(a) If, in the price structure quoted for the required goods/services/works, there is discrepancy between the unit price and the total price (which is obtained by multiplying the unit price by the quantity), the unit price shall prevail and the total price corrected accordingly, unless in the opinion of the purchaser there is an obvious misplacement of the decimal point in the unit price, in which case the total price as quoted shall govern and the unit price corrected accordingly.

(b) If there is an error in a total corresponding to the addition or subtraction of subtotals, the subtotals shall prevail and the total shall be corrected; and

(c) If there is a discrepancy between words and figures, the amount in words shall prevail, unless the amount expressed in words is related to an arithmetic error, in which case the amount in figures shall prevail subject to (a) and (b) above.

(d) If there is such discrepancy in an offer, the same shall be conveyed to the bidder with target date upto which the bidder has to send his acceptance on the above lines and if the bidder does not agree to the decision of the purchaser, the bid is liable to be ignored.

ANNEXURE - IV

Electronic Funds Transfer (EFT) OR

Paylink Direct Credit Form

Please Fill up the form in **CAPITAL LETTERS** only.
TYPE OF REQUEST(Tick one): _____ CREATE _____ CHANGE

BHEL Vendor / Supplier Code:
Company Name :
Permanent Account Number(PAN):
Address

City: PINCODE STATE

Contact Person(s)
Telephone No:
Fax No:
e-mail id:

1 Bank Name:
2 Bank Address:

3 Bank Telephone No:
4 Bank Account No:
5 Account Type: Savings/Cash Credit
6 9 Digit Code Number of Bank and branch appearing on MICR cheque issued by Bank
7 Bank IFSC Code(applicable for NEFT)
8 Bank IFSC code(applicable for RTGS) (Indian Financial System Code)

A I hereby certify that the particulars given above are true, correct and complete and that I, as a representative for the above named Company, hereby authorise BHEL, EDN, Bangalore to electronically deposit payments to the designated bank account.

B If the transaction is delayed or not effected at all for reasons of incomplete or incorrect information, I would not hold BHEL / transfering Bank responsible.

C This authority remains in full force until BHEL, EDN,Bangalore receives written notification requesting a change or cancellation.

D I have read the contents of the covering letter and agree to discharge the responsibility expected of me as a participant under ECS / EFT.

Date:

Authorised Signatory:
Designation: Telephone No. with STD Code

Company Seal

Bank Certificate

We certify that_____has an Account No_____ with us and we confirm that the bank details given above are correct as per our records.

Date: (.....)
Place: Signature

Please return completed form **along with a blank cancelled cheque or photocopy** thereof to:
Bharath Heavy Electricals Ltd,
Attn:
Electronics Division, Mysore Road,
BANGALORE - 560 026
In case of any Querry, please call concerned purchase executive.

ANNEXURE - V
PRESENT PROCEDURE FOR SALE IN TRANSIT (HIGH SEA SALES)

In case of High Sea Sales, vendor should submit following documents:

1. **ORIGINAL HIGH SEA SALES AGREEMENT**
   - Sale agreement (on Rs. 200/- non-judicial stamp paper & notarised with 2 witnesses with identity) has to be signed between BHEL and the Party importing material. The date of the sale documents should be in between the date of House Air Way Bill / Bill of Lading and before landing of the goods in Indian origin.
   - Following shall be included in the High Sea Sales Agreement:
     "THE BUYER ALSO UNDERTAKE DISCHARGES, THE OBLIGATION AND FULFILLMENT OF CONDITIONS, IF ANY, ATTACHED TO THE IMPORTATION, ASSESSMENT AND CLEARANCE OF THE GOODS IN TERMS CUSTOMS TARIFF ACT 1975, THE CUSTOMS ACT 1962 & RULES & REGULATIONS MADE THERE UNDER AND OTHER RELEVANT ACTS, ORDERS, NOTIFICATIONS".

2. **ORIGINAL INVOICES: INDIGENOUS RUPEE INVOICE & FOREIGN CURRENCY INVOICE**
   - Prices should be C.I.F., designated airport/seaport basis.
   - I.E.C., C.S.T., K.S.T. Nos. to be mentioned.
   - Description of item (Nomenclature), Unit & Quantity in both the Foreign Currency & the Indigenous Invoice in Rupee shall be exactly as per Purchase Order Description of item, Quantity and Unit. The Indigenous Invoice value shall be exactly as per Purchase Order value.
   - Seller should give Foreign Currency Invoice from the original consignor. The Foreign Currency Invoice value should be at least 2% (two per cent) less than the Indigenous Rupee Invoice value in equivalent foreign currency.

4. **ORIGINAL HOUSE AIR WAY BILL/ BILL OF LADING**
   - The sale agents should duly endorse House Air Way Bill (HAWB) for air shipments or original Bill of Lading (O.B.L.) for sea shipments and Foreign Currency Invoice in favour of BHEL-EDN.

5. **ORIGINAL CARGO ARRIVAL NOTICE FROM FORWARDER.**

6. **ORIGINAL DELIVERY ORDER ISSUED IN NAME OF BHEL-EDN.**

7. **ORIGINAL PACKING LIST.**

8. **A LETTER TO THE COMMISSIONER OF CUSTOMS FOR EFFECTING ABOVE SALE.**

9. **A LETTER TO THE DEPUTY ASSESSOR (OCTROI) FOR EFFECTING ABOVE SALE IN FAVOUR OF BHEL.**

REMARKS: In case vendor needs any clarifications on the above, the same may be sought in writing.

ELECTRONICS DIVISION, BANGALORE

Annexure-VI

BHEL MEMBER BANKS (LIST OF CONSORTIUM BANKS)

Bank Guarantee (BG) shall be issued from the following banks only:

Sl. No.	Nationalised Banks	Sl. No.	Public Sector Banks
1	Allahabad Bank	18	IDBI
2	Andhra Bank		
3	Bank of Baroda	Sl. No.	**Foreign Banks**
4	Canara Bank	19	CITI Bank N.A
5	Corporation Bank	20	Deutsche Bank AG
6	Central Bank	21	The Hongkong and Shanghai Banking Corporation Ltd. (HSBC)
7	Indian Bank	22	Standard Chartered Bank
8	Indian Overseas Bank	23	J P Morgan
9	Oriental Bank of Commerce		
10	Punjab National Bank	**Sl. No.**	**Private Banks**
11	Punjab & Sindh Bank	24	Axis Bank
12	State Bank of India	25	The Federal Bank Limited
13	Syndicate Bank	26	HDFC Bank
14	UCO Bank	27	Kotak Mahindra Bank Ltd
15	Union Bank of India	28	ICICI Bank
16	United Bank of India	29	IndusInd Bank
17	Vijaya Bank	30	Yes Bank

Note:

- All BGs must be issued from BHEL consortium banks listed above.
- This list is subject to changes. Hence vendors are requested to check this list every time before issuing BGs.
- Bank Guarantees issued by Co-operative Banks/Financial Institutions cannot be accepted under any circumstance.

Annexure-VII

BANK GUARANTEE FOR PERFORMANCE SECURITY

Bank Guarantee No:

Date:

To

NAME

& ADDRESSES OF THE BENEFICIARY

Dear Sirs,

In consideration of Bharat Heavy Electricals Limited (hereinafter referred to as the 'Employer' which expression shall unless repugnant to the context or meaning thereof, include its successors and permitted assigns) incorporated under the Companies Act, 1956 and having its registered office at _____[1] through its Unit at.....(name of the Unit) having awarded to (Name of the Vendor / Contractor / Supplier) with its registered office at_____[2] hereinafter referred to as the ' Vendor / Contractor / Supplier ', which expression shall unless repugnant to the context or meaning thereof, include its successors and permitted assigns), a contract Ref No.....dated .....[3] valued at Rs.....[4] (Rupees ----------)/FC.....(in words.....) for .....[5] (hereinafter called the 'Contract') and the Vendor / Contractor / Supplier having agreed to provide a Contract Performance Bank Guarantee, equivalent to .....% (.... Percent) of the said value of the Contract to the Employer for the faithful performance of the Contract,

we, ..., (hereinafter referred to as the Bank), having registered/Head office at ..... and inter alia a branch at ..... being the Guarantor under this Guarantee, hereby, irrevocably and unconditionally undertake to forthwith and immediately pay to the Employer any sum or sums upto a maximum amount of Rs ---------- [6] (Rupees ----------) without any demur, immediately on first demand from the Employer and without any reservation, protest, and recourse and without the Employer needing to prove or demonstrate reasons for its such demand.

Any such demand made on the Bank shall be conclusive as regards the amount due and payable by the Bank under this guarantee. However, our liability under this guarantee shall be restricted to an amount not exceeding Rs. _____.

We undertake to pay to the Employer any money so demanded notwithstanding any dispute or disputes raised by the Vendor / Contractor / Supplier in any suit or proceeding pending before any Court or Tribunal, Arbitrator or any other authority, our liability under this present being absolute and unequivocal.

The payment so made by us under this Guarantee shall be a valid discharge of our liability for payment thereunder and the Vendor / Contractor / Supplier shall have no claim against us for making such payment.

We the .....bank further agree that the guarantee herein contained shall remain in full force and effect during the period that would be taken for the performance of the said Contract/satisfactory completion of the performance guarantee period as per the terms of the Contract and that it shall continue to be enforceable till

all the dues of the Employer under or by virtue of the said Contract have been fully paid and its claims satisfied or discharged.

We .....BANK further agree with the Employer that the Employer shall have the fullest liberty without our consent and without affecting in any manner our obligations hereunder to vary any of the terms and conditions of the said Contract or to extend time of performance by the said Vendor / Contractor / Supplier from time to time or to postpone for any time or from time to time any of the powers exercisable by the Employer against the said Vendor / Contractor / Supplier and to forbear or enforce any of the terms and conditions relating to the said Contract and we shall not be relieved from our liability by reason of any such variation, or extension being granted to the said Vendor / Contractor / Supplier or for any forbearance, act or omission on the part of the Employer or any indulgence by the Employer to the said Vendor / Contractor / Supplier or by any such matter or thing whatsoever which under the law relating to sureties would but for this provision have effect of so relieving us.

The Bank also agrees that the Employer at its option shall be entitled to enforce this Guarantee against the Bank as a principal debtor, in the first instance without proceeding against the Vendor / Contractor / Supplier and notwithstanding any security or other guarantee that the Employer may have in relation to the Vendor / Contractor / Supplier 's liabilities.

This Guarantee shall remain in force upto and including..... [7] and shall be extended from time to time for such period as may be desired by Employer.

This Guarantee shall not be determined or affected by liquidation or winding up, dissolution or change of constitution or insolvency of the Vendor / Contractor / Supplier but shall in all respects and for all purposes be binding and operative until payment of all money payable to the Employer in terms thereof.

Unless a demand or claim under this guarantee is made on us in writing on or before the .....[8]we shall be discharged from all liabilities under this guarantee thereafter.

We, ... BANK lastly undertake not to revoke this guarantee during its currency except with the previous consent of the Employer in writing.

Notwithstanding anything to the contrary contained hereinabove:

a) The liability of the Bank under this Guarantee shall not exceed..... [6]
b) This Guarantee shall be valid up to .....[7]
c) Unless the Bank is served a written claim or demand on or before _____[8] all rights under this guarantee shall be forfeited and the Bank shall be relieved and discharged from all liabilities under this guarantee irrespective of whether or not the original bank guarantee is returned to the Bank.

We, _____ Bank, have power to issue this Guarantee under law and the undersigned as a duly authorized person has full powers to sign this Guarantee on behalf of the Bank.

For and on behalf of
(Name of the Bank)

Dated.....

Place of Issue.....

[1] *NAME AND ADDRESS OF EMPLOYER I.e Bharat Heavy Electricals Limited*

[2] *NAME AND ADDRESS OF THE VENDOR /CONTRACTOR / SUPPLIER.*

[3] *DETAILS ABOUT THE NOTICE OF AWARD/CONTRACT REFERENCE*

[4] *CONTRACT VALUE*

[5] *PROJECT/SUPPLY DETAILS*

[6] *BG AMOUNT IN FIGURES AND WORDS*

[7] *VALIDITY DATE*

[8] *DATE OF EXPIRY OF CLAIM PERIOD*

Annexure – VIII
(Applicable only for MSE suppliers)
Certificate by Chartered Accountant on Letter Head

This is to certify that M/s ....(hereinafter referred to as `Company') having its registered office at ..... is registered under MSMED Act 2006, (Entrepreneur Memorandum No (Part-11 ..... dtd ....., Category: ..... (Micro/Small) (Copy enclosed).

Further verified from the Books of Accounts that the investment of the company as per the latest audited financial year..... as per MSMED Act 2006 is as follows:

1. **For Manufacturing Enterprises:** Investment in plant and machinery (i.e. original cost excluding land and building and the items specified by the Ministry of Small Scale Industries vide its notification No.S.O.1722 (E) dated October 5, 2006:
   Rs.....Lacs.

2. **For Service Enterprises:** Investment in equipment (original cost excluding land and building and furniture, fittings and other items not directly related to the service rendered or as may be notified under the MSMED Act, 2006:
   Rs. .....Lacs.

The above investment of Rs. .....Lacs in within permissible limit of Rs.....Lacs for.....Micro / Small (Strike off which is not applicable) Category under MSMED Act 2006.

Or

The company has been graduated from its original category (Micro/ Small) (**Strike off which is not applicable**) and the date of graduation of such enterprise from its original category is ..... (dd/mm/yyyy) which is within the period of 3 years from the date of graduation of such enterprise from its original category as notified vide S.O. No. 3322(E) dated 01.11.2013 published in the gazette notification dated 04.11.2013 by Ministry of MSME.

Date:

(Signature)

Name:

Membership Number:

Seal of Chartered Accountant

IX

Annexure-I

INTEGRITY PACT

Between

Bharat Heavy Electricals Ltd. (BHEL), a company registered under the Companies Act 1956 and having its registered office at "BHEL House", Siri Fort, New Delhi - 110049 (India) hereinafter referred to as "The Principal", which expression unless repugnant to the context or meaning hereof shall include its successors or assigns of the ONE PART

and

_____, (description of the party along with address), hereinafter referred to as "The Bidder/ Contractor" which expression unless repugnant to the context or meaning hereof shall include its successors or assigns of the OTHER PART

Preamble

The Principal intends to award, under laid-down organizational procedures, contract/s for VFD System for Barh-1, Barh-2, Mauda and North Karanpura projects (Tender no. NKR0000346). The Principal values full compliance with all relevant laws of the land, rules and regulations, and the principles of economic use of resources, and of fairness and transparency in its relations with its Bidder(s)/ Contractor(s).

In order to achieve these goals, the Principal will appoint Independent External Monitor(s), who will monitor the tender process and the execution of the contract for compliance with the principles mentioned above.

Section 1- Commitments of the Principal

1.1 The Principal commits itself to take all measures necessary to prevent corruption and to observe the following principles:-

1.1.1 No employee of the Principal, personally or through family members, will in connection with the tender for, or the execution of a contract, demand, take a promise for or accept, for self or third person, any material or immaterial benefit which the person is not legally entitled to.

1.1.2 The Principal will, during the tender process treat all Bidder(s) with equity and reason. The Principal will in particular, before and during the tender process, provide to all Bidder(s) the same information and will not provide to any Bidder(s) confidential/ additional information through which the Bidder(s) could obtain an advantage in relation to the tender process or the contract execution.

1.1.3 The Principal will exclude from the process all known prejudiced persons.

1.2 If the Principal obtains information on the conduct of any of its employees which is a penal offence under the Indian Penal Code 1860 and Prevention of Corruption Act 1988 or any other statutory penal enactment, or if there be a substantive suspicion in this regard, the Principal will inform its Vigilance Office and in addition can initiate disciplinary actions:

Section 2 - Commitments of the Bidder(s)/ Contractor(s)

2.1 The Bidder(s)/ Contractor(s) commit himself to take all measures necessary to prevent corruption. He commits himself to observe the following principles during his participation in the tender process and during the contract execution.

2.1.1 The Bidder(s)/ Contractor(s) will not, directly or through any other person or firm, offer, promise or give to the Principal or to any of the Principal's employees involved in the tender process or the execution of the contract or to any third person any material, immaterial or any other benefit which he/ she is not legally entitled to, in order to obtain in exchange any advantage of any kind whatsoever during the tender process or during the execution of the contract.

2.1.2 The Bidder(s)/ Contractor(s) will not enter with other Bidder(s) into any illegal or undisclosed agreement or understanding, whether formal or informal. This applies in particular to prices, specifications, certifications, subsidiary contracts, submission or non-submission of bids or any other actions to restrict competitiveness or to introduce cartelization in the bidding process.

2.1.3 The Bidder(s)/ Contractor(s) will not commit any penal offence under the relevant Indian Penal Code (IPC) and Prevention of Corruption Act; further the Bidder(s)/ Contractor(s) will not use improperly, for purposes of competition or personal gain, or pass on to others, any information or document provided by the Principal as part of the business relationship, regarding plans, technical proposals and business details, including information contained or transmitted electronically.

2.1.4 Foreign Bidder(s)/ Contractor(s) shall disclose the name and address of agents and representatives in India and Indian Bidder(s)/ Contractor(s) to disclose their foreign principals or associates. The Bidder(s)/ Contractor(s) will, when presenting his bid, disclose any and all payments he has made, and is committed to or intends to make to agents, brokers or any other intermediaries in connection with the award of the contract.

2.2 The Bidder(s)/ Contractor(s) will not instigate third persons to commit offences outlined above or be an accessory to such offences.

2.3 The Bidder(s)/ Contractor(s) shall not approach the Courts while representing the matters to IEMs and will await their decision in the matter.

Section 3 - Disqualification from tender process and exclusion from future contracts

If the Bidder(s)/ Contractor(s), before award or during execution has committed a transgression through a violation of Section 2 above, or acts in any other manner such as to put his reliability or credibility in question, the Principal is entitled to disqualify the Bidder(s)/ Contractor(s) from the tender process or take action as per the separate "Guidelines on Banning of Business dealings with Suppliers/ Contractors", framed by the Principal.

Section 4 - Compensation for Damages

4.1 If the Principal has disqualified the Bidder from the tender process prior to the award according to Section 3, the Principal is entitled to demand and recover the damages equivalent Earnest Money Deposit/ Bid Security.

4.2 If the Principal has terminated the contract according to Section 3, or if the Principal is entitled to terminate the contract according to section 3, the Principal shall be entitled to

demand and recover from the Contractor liquidated damages equivalent to 5% of the contract value or the amount equivalent to Security Deposit/ Performance Bank Guarantee, whichever is higher.

Section 5 - Previous Transgression

5.1 The Bidder declares that no previous transgressions occurred in the last 3 years with any other company in any country conforming to the anti-corruption approach or with any other Public Sector Enterprise in India that could justify his exclusion from the tender process.

5.2 If the Bidder makes incorrect statement on this subject, he can be disqualified from the tender process or the contract, if already awarded, can be terminated for such reason.

Section 6 - Equal treatment of all Bidders/ Contractors / Sub-contractors

6.1 The Principal will enter into agreements with identical conditions as this one with all Bidders and Contractors. In case of sub-contracting, the Principal contractor shall be responsible for the adoption of IP by his sub-contractors and shall continue to remain responsible for any default by his sub-contractors.

6.2 The Principal will disqualify from the tender process all bidders who do not sign this pact or violate its provisions.

Section 7 - Criminal Charges against violating Bidders/ Contractors /Subcontractors

If the Principal obtains knowledge of conduct of a Bidder, Contractor or Subcontractor, or of an employee or a representative or an associate of a Bidder, Contractor or Subcontractor which constitutes corruption, or if the Principal has substantive suspicion in this regard, the Principal will inform the Vigilance Office.

Section 8 - Independent External Monitor(s)

8.1 The Principal appoints competent and credible Independent External Monitor for this Pact. The task of the Monitor is to review independently and objectively, whether and to what extent the parties comply with the obligations under this agreement.

8.2 The Monitor is not subject to instructions by the representatives of the parties and performs his functions neutrally and independently. He reports to the CMD, BHEL.

8.3 The Bidder(s)/ Contractor(s) accepts that the Monitor has the right to access without restriction to all contract documentation of the Principal including that provided by the Bidder(s)/ Contractor(s). The Bidder(s)/ Contractor(s) will grant the monitor, upon his request and demonstration of a valid interest, unrestricted and unconditional access to his contract documentation. The same is applicable to Sub-contractor(s). The Monitor is under contractual obligation to treat the information and documents of the Bidder(s)/ Contractor(s) / Sub-contractor(s) with confidentiality in line with Non- disclosure agreement.

8.4 The Principal will provide to the Monitor sufficient information about all meetings among the parties related to the contract provided such meetings could have an impact on the contractual relations between the Principal and the Contractor. The parties offer to the Monitor the option to participate in such meetings.

8.5 The role of IEMs is advisory, would not be legally binding and it is restricted to resolving issues raised by an intending bidder regarding any aspect of the tender which allegedly restricts competition or bias towards some bidders. At the same time, it must be understood that IEMs are not consultants to the Management. Their role is independent in nature and the advice once tendered would not be subject to review at the request of the organization.

8.6 For ensuring the desired transparency and objectivity in dealing with the complaints arising out of any tendering process, the matter should be examined by the full panel of IEMs jointly as far as possible, who would look into the records, conduct an investigation, and submit their joint recommendations to the Management.

8.7 The IEMs would examine all complaints received by them and give their recommendations/ views to CMD, BHEL, at the earliest. They may also send their report directly to the CVO and the Commission, in case of suspicion of serious irregularities requiring legal/ administrative action. IEMs will tender their advice on the complaints within 10 days as far as possible.

8.8 The CMD, BHEL shall decide the compensation to be paid to the Monitor and its terms and conditions.

8.9 IEM should examine the process integrity, they are not expected to concern themselves with fixing of responsibility of officers. Complaints alleging mala fide on the part of any officer of the organization should be looked into by the CVO of the concerned organisation.

8.10 If the Monitor has reported to the CMD, BHEL, a substantiated suspicion of an offence under relevant Indian Penal Code/ Prevention of Corruption Act, and the CMD, BHEL has not, within reasonable time, taken visible action to proceed against such offence or reported it to the Vigilance Office, the Monitor may also transmit this information directly to the Central Vigilance Commissioner, Government of India.

8.11 The number of Independent External Monitor(s) shall be decided by the CMD, BHEL.

8.12 The word `Monitor' would include both singular and plural.

Section 9 - Pact Duration

9.1 This Pact shall be operative from the date IP is signed by both the parties till the final completion of contract for successful bidder and for all other bidders 6 months after the contract has been awarded. Issues like warranty / guarantee etc. should be outside the purview of IEMs.

9.2 If any claim is made/ lodged during currency of IP, the same shall be binding and continue to be valid despite the lapse of this pact as specified above, unless it is discharged/ determined by the CMD, BHEL.

Section 10 - Other Provisions

10.1 This agreement is subject to Indian Laws and jurisdiction shall be registered office of the Principal, i.e. New Delhi.

10.2 Changes and supplements as well as termination notices need to be made in writing. Side agreements have not been made.

10.3 If the Contractor is a partnership or a consortium, this agreement must be signed by all partners or consortium members.

10.4 Should one or several provisions of this agreement turn out to be invalid, the remainder of this agreement remains valid. In this case, the parties will strive to come to an agreement to their original intentions.

10.5 Only those bidders / contractors who have entered into this agreement with the Principal would be competent to participate in the bidding. In other words, entering into this agreement would be a preliminary qualification.

For & On behalf of the Principal

(Office Seal)

[illegible], ಹಿರಿಯ ಎಂಜಿನಿಯರ್ / सी.इ.-एम.एम.-पी.आर.
नीलमणी कुमार, वरि. इंजीनियर / सी.ई.-एम.एम.-पी.आर.
NILMANI KUMAR, SR.ENGINEER/CE-MM-PR
BHEL-EDN, MYSORE ROAD, BANGALORE-560 026

Place----------

Date 27/10/2020

For & On behalf of the Bidder/ Contractor

(Office Seal)

Witness: Padmanabha 27/10/2020

(Name & Address) _____

~~ಎಂ.ಪದ್ಮನಾಭ, ಉಪ ಪ್ರಧಾನ ವ್ಯವಸ್ಥಾಪಕರು/ಮು.ಸೇ.~~
एम पद्मनाभ, उप महाप्रबंधक/~~मु.से.~~
M. PADMANABHA, DY. GENERAL MANAGER/~~CS~~ CE-MM-PR
BHEL-EDN, MYSORE ROAD, BENGALURU-560026.

Witness:_____

(Name & Address) _____

_____

Annexure-X

Restrictions under Rule 144(xi) of General Financial Rules, 2017 amendment dt: 23.07.2020

I. Any bidder from a country which shares a land border with India will be eligible to bid in this tender only if the bidder is registered with the Competent Authority.

II. "Bidder" (including the term 'tenderer', 'consultant' or 'service provider' in certain contexts) means any person or firm or company, including any member of a consortium or joint venture (that is an association of several persons, or firms or companies), every artificial juridical person not falling in any of the descriptions of bidders stated hereinbefore, including any agency branch or office controlled by such person, participating in a procurement process.

III. "Bidder from a country which shares a land border with India" for the purpose of this Order means :-

a. An entity incorporated, established or registered in such a country; or

b. A subsidiary of an entity incorporated, established or registered in such a country; or

c. An entity substantially controlled through entities incorporated, established or registered in such a country; or

d. An entity whose *beneficial owner* is situated in such a country; or

e. An Indian (or other) agent of such an entity; or

f. A natural person who is a citizen of such a country; or

g. A consortium or joint venture where any member of the consortium or joint venture falls under any of the above

IV. The *beneficial owner* for the purpose of (iii) above will be as under:

1. In case of a company or Limited Liability Partnership, the beneficial owner is the natural person(s), who, whether acting alone or together, or through one or more juridical person, has a controlling ownership interest or who exercises control through other means.

Explanation--

a. "Controlling ownership interest" means ownership of or entitlement to more than twenty-five per cent of shares or capital or profits of the company;

b. "Control" shall include the right to appoint majority of the directors or to control the management or policy decisions including by virtue of their shareholding or management rights or shareholders agreements or voting agreements;

2. In case of a partnership firm, the beneficial owner is the natural person(s) who, whether acting alone or together, or through one or more juridical person, has ownership of entitlement to more than fifteen percent of capital or profits of the partnership;

3. In case of an unincorporated association or body of individuals, the beneficial owner is the natural person(s), who, whether acting alone or together, or through one or more juridical person, has ownership of or entitlement to more than fifteen percent of the property or capital or profits of such association or body of individuals;

4. Where no natural person is identified under (1) or (2) or (3) above, the beneficial owner is the relevant natural person who holds the position of senior managing official;

5. In case of a trust, the identification of beneficial owner(s) shall include identification of the author of the trust, the trustee, the beneficiaries with fifteen percent or more interest in the trust and any other natural person exercising ultimate effective control over the trust through a chain of control or ownership.

V. An Agent is a person employed to do any act for another, or to represent another in dealings with third person.

ಭಾರತ್ ಹೆವಿ ಎಲೆಕ್ಟ್ರಿಕಲ್ಸ್ ಲಿಮಿಟೆಡ್
भारत हेवी इलेक्ट्रिकल्स लिमिटेड
Bharat Heavy Electricals Ltd.,
(A Government of India undertaking)
Electronics Division
PB 2606 , Mysore Road Bangalore , 560026 INDIA

CE: PR: 003- Rev 02

SPECIAL COMMERCIAL CONDITIONS OF CONTRACT

Reference is brought to BHEL's Instructions to Bidders (Document Ref: CE: PR: 001- Rev 03) and General Commercial Conditions for Contract (Document Ref: CE: PR: 002- Rev 02).

These two documents along with Special Conditions of Contract annexed to this RFQ will form an integral part of the contract as and when the RFQ culminates into a Purchase Order / Contract.

RFQ No: __NKR0000346___ **RFQ Date:** REFER EPROCUREMENT SYSTEM

Due Date: REFER EPROCUREMENT SYSTEM **Customer/Project:** Rarh -1, Barh – 2 , Mauda and North Karanpura

Item Description: VFD System

TYPE OF BID: THREE PART BID

E-Tender – Applicable - Bidder to submit tender in E-procurement site : https://bhel.abcprocure.com

Purchase Executives: Clarifications with regard to the tender shall be addressed to purchase officers whose e-mail IDs are given below:
___nilmanikumar@bhel.in _or _____ padmanabha@bhel.in

Splitting of tendered quantity to MSE vendors: The procurement is on package basis. Hence tendered quantity of one package will not be split to MSE vendor

Destination: a) For Indigenous scope of supply, items are to be directly despatched to BHEL's Site Office or Stores located at/near respective project site –

1. Barh 1 & Barh – 2 - NTPC Barh Super Thermal Power Station, Barh, Bihar – State, India
2. MUADA STPP – NAGPUR District/City in MAHARASHTRA State, India
3. NORTH KARANPURA STPP(3x660MW- Tandwa Town, Chatra District, Jharkhand State, India

Complete consignee details will be issued by BHEL along with Despatch Clearance.

b) For Imported scope of supply and High Sea Sale, destination is__Bangalore_. In case of shipment by sea, port of discharge shall be __any port in India and port of delivery shall be ICD- Bangalore.

Project Benefits: Merit Duty is applicable

Terms of Delivery:

- **Indigenous scope of supply:**

  Ex-works < station of dispatch > (including Packing & Forwarding charges but excluding Taxes & Duties).

- **Imported scope of supply:**

  F.C.A. (for air consignments) < indicate international port of dispatch >/ C.I.F. (for sea consignments)
  < ICD,Bangalore > (including Packing, Forwarding, Handling, Ancillary charges like processing of Sight Draft/ Letter of Credit, negotiation of bank documents, Export declaration, Country of Origin etc.).

  Kindly indicate the approximate weight of the total imported consignment, which is required for calculating air-freight charges: _____

Under-mentioned details shall be provided against indigenous supplies and services:

a. GSTIN (no.) of place of supply: _____

b. HSN (Harmonized System of Nomenclature) code: _____
Applicable tax and Rate: _____&_____

c. SAC (Service Accounting Code) no.:_____
Applicable tax and Rate: _____&_____

d. If service is also involved, GSTIN (no.) of place of supply of service: _____

I. Bidders to mandatorily provide confirmation/compliance for the under-mentioned terms:

SL NO.	TERMS	BHEL ACCEPTABLE TERM	BIDDER'S CONFIRMATION	REMARKS,if any
01	**Reverse Auction**	BHEL shall be resorting to Reverse Auction (RA) (Guidelines as available on www.bhel.com) for this tender. RA shall be conducted among all the techno-commercially qualified bidders. Price bids of all techno-commercially qualified bidders shall be opened and same shall be considered as initial bids of bidders in RA. In case any bidder(s) do(es) not participate in online Reverse Auction, their sealed envelope price bid along with applicable loading, if any, shall be considered for ranking.	**AGREE**	
03	**Delivery Period**	Within _16___ weeks from the date of issue of Manufacturing clearance along with approved document. Unitwise manufacturing clearance may be issued for each project. Manufacturing clearance will be issued strictly as per project requirement. Refer RFQ for tentative delivery period. Delay in contractual delivery will attract Penalty as per GCC Clause no.:04.b.	**AGREE** …… weeks	
04	**Terms of Payment at the time of material supply**	Refer Clause "**F**" of Instructions to Bidders for BHEL standard Payment terms and loading factors applicable for non-compliance against payment terms: **Indigenous Scope:** a)Supply with Service(s) (For Main Supply) b) Supply only (For Spares)	**AGREE**	

		Imported Scope: c)Supply with Service(s) (For Main Supply) d) Supply only (For Spares) **High-Sea sales:** e)Supply with Service(s) (For Main Supply) f) Supply only(For Spares) **Spares:** b) and/or d)/f) depending upon the scope		
05	**Declaration of Local content** (Refer Clause 'A' Sl. No. 12 of Instructions to Bidders)	Bidder to furnish the following details: (a) Percentage of local content: _____ (b) Details of the Location(s) at which the local value addition is made: _____ _____		
06	Declaration to be mandatorily submitted by the Bidder, as a compliance to Rule 144(xi) of GFR, 2017 amendment dt 23.07.2020 issued by Ministry of Finance, Govt. of India.	"I have read the clause regarding restrictions on procurement from a bidder of a country which shares a land border with India; I certify that this bidder is not from such a country or, if from such a country, has been registered with the Competent Authority. I hereby certify that this bidder fulfils all requirements in this regard and is eligible to be considered." (Refer Clause 'A' Sl. No. 13 of Instructions to Bidders).		

II. Bidder to note that Deviations shall not be permitted for the below mentioned terms and are deemed to be complied. In case of non-compliance/deviation, offer shall be liable for rejection:

(1) **Submission of documents post PO viz., drawings /data sheet etc. as indicated in Cl: 04 of GCC:** Within _3___ weeks from the date of receipt of Purchase Order. Delay in submission of complete set of specified documents in NIT, will attract Penalty as per GCC Clause no.:04.a.

(2) **Validity:** The offer will be valid for a period of _90_ days from the date of part-I bid opening and in case of Negotiation/ Counter-offer/Reverse Auction, price validity will apply afresh for a period of __ days from the date of according final price by bidder (or) upto original validity period, whichever is later.

(3) **Guarantee/ Warranty:** Barh 1 and Barh 2 - 24 months from the date of material receipt at site

Mauda - 24 months from date of despatch or 18 months from date of commissioning whichever is earlier.

North Karanpura - 24 months from the date of material receipt at site

(4) **Performance Bank Guarantee (PBG):** PBG will be applicable for a period of _24__ months from the date of dispatch of goods + claim period of 03 months, for a value equal to 10% of the basic value of the purchase order. Refer Clause "H" of Instructions to Bidders. Also note that PBG should be in the format specified in Annexure VII of ITB and no deviation to this format will be allowed.

Note: In case PBG is not furnished, the 10% basic amount will be withheld from the supply invoice. This withheld amount will be paid either against submission of supplementary invoice & Original PBG (or) against supplementary invoice without PBG after expiry of Warranty period.

(5) **Despatch Documents:** Complete set of despatch documents (original + 1 photocopy set) as per Purchase Order shall be forwarded to Purchase Executive/BHEL directly. Depending upon the project/customer demands, despatch documents may include one or more documents from the following: Invoice (02 sets of original), Lorry Receipt (L/R), Packing List, Air Way Bill (AWB)/Bill Of Lading (BOL), Copy of High Sea Sales (HSS) agreement, Country of origin certificate, NIL Short Shipment Certificate, Original Performance Bank Guarantee (directly from issuing bank to BHEL), insurance intimation letter, POD (Proof of Delivery) on L/R. Packing List shall be detailed giving Each package wise content details & Net & Gross weight of the package.
The precise list of despatch documents needed for the project will be specified in the Purchase Order.
One set of Invoice, Packing List and L/R or AWB shall be e-mailed/faxed immediately to BHEL-EDN after despatch.

(6) **Freight Charges (for indigenous scope of supply):** Freight charges shall be to vendor's account. Vendor to quote reasonable lump sum Freight charges separately, with applicable tax in priced offer.

(7) **Evaluation criteria for tendered item/s:**
a) Barh -1 and North Karanpura will be will evaluated as a single package
b) Barh -2 and Mauda will be evaluated as a single package
c) Evaluation and ranking of each package will be done separately

(8) **Integrity Pact:** Execution of Integrity Pact is applicable for this tender (Refer clause "K" of Instructions to Bidders)

Details of IEM for this tender are mentioned below:

1. Shri Arun Chandra Verma,IPS (Retd.)
   Email: acverma1@gmail.com

2. Shri Virendra Bahadur Singh,IPS (Retd.)
   Email: vbsinghips@gmail.com

~~**(9) Erection and Commissioning :**~~
~~In case the quoted total E&C value is less than __5__% of the main supply value, BHEL shall evaluate Bidders Price deducting differential amount from main supply price and apportioning towards E&C charges.~~
~~Refer Sl. no. 'g' under Clause 'F' of Instructions to Bidder for Payment term.~~

(10) Erection Supervision and Commissioning :
In case the quoted total Erection Supervision & Commissioning value is less than __5__% of the main supply value, BHEL shall evaluate Bidders Price deducting differential amount from main supply price and apportioning towards Erection Supervision & Commissioning charges.
Refer Sl. no. 'h' under Clause 'F' of Instructions to Bidder for Payment term.

(11) Comprehensive Annual Maintenance Contract : Not Applicable

(12)The evaluation currency for this tender shall be INR.

(13)The bidder declares that they will not enter into any illegal or undisclosed agreement of understanding, whether formal or informal with other bidder(s). This applies in particular to prices, specifications, subsidiary contracts, submission or non-submission of bids or any other actions to restrict competitiveness or to introduce cartelization in the bidding process.

In case, the Bidder is found having indulged in above activities, suitable action shall be taken by BHEL as per extent policies/guidelines.

(14)Evaluation methodology - Bidder's Part - 1 bid only will be opened on due date. Offer of only those bidders who qualify in PART -1 will be considered for Techno-commercial (Part -2) bid opening. Offer of only those bidders who qualify in PART -2 will be considered for price bid opening (Part -3). Schedule of part -2 and Part – 3 bid opening will be intimated to bidders qualified in Part-1 and Part -2 bid respectively.

(15)Any tender condition does not prohibit any bidder to submit their offer along with clause wise deviation from the specification/commercial terms of tender. Changes, if any, in technical specification / Scope etc shall be informed to participating bidders only.

(16)Any additional commercial term or deviation in commercial term, if sought by vendor, should be clearly brought out in Part -2 bidding form special commercial conditions of contract. Any additional commercial term or deviation in commercial term mentioned anywhere else shall be ignored and not be considered for evaluation

(17) Any technical or commercial clarification for this tender can be raised within one week of floating tender. No clarification will be entertained by BHEL after given cutoff date.

(18)Vendor has to mandatorily give price breakup for each item of scope of supply as per offered BOM (IN EXCEL FORMAT) as attachment in price bid.

(19)Total price submitted in online e-procurement portal shall be considered for evaluating L1 vendor. For further processing of offer of finalized L1 vendor, in case of mismatch in BOM quantities mentioned in price breakup uploaded / attached with price bid, following method shall be followed:

a. If the quantity mentioned in breakup for any item(s) is less than quantity mentioned in technical specification, bidder shall supply quantity as per technical specification within quoted price. The unit rate of such items shall be re-calculated by dividing sub-total with quantity required as per technical specification.

b. If the quantity mentioned in breakup for any item(s) is more than quantity mentioned in technical specification and bidder is L1 based on their e-procurement portal price, BHEL will use unit rate of such item(s) mentioned in breakup to calculate the sub-total of such item(s) as per quantity mentioned in technical specification/finalised during technical evaluation to meet technical specification.

With this, we hereby confirm that all the terms & conditions as indicated in Instructions to Bidders (Document Ref: CE: PR: 001- Rev 03) & General Commercial Conditions for Contract (Document Ref: CE: PR: 002- Rev 02) are accepted without any deviation.

Vendor's Signature with Seal

Pre-Qualification Criteria

Item: VFDs for RC Pump (1250kW, 3.3kV Motor)
Project : NTPC BARH1 FGD Project (3 x 660 MW)
Customer : NTPC

1. The vendor shall be an Original Equipment Manufacturer (OEM) of VFD Equipment. Only the OEM can submit offers.
2. The vendor should have designed, engineered, manufactured, type tested or got type tested, supplied and commissioned or supervised commissioning of at least one (1) number of VFD system (of the type & model offered) for feeding squirrel cage induction motor/ synchronous motor of 1000 kW, 3.3kV or higher kW rating, which is in successful operation for a period of at least one (1) year as on 01.07.2020. Necessary supporting document shall be provided. The Reference List of VFD supplies made giving the ratings, year of supply, application and details of the customers and their commissioning status to be provided along with the offer.
3. Vendor should also have VFD reference of the type & model offered with separately placed transformer
   a) Supplied (to any Customer)
   OR
   b) Under supply (for NTPC projects)
   Necessary supporting document shall be provided. The Reference List of VFD supplies made giving the ratings, year of supply, application and details of the customers etc. to be provided along with the offer.
4. The vendor or their authorized service representatives shall have trained engineers for commissioning & service for the offered equipment and shall be in a position to provide prompt after sales service and spares support for our installations. This service network shall necessarily be available in India.
5. The vendor shall be in a position to undertake AMC or provide service support for the equipment supplied, after the expiry of the warranty / guarantee period either directly or through a service representative.
6. Technical clearance of vendor offer will be based on Customer acceptance of Vendor Credentials.

Note:

a. Vendor must furnish all necessary supporting documents, as required, along with the bid to satisfy Pre-Qualification criteria as specified above.

b. The Pre-Qualification criteria are mandatory requirements and the technical bids will be evaluated only when the Pre-Qualification criteria are met.

Checklist for Pre-Qualification Criteria

Sl. No.	Vendor Confirmation to the points above	Reference of documents attached
1	Yes / No	
2	Yes / No	
3	Yes / No	
4	Yes / No	
5	Yes / No	
6	Yes / No	

PS/445/2636/BARH2/PQC
Date: 01.08.2020

Pre-Qualification Criteria

Item: VFDs for RC Pump (900kW, 3.3kV Motor)
Project : NTPC BARH2 FGD Project (2 x 660 MW)
Customer : NTPC

1. The vendor shall be an Original Equipment Manufacturer (OEM) of VFD Equipment. Only the OEM can submit offers.
2. The vendor should have designed, engineered, manufactured, type tested or got type tested, supplied and commissioned or supervised commissioning of at least one (1) number of VFD system (of the type & model offered) for feeding squirrel cage induction motor/ synchronous motor of 1000 kW, 3.3kV or higher kW rating, which is in successful operation for a period of at least one (1) year as on 01.07.2020. Necessary supporting document shall be provided. The Reference List of VFD supplies made giving the ratings, year of supply, application and details of the customers and their commissioning status to be provided along with the offer.
3. The vendor or their authorized service representatives shall have trained engineers for commissioning & service for the offered equipment and shall be in a position to provide prompt after sales service and spares support for our installations. This service network shall necessarily be available in India.
4. The vendor shall be in a position to undertake AMC or provide service support for the equipment supplied, after the expiry of the warranty / guarantee period either directly or through a service representative.
5. Technical clearance of vendor offer will be based on Customer acceptance of Vendor Credentials.

Note:

a. Vendor must furnish all necessary supporting documents, as required, along with the bid to satisfy Pre-Qualification criteria as specified above.

b. The Pre-Qualification criteria are mandatory requirements and the technical bids will be evaluated only when the Pre-Qualification criteria are met.

Checklist for Pre-Qualification Criteria

Sl. No.	Vendor Confirmation to the points above	Reference of documents attached
1	Yes / No	
2	Yes / No	
3	Yes / No	
4	Yes / No	
5	Yes / No	

PS/445/2636/MAUDA/PQC
Date: 31.07.2020

Pre-Qualification Criteria

Item: VFDs for RC Pump (900kW, 3.3kV Motor)
Project : NTPC Mauda FGD Project (2 x 500 MW)
Customer : NTPC

1. The vendor shall be an Original Equipment Manufacturer (OEM) of VFD Equipment. Only the OEM can submit offers.
2. The vendor should have designed, engineered, manufactured, type tested or got type tested, supplied and commissioned or supervised commissioning of at least one (1) number of VFD system (of the type & model offered) for feeding squirrel cage induction motor/ synchronous motor of 1000 kW, 3.3kV or higher kW rating, which is in successful operation for a period of at least one (1) year as on 01.07.2020. Necessary supporting document shall be provided. The Reference List of VFD supplies made giving the ratings, year of supply, application and details of the customers and their commissioning status to be provided along with the offer.
3. The vendor or their authorized service representatives shall have trained engineers for commissioning & service for the offered equipment and shall be in a position to provide prompt after sales service and spares support for our installations. This service network shall necessarily be available in India.
4. The vendor shall be in a position to undertake AMC or provide service support for the equipment supplied, after the expiry of the warranty / guarantee period either directly or through a service representative.
5. Technical clearance of vendor offer will be based on Customer acceptance of Vendor Credentials.

Note:

a. Vendor must furnish all necessary supporting documents, as required, along with the bid to satisfy Pre-Qualification criteria as specified above.

b. The Pre-Qualification criteria are mandatory requirements and the technical bids will be evaluated only when the Pre-Qualification criteria are met.

Checklist for Pre-Qualification Criteria

Sl. No.	Vendor Confirmation to the points above	Reference of documents attached
1	Yes / No	
2	Yes / No	
3	Yes / No	
4	Yes / No	
5	Yes / No	

PS/445/2636/NKR/PQC/R1
Date: 10.08.2020

Pre-Qualification Criteria

Item: VFDs for RC Pump (1250kW, 3.3kV Motor)
Project : NTPC North Karanpura FGD Project (3 x 660 MW)
Customer : NTPC

1. The vendor shall be an Original Equipment Manufacturer (OEM) of VFD Equipment. Only the OEM can submit offers.
2. The vendor should have designed, engineered, manufactured, type tested or got type tested, supplied and commissioned or supervised commissioning of at least one (1) number of VFD system (of the type & model offered) for feeding squirrel cage induction motor/ synchronous motor of 1000 kW, 3.3kV or higher kW rating, which is in successful operation for a period of at least one (1) year as on 01.07.2020. Necessary supporting document shall be provided. The Reference List of VFD supplies made giving the ratings, year of supply, application and details of the customers and their commissioning status to be provided along with the offer.
3. Vendor should also have VFD reference of the type & model offered with separately placed transformer
   a) Supplied (to any Customer)

   OR

   b) Under supply (for NTPC projects)
   Necessary supporting document shall be provided. The Reference List of VFD supplies made giving the ratings, year of supply, application and details of the customers etc. to be provided along with the offer.
4. The vendor or their authorized service representatives shall have trained engineers for commissioning & service for the offered equipment and shall be in a position to provide prompt after sales service and spares support for our installations. This service network shall necessarily be available in India.
5. The vendor shall be in a position to undertake AMC or provide service support for the equipment supplied, after the expiry of the warranty / guarantee period either directly or through a service representative.
6. Technical clearance of vendor offer will be based on Customer acceptance of Vendor Credentials.

Note:

a. Vendor must furnish all necessary supporting documents, as required, along with the bid to satisfy Pre-Qualification criteria as specified above.

b. The Pre-Qualification criteria are mandatory requirements and the technical bids will be evaluated only when the Pre-Qualification criteria are met.

Checklist for Pre-Qualification Criteria

Sl. No.	Vendor Confirmation to the points above	Reference of documents attached
1	Yes / No	
2	Yes / No	
3	Yes / No	
4	Yes / No	
5	Yes / No	
6	Yes / No	

REVISION HISTORY SHEET

REV. NO.	DATE	NATURE OF CHANGE	REASONS	PREPARED BY	APPROVED BY
00	31-07-2020	FIRST ISSUE	------	GITESH DAS	L SUBBALAKSHMI

TECHNICAL SPECIFICATION OF IGBT/ IGCT/ SGCT BASED VFD FOR SQUIRREL CAGE INDUCTION MOTOR

1. Project Details

Sl. No.	Parameter	Specification
1	Project title	As per attached Annexure to Specification
2	Customer	

2. Environment Specifications

Sl. No.	Parameter	Specification
1	Maximum Ambient Temperature	As per attached Annexure to Specification
2	Minimum Ambient Temperature	
3	Equipment Design Temperature (IS-9676)	
4	Relative Humidity	
5	Altitude	
6	Location of VFD Panels	
7	Seismic Zone	
8	Environment	

3. Input and Transformer Data

Sl. No.	Parameter	Specification
1	System Voltage / Frequency / Phase	Refer attached Annexure to Specification
2	Voltage Variation	
3	Frequency Variation	
4	Combined Voltage and Frequency Variation	
5	Fault Level	
6	Transformer Type	
7	Rating	Transformer must be designed to carry 110% current of calculated VFD rating. Transformer sizing calculation shall be provided along with offer.
8	Power Cables	1. Cable glands (Weatherproof) to be provided by the vendor for Transformer HV side cable termination suitable for Cable size mentioned in Annexure to Specification. The exact no. and size will be intimated during drawing approval stage. Cables and termination kits are in Customer /BHEL scope. 2. All interconnecting cables and cable lugs for VFD panel to Transformer connection to be provided by vendor. Refer attached Annexure to Specification for more details. For VFD with non-integrated Transformer, Power Cables between Transformer & VFD shall also consider adequate derating factor as these cables shall travel through trenches and trays. 3. For VFD panel with non-integrated type transformer, Cables glands and termination kits for connection between Transformer LV side and VFD input side termination shall also be supplied by the vendor.
9	Termination cubicle	Any special termination cubicle, supporting structures, etc. if required for non-integrated type VFD system shall also be supplied by the VFD vendor.

4. Motor Data

Sl. No.	Parameter	Specification
1	Type	Squirrel Cage Induction Motor
2	Scope	Manufactured by BHEL-Bhopal
3	Rating (kW)	Refer attached Annexure to Specification
4	Rated Voltage and Current	Refer attached Annexure to Specification
5	Fed from	Variable Frequency Drive (V/f Control)
6	Duty Class	Continuous - S1
7	Efficiency and Power Factor	Refer attached Annexure to Specification
8	Power Cables	Cable glands (Weatherproof) to be provided by the vendor for VFD Output side cable termination suitable for cable sizes mentioned in the attached Annexure. The exact no. and size will be intimated during drawing approval stage. Cables and termination kits are in Customer /BHEL scope.

5. Scope:

Sl. No.	Scope of Supply	Description
1	Refer Consolidated Scope of Supply and Services in attached Annexure for details.	The vendor shall be responsible for engineering and functioning of the complete VFD system comprising of Dry type Transformer and VFD panel, meeting the intent and requirement of this specification, Customer specification and datasheet. This shall include but not be limited to inverter sizing, transformer sizing, transformer impedance selection, vector group, input and output harmonic filter design and sizing, output dv/dt filter sizing, adequacy of motor cable size selected by BHEL etc. All necessary interlocks as required for safe and reliable operation of VFD system along with Input breaker shall be provided in VFD system. If any special arrangement is required in input breaker, same shall be informed by the vendor in offer. The machine shall continuously run on VFD.
2	a) All interconnecting cables between VFD panel and Transformer panel both for integrated type VFD system and non- Integrated type VFD system. b) Any special cable other than power and control cables from VFD to other equipment. c) Power Cable glands, lugs and hardwares for VFD and transformer. d) Any special tools and tackles.	

6. VFD Specifications:

Sl.No.	Parameter	Specification
1	Drive Application	Refer attached Annexure to Specification
2	Input Voltage	From Dry type Transformer.
3	Power/Torque vs Speed	Torque α Speed^2 , Power α Speed^3
4	Single Line Diagram	Refer attached Annexure to Specification
5	Output Voltage of VFD	
6	Output Current of VFD	
7	Output Frequency	0 to 50Hz , Resolution: +/- 0.01% under transient conditions; +/- 0.5% under steady state conditions
8	Overload capacity	Refer attached Annexure to Specification
9	Speed Regulation & Speed Accuracy	+ 0.5% +1%
10	Drive Control	Sensorless Vector Control
11	Braking Operation	Not Applicable
12	Output LC Sinusoidal Filter	Motor is designed for PWM operation. Distance between VFD and Motor are as per Annexure attached with Specification. Vendor to clarify and offer output Filter, if required.

13	VFD Panel Construction	a) Protection Class: Please refer attached Annexure b) Panel: Free standing, floor mounting type, comprising of rigid welded structural frames with Cold Rolled Sheet Steel enclosure of minimum thickness 2 mm for load bearing and 1.6 mm for other members. All doors and removable covers shall have neoprene gaskets. Ventilating louvers shall have easily removable and washable dust filters. c) Busbar Material – Electrolytic grade Copper, colour coded. Sleeving/shrouding for safety purposes shall be done. d) Cooling: Forced Air Cooled VFD should be considered. Cooling system shall include well dimensioned panel, adequate cooling air flow path. Vendor shall ensure that the panel dimensions and flow paths have been designed for continuous running at the specified ambient without overheating. Suitable thermal switch for exit air temperature monitoring shall also be incorporated. e) Earth Bus – minimum 50*6 mm Copper. f) Door Interlock: The VFD shall have a door interlock for safety. This interlock system should ensure that none of the power cabinets can be opened until the main source of power is disconnected or will cause the main source of power to trip. Additionally the same interlock system should ensure that power cannot be initialized to the drive unless the doors are closed. Suitable shrouding mechanism shall be provided so that the DC capacitors cannot be touched till their voltage is zero. g) Painting: 2 Coats of Primer and 2 Coats of Finish Paint to be given for all surfaces of enclosure. Paint shall be Epoxy Based with Powder Coated Finish - shade RAL9002 front and rear panels, end panel sides RAL5012. Paint Thickness: 80 Microns (minimum). Exact paint shade will be confirmed during drawing approval stage. h) Power and Control Wiring shall be done with Fire retardant (FRLS) cables. i) Double compression type Nickel plated brass cable glands shall be supplied. Height of the terminal from cable gland plate shall be adequate to take care of the cable sizes and quantity mentioned. Minimum space for the power cable termination shall be 600mm clear from the cable gland plate. Cable entry will be from bottom only. Gland Plates shall be blank (undrilled) – to be drilled at site. The gland plate thickness shall be 3.0 mm

13	VFD Panel Construction	for hot / cold-rolled sheet steel and 4.0 mm for non-magnetic material. Gland plate shall be of sufficient strength to handle all the cables. j) All electronic modules and components shall be accessible from front of panel only. Modular assemblies for both the system control electronic equipment and power electronic equipments shall be used. k) All low voltage compartment and cabling shall be electrically and physically separated from the high voltage compartment. l) 20% spare terminals shall be provided for future use.
14	Noise Level	Shall be less than 85dB at a distance of 1 metre from the outline of VFD Panels at a height of 1.5 metres from the floor with all the fans running in the VFD Panels.
15	Storage Temp.	-40°C to +60 °C
16	Vibration	According to IEC68-2-6
17	Interference	According to IEC801 parts 2,3,4 Immunity: The panels shall be designed so as to have low Radio Freq Interference (RFI) & Electromagnetic Interference (EMI).
18	VFD Efficiency	Shall be as per NTPC VFD specification. Exact value to be specified by the Vendor in Datasheet.
19	Duty Cycle	Class I Duty Cycle as per IEC 146-1
20	VFD Requirements	a) Input Choke: Input chokes to be provided, if necessary. b) Local/Remote: Selector switch shall be provided for operator to select type of operation: ➢ Local – Operation from VFD Panel for Speed Control from door mounted interface; ➢ Remote – Operation from DCS. If VFD is set for speed reference from Remote, it shall be possible to program the VFD to either shutdown, go to minimum speed or continue operation at its last known speed reference point whenever a loss of speed reference is detected. c) Local Start/Stop Push Button to be provided either on Panel door or on keypad. d) Door Mounted Lockable Push-Button with cover to be provided with 2NO + 2 NC contact for Emergency Stop. One normally open and close contact to be wired to Terminal Block for external Interlocking / Annunciation. e) Every Panel shall be provided with illumination lamp with limit switch and MCB. Space heater shall be provided in panel with switch fuse and variable setting thermostat. 240V power socket with MCB shall be provided.

Sl. No.	Parameter	Specification
20	VFD Requirements	f) 230V, 1phase, 50Hz (exact rating during drawing approval stage) Power Supply to the motor space heater shall be derived from VFD. Necessary interlocking arrangement for this supply shall also be made available in the VFD panels. g) PLC: PLC shall be provided for Interlocking and Protection (if required) h) The expected life time of the drive system shall be minimum 20 years. The system including all individual components forming part of the system shall have an availability of minimum 0.997 and a minimum MTBF of 4 years. i) Any special requirement regarding CT/ PT, protection relay or any other device, in input breaker, which is required for functioning and protection of VFD system shall be considered by the VFD vendor in their scope.
21	VFD Features	a) Soft Start and Auto Restart b) Auto Speed Search Facility (Catch on Fly) shall be available for starting into rotating loads. c) Power loss ride through (Kinetic Buffering) and for voltage dips over 20% or Power interruption for less than 2 secs. d) Automatic VFD tuning during start-up. e) Flux optimisation function shall be provided to reduce the total energy consumption and noise level in case drive is operated below nominal load. f) Selectable reverse run prohibition g) Adjustable motor overload feature h) Settable minimum and maximum operating frequency i) VFD shall produce not greater than 1% torque pulsation to the shaft of driven equipment. j) Field adjustable Torque limits and acceleration and deceleration ramps k) Accelerate / Decelerate Times to be specified. l) Four (4) user programmable preset speeds. m) The equipment may be stored outdoors for long periods before installation.The packing should also be suitable for outdoor storage areas with heavy rains / high ambient temperatures. n) Vendor shall certify readiness of system fit for commissioning. Vendor's scope shall also include supply of all specialized tools and tackles required. o) VFDs shall be installed in Air-conditioned area but it shall be suitable for operation in non-air-conditioned area also. p) Earthing scheme should be provided by the vendor.

21	VFD Features	q) Any special cable other than power and control cables required to connect VFD to other equipment shall be in vendor scope. r) All electronic PCBs/Modules must have conformal coating to take care of site conditions.
22	Controls and monitoring	a) VFD shall be with an interactive and user-friendly door mounted digital operator interface with LCD display and sealed membrane type keypad. b) The operator interface shall be used for drive programming, drive monitoring and drive trouble shooting. The operator interface must also be able to start and stop the drive, reset VFD faults and manually adjust the VFD's speed reference. c) The operator interface shall have LED indicators for drive fault, drive run, and drive in current limit etc. d) The operator interface shall allow monitoring of inverter operating conditions including speed, current, voltage, torque, power etc. e) Messages shall be alphanumeric in nature. All the fault messages shall be in English. f) Provision shall be made available for remote operation. g) The operator interface shall be able to display all real time operating variables and all drive programming parameters. The operator interface shall be capable of displaying a specific user selected parameter on power-up. This power-up parameter would typically be a parameter that is important to the operator such as motor speed or motor load. h) The following Control signals must be provided: ➢ Local/Remote ➢ Emergency stop ➢ Trip/Close Input breaker These are indicative. Vendor to suggest the interlocking scheme using these and other outputs as required for the system during detailed Engineering. These Outputs shall be provided with individual relay having 3 changeover potential free contacts wired to terminal blocks. i) All VFD operating parameter shall be stored in nonvolatile memory. j) The drive shall have built in monitoring of following parameters as minimum on its digital operator interface and these parameter shall also be displayed at Plant DCS through Modbus link: i) Input & Output Frequency ii) Input & Output Current iii) Motor Speed iv) Input & Output Voltage v) DC Bus Voltage vi) Torque

22	Controls and monitoring	vii) Input & Output Power (It shall be possible to display power output of the drive in kW) viii) Digital Input Status ix) Digital Output Status x) Analog Input Status xi) Drive Thermal state xii) Output kWhr of Drive xiii) Hour run xiv) Transformer Temperature for alarm & trip l) Necessary transducer shall be provided with 4-20 mA output for indicating Motor Speed and Motor Current in the DCS. Transducers shall be capable of driving 500 ohms load. m) The following indications shall be provided on the VFD Panel Door/ Keypad: i) Motor Running/ VFD ON ii) Motor Stopped/Tripped iii) Local/Remote status iv) AC Mains ON v) Auxiliary Control Supply ON vi) VFD Ready vii) VFD Fault viii) External Fault ix) Emergency Stop Activated x) Motor Overspeed xi) Input Breaker Trip xii) Motor zero speed xiii) Rectifier output 'ON' xiv) Transformer winding temperature alarm & trip. n) The VFD shall store fault logs of minimum last 10 faults in memory. o) The interface details of VFD shall be incorporated as required for data communication with DCS system with serial interfaces with RS485 data links. Necessary hardware shall be included in the scope and the interface protocol (i.e. Modbus only) shall be provided.

22	Controls and Monitoring	The following Audio-visual annunciations must be provided. 1) Rectifier fuse failure / drive fault 2) Main AC failure 3) Inverter fuse failure / Drive fault 4) Inverter overload 5) Inverter high temperature / Drive fault 6) Cooling system failure 7) Motor failed to start / Drive fault 8) Transformer fault and alarm 9) Communication and measurement system unhealthy
23	Protection	Following protections shall be built in within the inverter and any other protection as required: a) Motor Overload / Over Torque b) Instantaneous Over current (This device shall monitor the peak output current continuously and shall provide instantaneous shutdown without component failure whenever its trip point is surpassed. The trip point must be greater than or equal to 110% of the VFD's rated full load output current) c) Ground Fault Protection d) Over Voltage/Under Voltage - VFD shall be able to withstand >20% dip in supply voltage for 2 secs without damage to semiconductors or fuses. e) Output Short Circuit f) Output Phase Loss, Phase reversal, Locked rotor protection g) Phase Sequence Protection h) Input Phase Loss/Single Phasing Preventer i) Over Speed/Over frequency of motor j) Heat sink over temperature/VFD Panel Temperature High Stall prevention (During acceleration, deceleration and constant speed operation) k) Loss of Cooling Fans (Ventilation failure Indication and Alarm) l) External faults like Transformer Fault and Alarm m) Incoming and outgoing Line surge protection n) Loss of Speed reference o) Inverter fault (Converter/Inverter module failure indication) p) The system shall be designed to deliver the motor input current and torque for the complete speed torque characteristics of the driven equipment.

23	Protection	q) If the motor load exceeds the limit, the drive shall automatically reduce the frequency and voltage to the motor to guard against overload. If load demands exceed the current limit for more than 1 min, the drive shall shut down to prevent over heating of the motor and damage to the drive. r) The drive shall trip in case the speed exceeds 110% of the maximum operational speed or reduces to 95% of the minimum operational speed for more than 10 seconds.(Speed ref loss protection) s) Fault diagnostic shall be built into the system to supervise the operation and failure of the system. The information regarding failure of any of the system including shut down of the system shall be available for a period of minimum 4 days after a shut down even though no supply available. t) Converter transformer: Short circuit, over current, Earth fault, and Winding temperature high protection.

Sl. No.	Parameter	Specification
24	Dry type Transformer (mounted in panel)	Dry type Transformer a) HV: Taps of ±5% in steps of 2.5% b) LV voltage: Multi secondary type. Number of secondaries and secondary voltage to be indicated by the vendor in technical offer. c) Class of insulation: F or higher. Temperature rise of the transformer shall be as per applicable IEC. d) Winding material : Electrolytic grade Copper **Protection**: RTDs to be provided in each limb for winding temperature measurement. Temperature scanner to be provided for winding temperature measurement of all limbs. Alarm and trip contacts required for annunciation for fault and tripping action. **Connection**: HV Incomer: Termination arrangement and Cable glands to be provided by the vendor. The exact number and sizes will be intimated during drawing approval stage. Cables in BHEL/Customer scope. LV Connection: Cables along with glands, Lugs for connection between LV secondaries and VFD to be supplied by the Vendor. This shall be used for testing of the VFD and later bunched in the panel during dispatch and the same shall be connected at site. Necessary connection and routing arrangements to be made at Vendor's works. For more details please refer Annexure attached with this Specification. In case of non-integrated transformer, Cable termination kits (if required) for LV connection between transformer and VFD shall also be supplied by vendor.

Sl. No.	Parameter	Specification
25	Type of Control:	Completely programmable by the user as: a) Flux vector control with speed feedback b) Flux vector control without speed feedback c) Scalar V/F. VFD shall be capable of maintaining motor speed within ±0.5% without the use of a motor mounted encoder or tachometer. The drive shall have programmable V/F patterns along with user definable custom V/F patterns.
26	Harmonic Limitations – Source	Shall be as per latest IEEE 519 Voltage harmonics: Vendor to inform the values with calculations during detailed engineering stage. Current harmonics: Vendor to inform the source side 5^{th}, 7^{th} & 11^{th} harmonics values with calculations during detailed engineering stage. Vendor to supply harmonic filters, if required, to filter the harmonics generated by VFD at input/ supply side. The above compliance shall be verified by the field measurements of harmonics at the PCC with and without VFDs operation as per NTPC Specification.
27	Harmonics at VFD Output / Motor Input	Shall be as per latest IEC 61800-4 Vendor to specify the maximum amount of voltage and current harmonics at the VFD Output / Motor Input terminals.
28	Switching frequency	To be specified by the vendor in Datasheet.
29	Auxiliary Supply	Refer attached Annexure to Specification

Sl. No.	Parameter	Specification
30	Testing and Quality Plan	a) Routine Tests shall be carried out on all Panels and transformer as per relevant standards and NTPC specifications. b) Type Test Certificates for similar equipment and rating supplied by the Vendor shall be submitted during detailed engineering. Refer clause no. 28.02.00, 28.03.00 & 28.04.00 (2) of NTPC Specification. If valid type test certificates for transformer and VFD panels are not available as per NTPC Specification, vendor shall conduct the type tests without any cost implication to BHEL/NTPC. c) During fabrication, the drive and Transformer shall be subject to inspection by BHEL/ Customer, or by an agency authorized by the BHEL/ Customer to assess the progress of work, as well as to ascertain that only quality raw material is used.
31	Inspection, Training and Commissioning Support	a) Final Inspection: BHEL / Customer representative will be present at manufacturer's works for witnessing of final testing for transformer and VFD. This is to be incorporated in the Quality Plan. No charges shall be applicable for witnessing of final tests. b) Training: Refer attached Annexure to Specification. c) Commissioning: Commissioning of all VFD Systems at site shall be in the scope of Vendor. Final Acceptance shall be based on successful completion of the same. d) Any replacement of failed/damaged items during commissioning shall be exclusively at Vendor's cost. e) Vendor is advised to stock necessary spares and ensure easy availability to facilitate trouble free commissioning.
32	Laptop & Software for Computer Interface	Laptops shall be installed with Latest Compatible Licensed Operating System. The software must be loaded in the laptops & supplied along with interconnecting cables and accessories required for interface with the drive. The software should be an easy to use commissioning tool for drives and shall be provided along with the system. The interface details of VFD shall be incorporated as required for data communication with DCS system with serial interfaces with RS485 data links. Necessary hardware shall be included in the scope and the interface protocol (Modbus only) shall be provided.

Sl. No.	Parameter	Specification
33	Maintenance	The procedure for maintenance of VFD panels and the schedule thereof shall be mentioned in the offer.
34	Spares	Please refer attached Annexure with this Specification.
35	Confirmations/Deviations to Specification	**Point-wise confirmation to this specification and NTPC Specification to be given along with offer**. Deviations, if any, shall be indicated separately. If there are no deviations to the specifications, supplier shall mention the same explicitly. A reply from vendor stating that "**Equipment will generally meet the specifications**" will not be accepted by BHEL. Clause-wise Confirmation / Clarifications of all Clauses in the Purchase Specifications 1 to 34 of Specification shall be furnished in the format below.

Point No.	Page No.	Confirmation / Clarification / Information / Deviation	Details	Remarks, if any

7. Documentation

Sl. No.	Parameter	Specification
1	Attached Documents	a) NTPC specification for VFD System and QA documents b) Motor Datasheet and Curves. c) Single Line Diagram d) "Annexure" to Specification for project specific data. e) Provenness Criteria : Refer "Annexure" attached with the Specification.
2	Technical Information required along with Offer	a) Dimensional Drawing of Panels along with minimum clearance to be maintained for effective cooling, and Weight b) Technical Catalogue of VFD System being offered. c) Reference list for similar rating VFDs giving the following: Model number, Application, Rating, Year of supply and commissioning. Provenness Criteria of Medium Voltage Variable Frequency Drive shall be used as qualifying criteria (if attached with this specification). d) Confirmation / Clarification / Information / Deviation List as per Point 35 in page no. 16. e) Confirmation / Clarification / Deviation List to NTPC Specifications and other documents in Sl No. (1) above. f) Design calculation for sizing of Transformer and VFD. g) Filled up Datasheet for VFD system
3	Information / Confirmations required along with offer	a) Supply of the VFD shall be by OEM only. The name of the country from which the drive is sourced and the location of the manufacturing plant should be mentioned in the offer. b) After Sales Service and Support shall be given by the Vendor for a minimum period of 15 (fifteen) years after commissioning. Address of the Sales and Service Representatives in India with complete contact details: Name/Telephone/Email are to be provided. c) Vendor shall give a notice of at least 1 year to the end user of the equipment and BHEL before phasing out the product / spares to enable the end user for placement of order for spares and services.

Sl. No.	Parameter	Specification
4	Technical (unpriced) and Commercial (priced) Bids – For Evaluation	Refer "Consolidated Scope of Supply & Services" in Annexure attached with this Specification for Unpriced and Priced Bids.
5	Information required for Customer / Consultant Approval (within 3 weeks from the date of Purchase Order)	a) Dimensional Drawing of Panels along with minimum clearance to be maintained for effective cooling, and Weight b) Schematic Diagram c) Bill of Materials for equipment to be supplied d) Feeder Requirements – UPS and 415V supply e) Losses at Rated Load (including Fans) f) Heat Loss for Air Conditioning System sizing g) Technical Catalogue of VFD System being offered h) Test Protocol and Quality Plan i) Type test certificates of similar or higher rating equipment j) Filled up Data sheet for VFD system and Transformer
6	Information Required along with Supply. Maintenance Manuals and Documentation	a) Erection, Commissioning and Maintenance Manuals along with Final Drawings and Documentation b) Test and Guarantee Certificates. c) Complete Bill of Material (item wise) for the equipment supplied. d) 1 no. CD ROM consisting all of the above.

VFD SYSTEM DATA SHEET

A	VFD Data	
1	Manufacturer	
2	Model No.	
3	Manufacturing Location	
4	Rating and Application	
5	Applicable codes /standards	
6	Speed reference	4-20 mA from DCS
7	Speed range	
8	Switching Frequency	
9	No. of Pulse	
10	Total number of Diodes/ IGBTs/ IGCTs	
11	Drive output Voltage	
12	Overload capability	
13	Inrush current 250% In for	
14	Combined efficiency (Transformer & Drive) at:	
	i) 100% Load	
	ii) 75% Load	
	iii) 50% Load	
	iii) 25% Load	
15	Overall power factor at:	
	i) 100% Load	
	ii) 75% Load	
	iii) 50% Load	
	iii) 25% Load	
16	Output voltage range and Accuracy	
17	Output Frequency range and Accuracy	
18	Type of Cooling	
19	Redundancy in Cooling	
20	Type of feedback for speed control	
21	Output Filter/ Choke:	
	i) Manufacturer	
	ii) Type/ Model No.	
	iii) Rated Current and Voltage	
22	Acceleration / Deceleration time	
23	Degree of protection	

24	VFD Panel Dimensions (Dimensional details inclusive of all panels shall be furnished)		
	i) Length (mm)		
	ii) Height (mm)		
	iii) Depth (mm)		
	iv) Weight (kg)		
25	Paint Shade		
26	Heat Load (kW)		
27	Auxiliary Power Requirement:	415V, 3ph, 4Wire	UPS supply
	i) KVA		
	ii) Voltage and Phase		
B	**Transformer Data**		
1	Manufacturer		
2	Manufacturing Location		
3	Type	Dry type Transformer	
4	Integrated / Non-Integrated		
5	Duty	Continuous (Converter Duty)	
6	Rating (Transformer must be designed to carry 110% current of calculated VFD rating.)		
7	Class of insulation and Temperature Rise		
8	Insulation level:		
	P. f withstand		
	i) HV Winding		
	ii) LV Winding		
	Impulse withstand		
	i) HV Winding		
	ii) LV Winding		
9	Fault Level on HV Side		
10	HV Voltage and Phase		
11	LV Voltage/ Current		
12	No. of LV Windings		
13	Rated Frequency	50Hz	
14	Impedance		
15	Cooling Type		
16	Winding Material	Electrolytic grade Copper	
17	Location of Tap Changer	HV Winding	
18	No. of Taps and Type		
19	Vector Group		

20	Neutral CT specification:	
	51G	
	64R	
	Vk	
	Im at Vk/2	
	RCT	
21	Cable Size/Type	
	i) HV Winding	
	ii) LV Winding	
22	No Load Loss	
	i) At 100% Voltage	
	ii) At 110% Voltage	
23	Full Load Copper loss at 75°C	
24	No Load Current	
	i) At 100% Voltage	
	ii) At 110% Voltage	
25	Efficiency at 75°C and unity power factor	
	i) At 100% of Full Load	
	ii) At 75% of Full Load	
	iii) At 50% of Full Load	
	iv) At 25% of Full Load	
26	Efficiency at 75°C and 0.8 power factor	
	i) At 100% of Full Load	
	ii) At 75% of Full Load	
	iii) At 50% of Full Load	
	iv) At 25% of Full Load	
27	Load at which maximum efficiency occurs	
28	Regulation at 75°C at full load	
	i) At 0.8 pf	
	ii) At UPF	
29	Dimensions	
	i) Length (mm)	
	ii) Height (mm)	
	iii) Depth (mm)	
	iv) Weight (kg)	
30	Degree of protection for enclosure.	
31	Paint Shade	
32	Heat Load (kW)	

ANNEXURE-3 TO PS/445/2636

1. Input Data

Sl. No.	Parameter	Specification
1	Project Title	**BARH1 FGD Project (3 x 660MW)**
2	Customer	NTPC
3	**Environmental Specifications :**	
	Parameter	**Specification**
	Max. Ambient temperature	50°C
	Min. Ambient temperature	0°C
	Equipment Design temperature	50°C
	Relative Humidity	95% at 40°C
	Altitude	Less than 1000m above mean sea level
	Location of VFD Panels	Indoor, Ventillated Room with Air Conditioning
	Seismic Zone	As per IS-1893-Zone-II
	Environment	All cards/hardware of VFD panel shall be suitable for operation in harsh environmental conditions with respect to high temperature, humidity & dust.
4	Drive Application	Slurry Re-Circulation (RC) Pump
5	System Voltage / Frequency / Phase	3.3kV / 50 Hz / 3-phase
6	Voltage Variation	± 6%
7	Frequency Variation	+3%, -5%
8	Fault Level at 3.3kV input side	40kA for 1 Sec.
9	Combined Voltage and Frequency Variation	10%
10	Output Voltage of VFD	0 to 3.3kV (V/f = Constant)
11	Overload capacity	The overload capacity shall be 110% of rated current for 1 minute at rated voltage.
12	Motor Rating	1250kW, 3.3kV, 264 Amps, 1489 rpm
13	Motor Efficiency & Power Factor	95.2% & 0.87 respectively
14	VFD type	Fully Assembled Units of 3.3kV VFD Panels (IGBT/SGCT/IGCT), Air Cooled with non-integrated Dry Type Transformer
15	Transformer type	Dry type non-integrated Transformer (in VFD Vendor's scope). Transformer will be placed in non-AC ventilated area. Maximum distance between VFD and transformer shall be 50m. Cables between VFD and transformer shall be in VFD vendor's scope.
16	Degree of Protection	IP:3X or better
17	VFD Output Current	264 A at 50°C (Design Ambient)

18	Distance between VFD & Motor (approx.)	600 meters
19	Cable Sizes between : a) 3.3kV Swbd. & VFD Transformer b) VFD Transformer & VFD c) VFD & Motor	a) 2R x 03C x 150 Sq. mm, Al, XLPE b) In VFD Vendor's scope c) 2R x 03C x 150 Sq. mm, Al, XLPE
20	Auxiliary Supply	a) 230V UPS feeder will be provided by BHEL. KVA rating is to be given by the Vendor. Control supply for electronic modules has to be derived from the UPS. b) Auxiliary Supply – 415V, 3ϕ, 50Hz, 4 wire will be provided by BHEL. Feeder Power rating (short time & continuous) to be specified by the Vendor. c) Other supplies required by the VFD system to be generated internally within the VFD system.
21	Single Line Diagram	Refer Drg. No. 3-661-00-00973
22	Provenness Criteria	Provenness Criteria requirement of Medium Voltage Variable Frequency Drive (3.3 kV VFD) is attached. Vendor to furnish details in line with the document.
23	Mandatory Spares	HV Bushing/Insulator – 3 nos.; LV Bushing/Insulator – 3 nos.; WTI (if applicable) – 3 Nos
24	Training	Training for NTPC personnel for 20 Mandays at Manufacturer's works.

2. Consolidated Scope of Supply and Services

Sl. No.	Items For RC Pump BARH1	Quantity (Nos.)
1.	a) Fully Assembled Units of 3.3kV VFD Panels (IGBT/SGCT/IGCT), Air Cooled with non-integrated Dry type transformer, Power cable and control cable between VFD & Transformer, Termination cubicle (if required)	3 Nos.
	b) Cable Accessories	01 Set
2.	Laptop loaded with Drive software	1 No.
3.	Mandatory Spares (Optional price)*	01 Set
4.	Erection Supervision & Commissioning (Vendor to quote lumpsum commissioning charges for 12 days per Drive which shall be considered for bid evaluation) Payment shall be made for actual mandays consumed at Site with per day charges calculated on the basis of the lumpsum charges quoted above. Lumpsum charges quoted shall include travelling, boarding and lodging expenses.	03 Lots
5.	N+1 redundancy of cooling fan for Transformer cubicle with auto c/o arrangement (optional price)*	3 nos.

* : Optional prices shall be considered for bid evaluation.

FIRST ANGLE PROJECTION

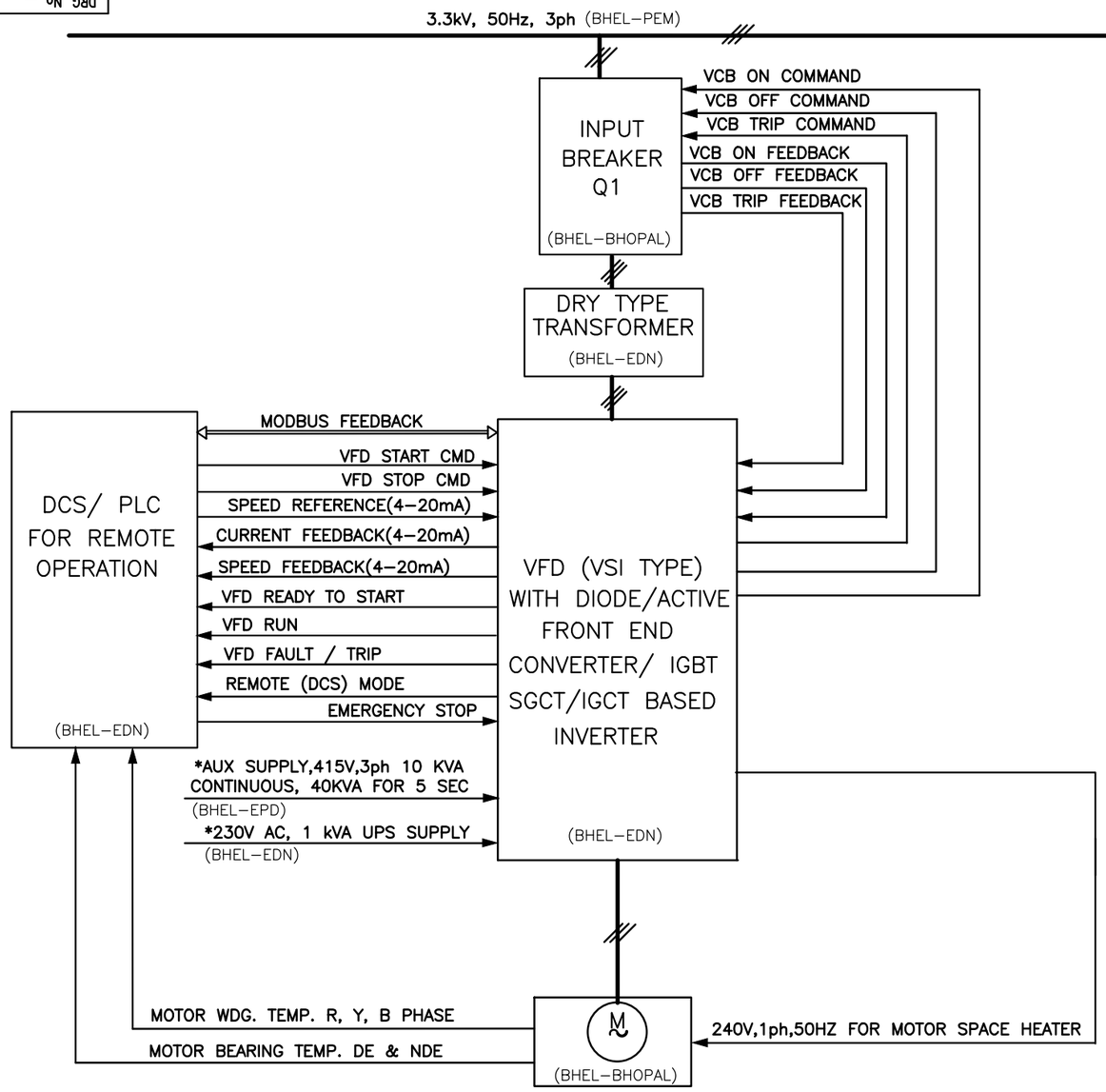
(ALL DIMENSIONS ARE IN mm)

DRG. No. 3-661-00-00973

REF. DRG. No.

SIGN. & DATE

INVENTORY No.



**3.3kV, 1060 KW 50HZ,
SQUIRREL CAGE INDUCTION MOTOR

NOTE:

1. IP CLASS VFD : IP 32
2. **TENTATIVE MOTOR RATING 1060KW,3.3KV
3. *FINAL RATING DURING DRAWING APPROVAL STAGE.

PROJECT- BARH FGD Project Stage 1 (3X660MW)
CUSTOMER- NTPC

REV.	DATE			REV.	DATE				NAME	SIGN	DATE
02	03.02.20	ALTERED	KD	01	08.07.19	ALTERED	KD	DRAWN	KD		06.06.19
		CHECKED	LSL			CHECKED	LSL	CHECKED	LSL		06.06.19
		APPROVED	LSL			APPROVED	LSL	APPROVED	LSL		06.06.19
	TRANSFORMER AND VFD ARE SHOWN SEPARATELY.				CUSTOMER COMMENT INCORPORATED.			DISTRIBUTION OF PRINTS			DEPT. / CODE

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

CARD CODE

TITLE:
SINGLE LINE DIAGRAM – VFD FOR RC PUMP

No. OF SHEETS: 01
SHEET No.: 01
REV: 01

M.O. No. CE/1521

AS PER OPEN TOLERANCE TO ED 0230499

DRG. No. 3-661-00-00973

FORM No. A3-03

A3 SIZE

BHARAT HEAVY ELECTRICALS LIMITED, BHOPAL
A.C. MACHINES ENGINEERING DIVISION
MOTOR TECHNICAL DATA (REV-00)

CUSTOMER	**M/s NTPC LTD.**	**INSPECTION BY**	**NTPC**
PROJECT	**3X660MW BARH-I FGD**	**WO NO.**	**48210A401-51, 52 & 53**
TD Date	**27-Jul-2020**	**NTPC DOC NO.**	**9558-109-PVE-Y-003**

Note 1: Data given below is subject to tolerance as per IS/IEC:60034 unless specified otherwise as '*' for which the data is guaranteed.

1. GENERAL	**1.**
(i) Manufacturer	(i) BHEL, BHOPAL
(ii) Equipment driven by motor	(ii) RC PUMP
(iii) Motor type	(iii) SCIM
(iv) Country of origin	(iv) INDIA
(v) Quantity	(v) 05 + 05 + 05 Nos. (Total= 15 Nos.)
2. DESIGN AND PERFORMANCE DATA	**2.**
(i) Frame Size ***(Note: RC PUMP motors are suitable for both VFD & DOL start / operation)***	(i) 1LA7716-4
(ii) Type of duty	(ii) CONTINUOUS
(iii) Type of enclosure, Method of Cooling, Degree of Protection	(iii) TETV / IC511 / IP55 AS PER CL. 10 OF IEC: 34-5
(iv) Applicable standard to which motor generally conforms	(iv) IS/IEC:60034
(v) Type of mounting	(v) Horizontal (B3)
(vi) Direction of rotation viewed from driving end.	(vi) CW (BI-DIRECTIONAL)
(vii) Standard continuous rating at 40deg.C ambient temp.(KW)	(vii) 1336
(viii) Derated rating for specified normal condition i.e., ambient temperature of 50 Deg.C (KW)	(viii) 1250
(ix) Rated voltage (Volts) / Rated Frequency (Hz)	(ix) 3300 / 50
(x) Permissible variation of (a) Voltage (%) (b) Frequency (%) (c) Combined voltage and frequency	(x) (a) $\pm$ 6 (b) + 3, - 5 (c) 10 % (Abs.)
(xi) Minimum permissible starting voltage (%)	(xi) 80
(xii) Rated speed at rated voltage and frequency (r.p.m.)	(xii) 1489

(xiii) At rated voltage and frequency	(xiii)
(a) Full load current (Amp)	(a) 264
(b) No load current (Amp)	(b) 68
(xiv) Power Factor at	(xiv)
(a) 100% load	(a) 0.87
(b) 75% load	(b) 0.82
(c) 50% load	(c) 0.75
(d) No load	(d) 0.053
(e) Starting	(e) 0.18
(xv) Efficiency (%) at rated voltage and frequency at	(xv)
(a) 100% load	(a) 95.2
(b) 75% load	(b) 94.5
(c) 50% load	(c) 93.0
(xvi) Starting current (%) at	(xvi)
(a) Rated Voltage	(a) 720 % (Maximum)
(b) Minimum starting Voltage	(b) 576 (Maximum) AT 80 % RV
(xvii) Starting time with minm. Permissible voltage	(xvii)
(a) Without driven equipment coupled	(a) 3 Sec
(b) With driven equipment coupled	(b) 6 Sec
(xviii)Safe stall time with 100 % rated voltage	(xviii)
(a) From hot condition	(a) 15 Sec
(b) From cold condition	(b) 20 Sec
(xix) Torque at (in % / kg-m)	(xix)
(a) Starting (at minimum permissible voltage)	(a) 58 % / 473.86 kg-m
(b) Pull up at 100% Voltage	(b) 85 % / 694.45 kg-m
(c) Pull out at 100% Voltage	(c) 215% / 1756.6 kg-m
(d) Rated load (kg-m) at 100 % Voltage	(d) 817 kg-m
(e) Mínimum Accelerating Torque (Kg-m) at 80 % RV	(e) 28 % / 228.76
(xx) Stator winding resistance per phase (ohms) ref. to 20 deg.C.	(xx) 0.04139 +/- 5%
(xxi) Flywheel Moment of motor (Kg-m2) (GD2)	(xxi) 204 kg-m²
(xxii) Permissible starts from Hot/Cold condition	(xxii) 2 / 3 Nos.
(xxiii)Locked Rotor KVA Input (at Rated Voltage)	(xxiii) 10864.53
(xxiv)Locked Rotor kVA / Rated kW	(xxiv) 8.7 (Maximum)

(xxv) Vibration at No Load (Brg.Housing)	(xxv)
(a) Velocity (mm/s)	(a) 2.3 (rms)
(b) Displacement (Microns)	(b) 37 (p-p)
(xxvi)Noise Level at No Load	(xxvi) 85 dBA at 1.0 metre.
3. CONSTRUCTIONAL FEATURES	3.
(i) Stator winding Insulation	(i)
(a) Class & type	(a) F/EPOXY MICA RESSIN POOR (VPI)
(b) Tropicalised (Yes/No)	(b) YES
(c) Temperature rise over specified ambient of 50 deg C (deg C)	(c) 70
(d) Method of temp. Measurement	(d) BY RESISTANCE
(e) Stator winding connection	(e) STAR
(f) No. of terminals brought out	(f) 6
(ii) Type of terminal box for	(ii)
(a) Stator leads	(a) ELASTIMOLD T.B.
(b) Space heater	(b) CAST / FABRICATED
(c) Temperature detectors	(c) CAST / FABRICATED
(d) Instrument switches etc.	(d) NIL
(iii) For main terminal box	(iii)
(a) Location (from DE)	(a) RHS
(b) Entry of cables	(b) BOTTOM OF TB
(c) Recommended cable size (Runs/cores/x-section mm^2/ material)	(c) 2R X 3C X 185 Sq.mm.
(d) Fault level (MVA)/ Duration (Sec)	(d) 25 kA / 0.17 sec
(iv)For Bearing	(iv)
(a) Type	(a) ANTIFRICTION
(b) Manufacturer	(b) NTPC APPVD. SUPPLIER
(c) Recommended lubricant	(c) IOC SERVOGEM-3/EQV. GREASE
(d) Guaranteed Life in Hrs.	(d) 40000 Hrs.
(e) Lubrication Type	(e) SELF
(f) Whether Dial Type Thermometer Provided	(f) NO
(v)Type of cooler (CACA/CACW)	(v) NA
(vi)Cooling water requirement for CACW motors	(vi)
(a) Quantity required	(a) NA
(b) Maximum permissible inlet water temperature (deg C)	(b) NA
(c) Pressure of water at inlet to coolers	(c) NA
(d) Outlet temperature of water at full load (anticipated value)	(d) NA
(vii)Weight of	(vii)
(a) Motor Stator (Kg)	(a) 6150
(b) Motor rotor (Kg)	(b) 1500
(c) Cooler (Kg)	(c) NA
(d) Total weight (Kg)	(d) 7650
(ix) Max. Perm. Temp. of Rotor	(ix) 350 Deg. C
(x) Total Temp. of Rotor during I Start	(x) 132 Deg. C
(xi) Total Temp. of Rotor during II Start	(xi) 144 Deg. C
(xii) Surge Withstand Voltage (Stator winding)	(xii) As per IEC: 60034-15
(a) 0.3/ 3 Microsecond Surge (kVp)	(a) 11.8
(b) 1.2/ 50 Microsecond Surge (kVp)	(b) 18.2

4.00 LIST OF ACCESSORIES

4.01 RTDs for winding (Type/Nos/Leads /location/make/Res. at 0 Deg.C)	: PT100 SIMPLEX / 12 / 3 Wire Between Coil Sides in slots/ Reputed NTPC Appvd./ 100 Ohms
4.02 RTDs for bearing (Type/Nos./Leads /location/make/Res. at 0 Deg.C)	: PT100 DUPLEX/ 3 nos per bearing side(Total=6) / 4 Wire In Bearing Housing/ Reputed NTPC Appvd./ 100 Ohms
4.03.01 RTDs for Hot Air (Type/No/Leads)	: NA
4.03.02 RTDs for Cold Air (Type/No/Leads)	: NA
4.04 Space Heaters	: YES
4.04.01 Nos.	: 4 Nos of 800W each.
4.04.02 Power (Watts)	: 800 W
4.04.03 Supply Voltage	: 1 PH. 240VAC
4.04.04 Location	: In air pockets
4.05 Stator Terminal Box	
4.05.01 Type	: ELASTIMOLD T.B.
4.05.02 Short time current rating	: 25 kA
4.05.03 Duration (sec)	: 0.17
4.06 Neutral TB	: PHASE SEPARATED T.B.
4.07 Current Transformers	: NA
4.07.01 Nos.	: --
4.07.02 Ratio	: --
4.07.03 Accuracy Class	: --
4.07.04 Vk (V)/Rct	: --
4.07.05 Exciting Current	: --
4.08 Dial Type Thermometer (Type/make Accuracy/ Connection Type & size	: Mercury in Steel/ NTPC Appvd/ + - 1% Full Scale / BSP 3/4"
4.08.01For Bearings (Nos.)	: NA
4.08.02For Air Temp (Nos.) a. Hot Air	: NA
b. Cold Air	: NA
4.08.03Contact Rating	: 5 A AT 240 V AC/ 0. 5 A AT 220 V DC.
4.08.04Range	: 0 -120 Deg. C.
4.08.05Supply Voltage	: 240 V, 50 Hz, 1 Phase
4.09 Rotor Terminal Box	: NA
4.10 TBs for RTDs, BTDs & Space Heater	: Yes
4.11 Sole Plate	: NO
4.12 Anchoring items	: Yes (As per OGA)
4.13 Base Frame	: NO
4.14 Speed Switch	: NO
4.14.01 Supply Voltage	: NA

4.15	Insulation of Bearing	: Yes, NDE bearing housing
4.16	Forced Oil lubrication	: NA
4.17	Oil level Indicator	: NA
4.18	Noise Reducer	: Yes
4.19	Water flow Indicator	: NA
4.19.01	No/Contact Rating	: NA
4.20	Water leakage detector	: NA
4.21	Tachogenerator	: NA
4.22	Grounding Pads	
4.22.01	Nos. & Size on motor body	: 2, 6Tk X 25 X 55 mm
4.22.02	Nos. on Terminal Box	: 2
4.23	Vibration Pads	: Yes
4.23.01	Nos & Size	: 02 (total), 80 mm cube
4.23.02	Location	: At DE and NDE endshield.
4.24	Paint Shade	: RAL 5012
4.25	Any other fitments	: Earth Brush at DE
4.26	External Thrust on Motor	: NA

NOTE: The motor is suitable for both VFD and DOL start / operation.

5.00 LIST OF CURVES

5.01	Thermal Withstand Characteristics	: 48210-51 /01
5.02	Torque Vs Speed Curves	: 48210-51 /02
5.03	Current Vs Speed Curves	: 48210-51 /02
5.04	Current Vs Time curves	: 48210-51 /03
5.05	Speed Vs Time curves	: 48210-51 /03
5.06	Efficiency & PF Vs Load Curves	: 48210-51 /04
5.07	Negative sequence curve	: 48210-51 /05
5.08	Calibration curve for RTD/BTD	: 48210-51 /06

PREPARED BY :

(BHASKAR)
AME Department
BHEL-BHOPAL

BHARAT HEAVY ELECTRICALS LIMITED, BHOPAL

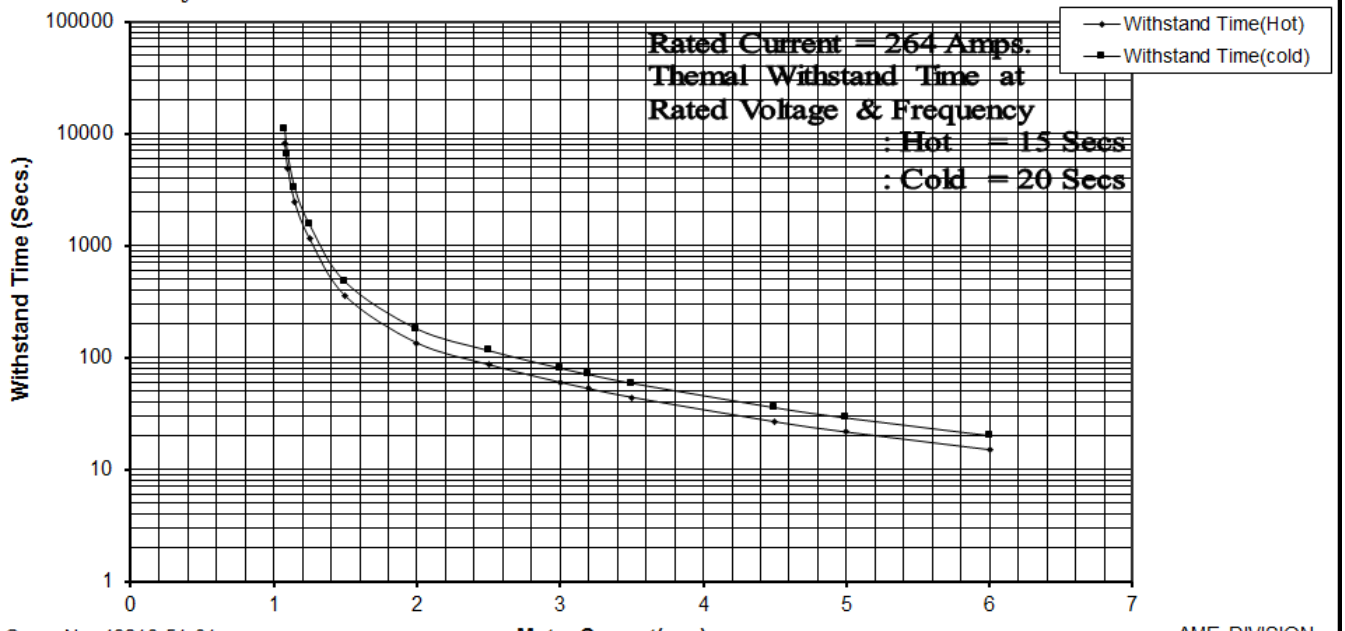
A.C. MACHINES ENGINEERING DIVISION

MOTOR TECHNICAL DATA (REV 00)

WO: 48210A401-51,52 & 53

Thermal Withstand Curves

Rating : 1250 KW, 3300 V, 4 P, VFD Cum DOL , TETV , Cage Rotor Asyn. Motor.
Frame : 1LA7716-4
W.O.No. : 48210A401-51, 52 & 53
Customer : M/S NTPC LTD.
Project : 3X660MW BARH-I FGD



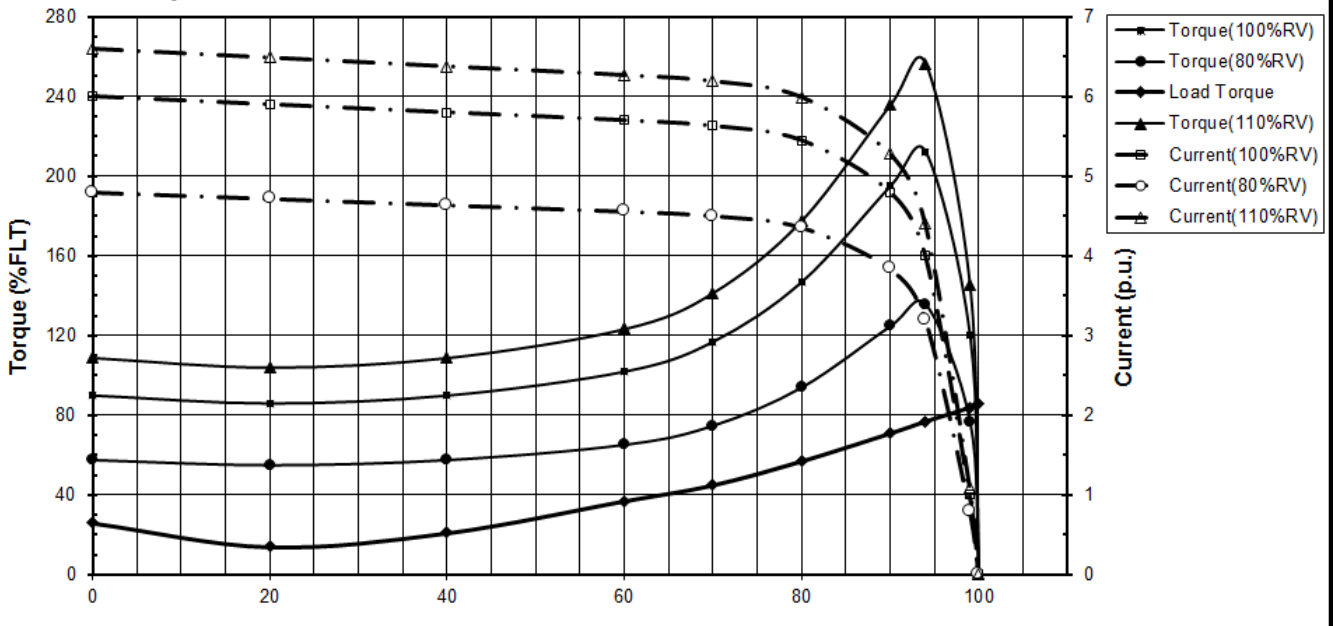
Curve No. 48210-51-01

AME DIVISION

Torque & Current Vs Speed Curves

Rating : 1250 KW, 3300 V, 4 P, VFD Cum DOL , TETV , Cage Rotor Asyn. Motor.
Frame : 1LA7716-4
W.O.No. : 48210A401-51, 52 & 53
Customer : M/S NTPC LTD.
Project : 3X660MW BARH-I FGD

Rated Torque = 817 kg-m
Rated Current = 264 A



Curve No. 48210-51-02

AME DIVISION

BHARAT HEAVY ELECTRICALS LIMITED, BHOPAL

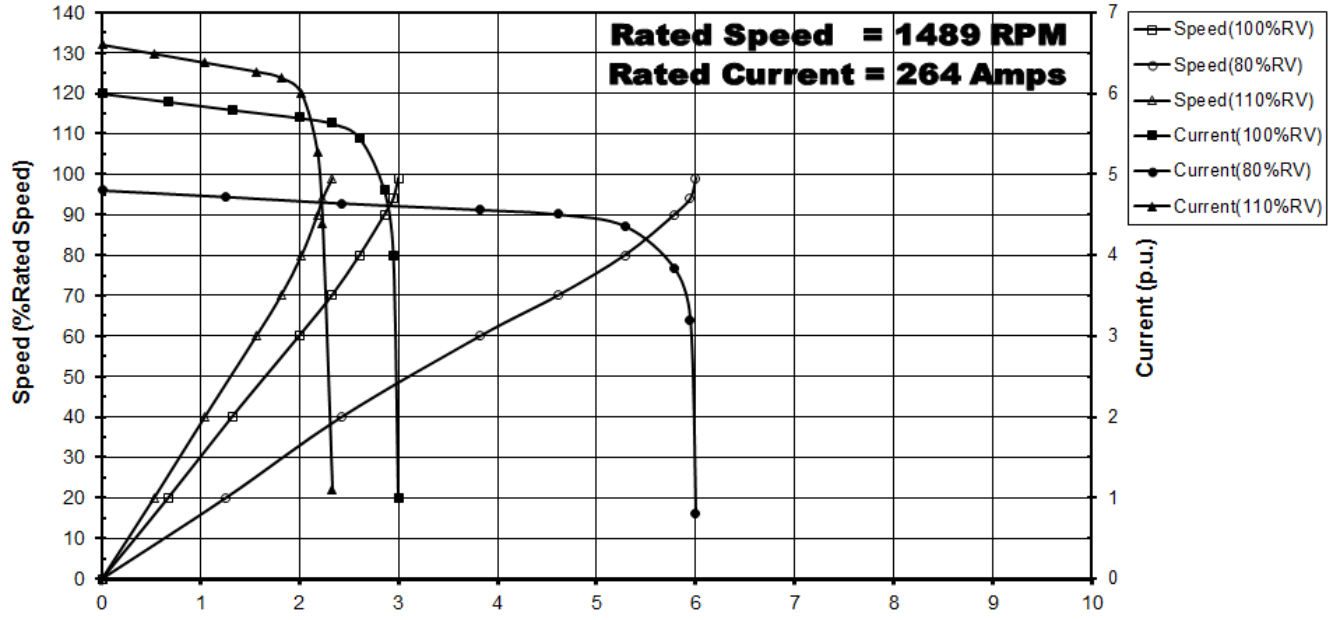
A.C. MACHINES ENGINEERING DIVISION

MOTOR TECHNICAL DATA (REV 00)

WO: 48210A401-51,52 & 53

Speed & Current Vs Time Curves

Rating : 1250 KW, 3300 V, 4 P, VFD Cum DOL , TETV , Cage Rotor Asyn. Motor.
Frame : 1LA7716-4
W.O.No. : 48210A401-51, 52 & 53
Customer : M/S NTPC LTD.
Project : 3X660MW BARH-I FGD

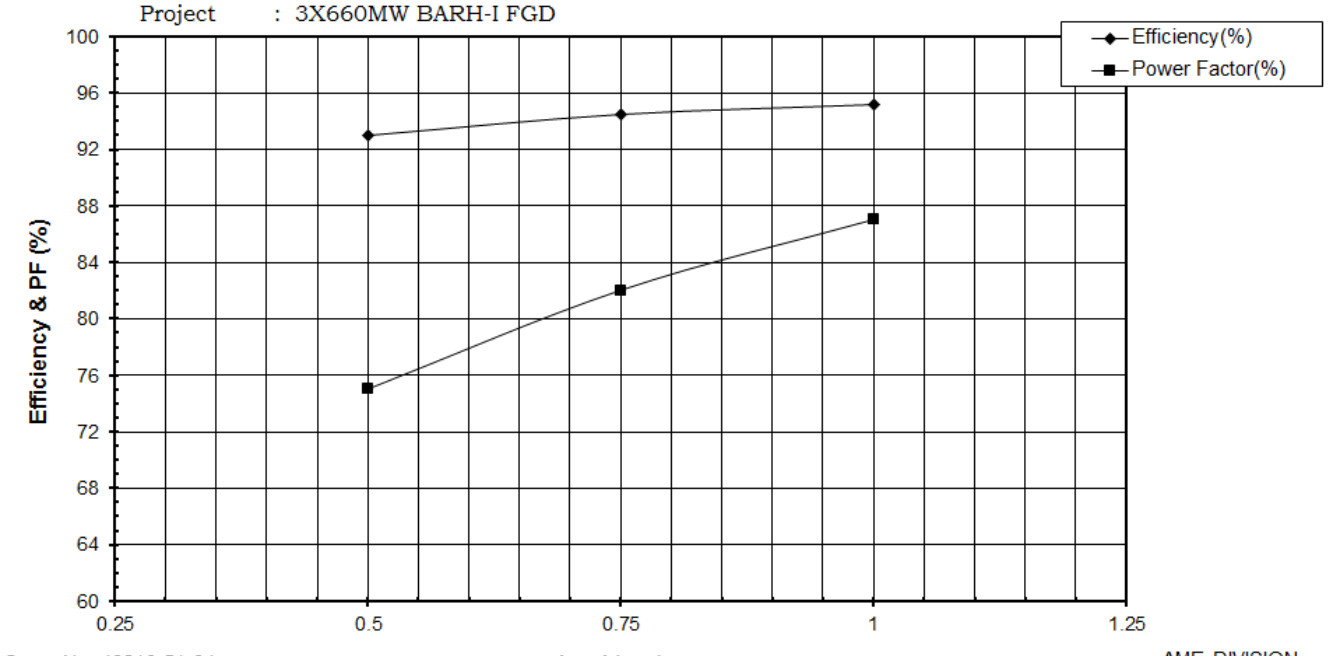


Curve No. 48210-51-03

AME DIVISION

Efficiency, PF Vs Load Curves

Rating : 1250 KW, 3300 V, 4 P, VFD Cum DOL , TETV , Cage Rotor Asyn. Motor.
Frame : 1LA7716-4
W.O.No. : 48210A401-51, 52 & 53
Customer : M/S NTPC LTD.
Project : 3X660MW BARH-I FGD



Curve No. 48210-51-04

AME DIVISION

BHARAT HEAVY ELECTRICALS LIMITED, BHOPAL

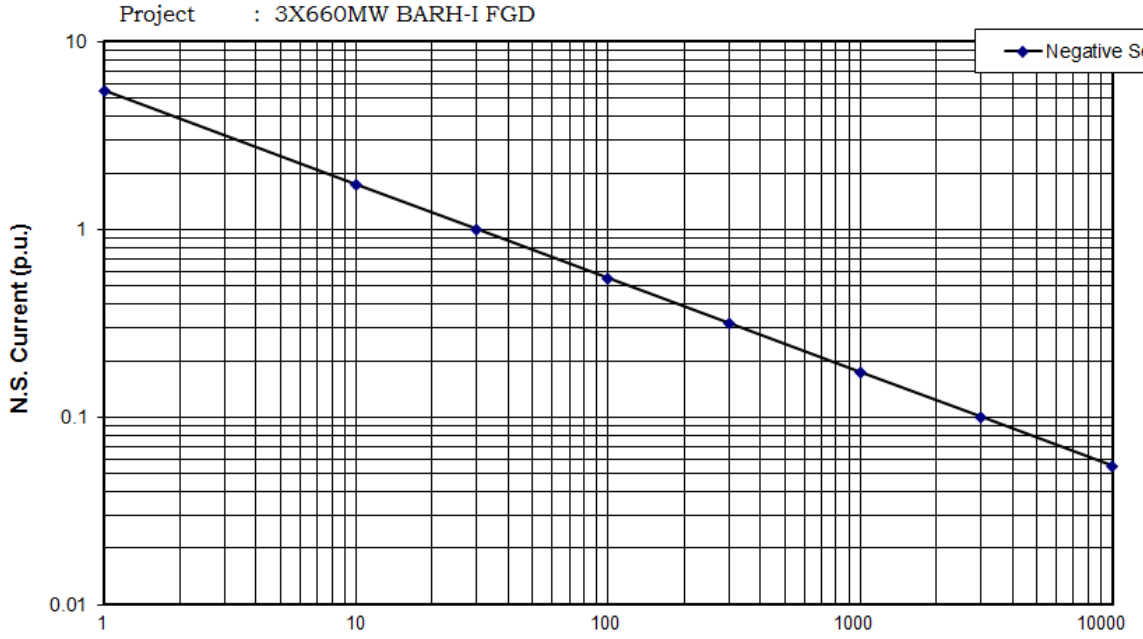
A.C. MACHINES ENGINEERING DIVISION

MOTOR TECHNICAL DATA (REV 00)

WO: 48210A401-51,52 & 53

NEGATIVE SEQUENCE CURVE

Rating : 1250 KW, 3300 V, 4 P, VFD Cum DOL , TETV , Cage Rotor Asyn. Motor.
Frame : 1LA7716-4
W.O.No. : 48210A401-51, 52 & 53
Customer : M/S NTPC LTD.
Project : 3X660MW BARH-I FGD

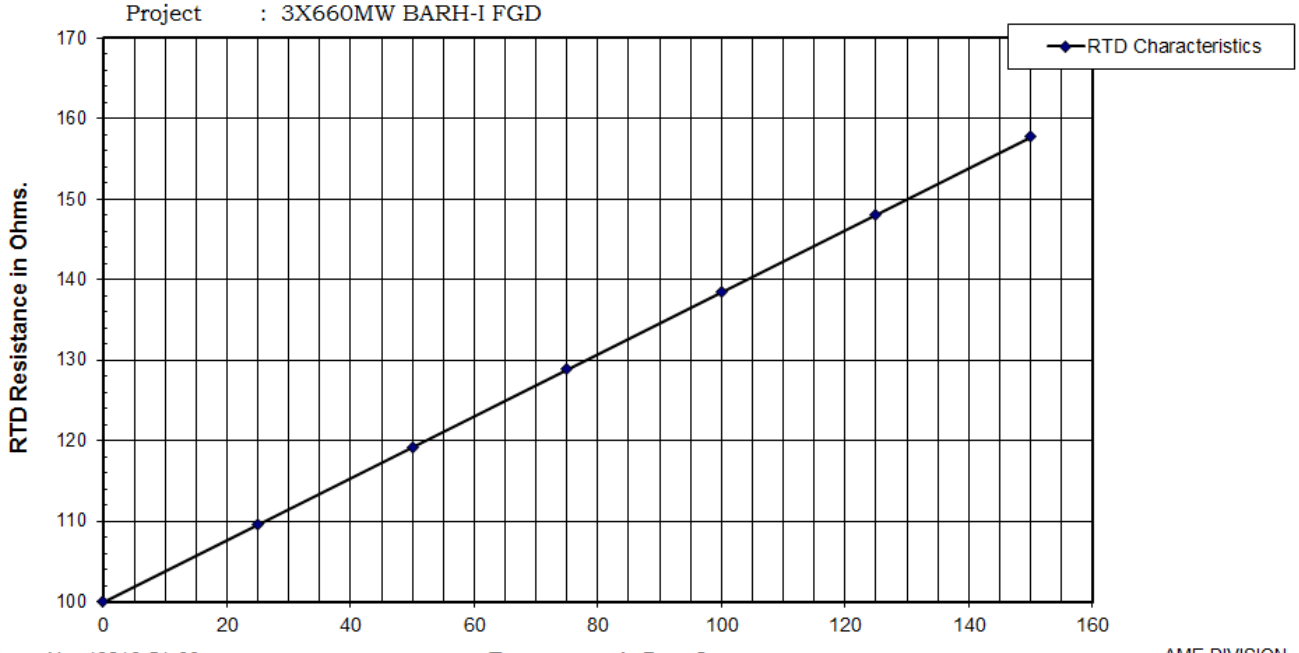


Curve No. 48210-51-05

AME DIVISION

RTD Characteristics(PT-100)

Rating : 1250 KW, 3300 V, 4 P, VFD Cum DOL , TETV , Cage Rotor Asyn. Motor.
Frame : 1LA7716-4
W.O.No. : 48210A401-51, 52 & 53
Customer : M/S NTPC LTD.
Project : 3X660MW BARH-I FGD



Curve No. 48210-51-06

AME DIVISION

Electrical Annexure-2

Variable Frequency Drive (VFD)

1.00.00 **GENERAL**

The Design, manufacture, erection, testing and performance of items and services provided under this specification shall comply with the latest edition including all applicable official amendments and revisions as on date of award of the following standards. In case of conflict between this specification and code (IS Code, standards, etc.) referred herein, the former shall prevail. All work shall be carried out as per the following codes and standards.

2.00.00 **CODES AND STANDARDS**

HT breaker	IEC:60056
DC reactor	IEC 60289
Transformers	IS:2026, IEC: 60076 IEC 61378
Bushing	IS: 2099, IEC 60137
Adjustable Speed Electrical Power Drive Systems	IEC 61800
Semiconductor converters–General requirements	IEC 60146
IEEE Recommended practices and requirements for harmonic control in electrical power systems	IEEE 519
Degrees of protection provided by enclosures (IP Code)	IEC 60529
Electrostatic immunity test	IEC1000-4-2
Fast transient immunity test	IEC1000-4-4
Surge immunity test	IEC1000-4-5
High-voltage switchgear and controlgear; Pt.102: Alternating current disconnectors and earthing switches	IEC 62271-102
High-voltage switchgear and controlgear; Pt.200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 KV	IS/IEC: 62271-200
AC electricity meters	IS: 722
Metal oxide surge arrestor without gap for AC system	IEC: 60099-4
Terminal blocks for copper conductors	IEC: 60947-7-1
Dry transformer	IS: 11171
Motor	IEC 60034-18-41 &42, IEC60034 / NEMA 30 & 31,
Contactor/Switches/Fuses etc.	IEC:60947, IS: 13947
Harmonics & EM compatibility	IEEE:519/IEC: 61000
VFD	IEC:60034/ IEC: 61800

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 Bidder shall clearly indicate

the standard(s) adopted, furnish a copy in English of the latest revision amendments and revision in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

3.00.00 **OPERATING CONDITIONS**

3.01.00 For the purpose of design of equipment/systems, an ambient temperature of 50 deg. Centigrade and also relative humidity of 95% at 40 deg. Celsius shall be considered.

3.02.00 All equipment shall be suitable for rated frequency of 50 Hz with a variation of +3% & -5%, and 10% combined variation of voltage and frequency unless specifically brought out in the specification.

3.03.00 The auxiliary AC voltage supply arrangement shall have 11/6.6/3.3kV and 415V systems (as applicable). It shall be designed to limit voltage variations as given below under worst operating condition:

1. 11kV/ 3.3 kV/ 6.6 KV : +/- 6%
2. 415V : +/- 10%

Note: The Voltage level mentioned above is the Nominal Voltage available at the input of the VFD System from the MCC/ Switchgear/transformer, based on the system requirement/Availability.

The voltage level for the VFD output to be fed to motor shall be as follows:-

1. Upto 400 kW : 415V/690V, Low Voltage, Three Phase AC
2. Above 400kW and upto 700 KW : 690V, Low Voltage, Three Phase AC
3. Above 700KW : Medium Voltage

From here onwards in the specifications all the VFD Systems consisting of either 415 V or 690 V may be termed as LV VFD while the higher rated VFD System shall be termed as MV VFD. If nothing is mentioned than the Clause is applicable for both the LV and the MV VFD until deliberated otherwise.

4.00.00 **SYSTEM DESCRIPTION**

Type of drive	3-Phase Diode / Thyristor / Multi Stage IGBT / IGCT / SGCT/ IEGT
Type of Cooling of VFD	Naturally air cooled/forced air cooled/Liquid cooled
Converter Type	Full wave diode rectifier/active front end type
Inverter Type	Thyristor/IGBT/IGCT/SGCT/IEGT

5.00.00

GENERAL REQUIREMENTS

5.01.00 **Medium Voltage VFD**: The Variable frequency drive (VFD) system shall be of a modern proven design for similar applications in power plants/industry. The system

	shall be either Current Source Inverter (CSI) or Voltage Source Inverter (VSI) type with minimum eighteen (18) pulse design.
5.02.00	**415 V/690 V LV VFD:** The Variable frequency drive (VFD) system shall be of a modern proven design for similar applications in power plants/industry. The system shall be either Current Source Inverter (CSI) or Voltage Source Inverter (VSI) type with minimum Twelve (12) pulse design. For drives less than 100 KW Six (6) pulse can be offered meeting all other requirements.
5.03.00	The system shall be fully digital, PLC/Microprocessor based, energy efficient, and shall provide very high reliability, high power factor, low harmonic distortion and low vibration and wear and noise. It shall be easy to install in minimum time and expense and no special tools shall be required for routine maintenance.
5.04.00	The offered equipment shall be with state of art technology and proven field track record. No prototype equipment shall be offered.
5.05.00	The VFD manufacturer shall ensure the proper coordination of their VFD with the Driven Motor and the supply system. All the Motors which are to be driven by VFDs will be of Inverter duty type. Also these motors shall comply the requirements stipulated in IEC: 60034-18-41 and IEC: 60034-18-42 as applicable. The VFD operation shall have no inherent detrimental impact on the Motors/ cables & supply system.
6.00.00	**TECHNICAL AND OPERATIONAL REQUIREMENTS**
6.01.00	The system shall be designed to deliver the motor input current and torque for the complete speed torque characteristics of the driven equipment, with worst input supply voltage and frequency variation. The system shall be suitable for the load characteristics and the operational duty of the driven equipment.
6.02.00	The overload capacity of the controller shall be 150% of the rated current of the motor for one minute for constant torque applications and 110% of rated current for one minute for variable torque applications at rated voltage. If the motor load exceeds the limit, the drive shall automatically reduce the frequency and voltage to the motor to guard against overload.
6.03.00	The drive system shall be designed to operate in one or more of the following operating modes as to suit characteristics of the driven equipment or specified by the load: a. Variable torque changing as a function of speed. b. Constant torque over a specific speed range. c. Constant power over a specific speed range. d. Any other as specified in data-sheet
6.04.00	VFDs shall comply with the latest edition of IEEE 519 & IEC 61000 for both individual as well as total harmonic voltage and current distortion limits. The Voltage and Current limits shall be applicable at the Point of Common Coupling (PCC), which shall be the MCC/ Switchgear/ from which the VFD system is fed.

6.05.00	The above compliance shall be verified by the field measurements of harmonics at the PCC with and without VFDs operation.
6.06.00	VFD shall be capable of withstanding the thermal and dynamic stresses and the transient mechanical torque, resulting from short circuit. Any damage resulting from such a short circuit or internal fault shall be limited to the component concerned.
6.07.00	The system shall be suitable to maintain speed variation within range 10-110% or as per the requirement of driven equipment with speed set accuracy of +1% of rated maximum speed and steady state regulation of +0.5% of rated speed as per system requirement.
6.08.00	The VFD System shall maintain a power factor of 0.95 (minimum) (for LV VFD system) and 0.9 (minimum) (for MV VFD system) in the entire operating range.
6.09.00	Maximum allowable audible noise from the VFD system will be 85 dB (A) at a distance of one meter under rated loaded with all cooling fan operating conditions.
6.10.00	All the circuit components shall be suitably protected against over voltages, surges, lightning etc.
6.11.00	The panels shall be designed to provide easy access to hardware, to facilitate replacement of cards in case of any failure.
6.12.00	All the VFDs for particular application shall be of same design so as to ensure 100 % interchangeability of components.
6.13.00	For each programmed warning and fault protection function, the VFD shall display a message in complete English words or Standard English abbreviations. At least 30 time tagged fault messages shall be stored in the drive's fault history.
6.14.00	The VFD cubicles shall be placed in air conditioned environment. However if VFDs of less than 100 kW are designed to operate in non-air condition environment the same shall also be acceptable.
6.15.00	The 3-Phase Thyristor/IGCT/SGCT/ multistage IGBT/IEGT based VFD system shall have minimum number of components to ensure very high reliability. The input side converter shall have 3-Phase Diode/Thyristor bridge configuration modular type and inverter shall be of 3-Phase Thyristor/IGCT/SGCT/multi stage IGBT/IEGT type, using Pulse Width Modulation or better technique for generating near sine wave output to motor.
6.16.00	Fiber optic cable connection shall be provided preferably to ensure high network reliability.
7.00.00	**VFD COMPATIBILITY WITH THE MOTOR**
7.01.00	MV VFD output current waveform, as measured at the motor, shall be inherently sinusoidal at nominal loads, with a total harmonic current and voltage distortion within acceptable/standard limits. VFD with transformers on output side are not acceptable.

7.02.00	The system design shall not have any inherent output harmonic resonance in the operating speed range.
7.03.00	VFD shall provide stable operation of motor from high-voltage dv/dt stress, regardless of cable length to motor. The vendor shall clearly state the limitations in the motor cable distance in his proposal. However, due to system requirements & constraints if the cable length becomes critical, filters/ chokes etc. shall be provided by the VFD manufacturers as an integral part of the VFD to mitigate the reflected wave effect of harmonics.
8.00.00	**BYPASS ARRANGEMENT (OPTIONAL, IF SPECIFIED)**
8.01.00	The VFD System shall have an optional feature to run the motor under bypass arrangement for operation of Motor with VFD bypassed. During starting (under rated conditions) the motor will be switched on in VFD Mode to limit the starting current and after gaining speed, the load would be switched over to bypass mode.
8.02.00	Comprehensive motor protection scheme for protection and control for operation VFD during bypass mode shall be finalized during detailed engineering.
9.00.00	**STANDBY VFD ARRANGEMENT (OPTIONAL, IF SPECIFIED)**
9.01.00	A Common standby arrangement with auto/manual switchover shall be provided in case of failure of any VFD in a group of drives. Complete protection, interlocks & control required shall be provided in the changeover module.
10.00.00	**EFFICIENCY**
10.01.00	Efficiency (Drive only) shall be minimum 98% for both MV VFD and LV VFD. Overall efficiency shall be minimum 96.5% for LV VFD and minimum 94 % for MV VFD at rated load and speed. Overall Efficiency evaluation shall include input transformer, harmonic filters and power factor correction (if applicable), VFD converters, cooling fans and output filter, as applicable in the system. Auxiliary controls, such as internal VFD control boards, cooling fans/pumps.
10.02.00	In absence of valid test report, a factory test shall be performed at the VFD manufacturer's facility verifying the efficiencies. Manufactures who are supplying Drive and transformer from different locations, efficiency test will be conducted separately for Drive and transformer.
11.00.00	**COOLING SYSTEM**
11.01.00	The VFD shall be designed to operate indoor under temperature range of 0 deg C to 50 deg C and relative humidity of 95 %(at 40 deg C).
11.02.00	VFD manufacturer to primarily offer Air cooled Design. However in case of large ratings, liquid cooled drives may be accepted subject to employer's approval. In case of liquid cooled system, there shall be no necessity of continuous water supply system (Closed Loop System).
11.03.00	In case of Air cooled design, the VFD Cooling system shall be such that it puts minimum heat load inside the room and preferably throw the hot air outside the room with ventilation ducts. The Cooling system shall be designed in such a way that the Air Conditioning & Ventilation Air requirements are kept to minimum. The VFD

	Manufacturer shall furnish the data regarding heat load, air flow requirements during the detailed engineering.
11.04.00	Air cooled VFDs shall be provided with cooling fans mounted integral to the VFD/ enclosure. The VFD shall include air-flow pressure switches and temperature detectors to monitor proper operation of the air cooling system. If the fan fails, the system must generate the alarm/trip for the fan failure.
12.00.00	**TRANSFORMER:**
12.01.00	Type: Outdoor Mineral oil filled ONAN type or Indoor natural air-cooled Dry type, Three phase unit, rectifier/converter duty type transformer.
12.02.00	All other components, technical parameters shall be as per applicable IEC/IS.
12.03.00	Enclosure for Dry Type Transformer (as applicable)
	Enclosure shall be of a tested quality sheet steel of minimum thickness 2 mm & shall also accommodate cable terminations. The housing door shall be interlocked such that it should be possible to open the door only when transformer is off. The enclosure shall be provided with lifting lugs and other hardware for floor mounting.
12.04.00	Core — Shall be High grade non-ageing cold rolled grain oriented silicon steel Laminations.
12.05.00	Winding conductor — Shall be electrolytic grade copper. Windings shall be of class F insulation.
12.06.00	Winding temperature Indicator (WTI) — Shall be Platinum resistance type temperature detector in each limb.
12.07.00	Thermistors — Shall be embedded in each limb with alarm and trip contacts for remote annunciation.
12.08.00	Temperature rise: Winding temperature rise shall be as per applicable IEC.
13.00.00	**POWER CONVERTER:**
13.01.00	The static power converter shall consist of a line side converter for operation as a rectifier and a load side power converter for operation as a fully controller inverter. Power converter shall be fast switching, most efficient and low loss type.
13.02.00	The converter shall be coordinated with the transformers. The converter shall be able to withstand a three phase short circuit current until interrupted by normal breaker operation.
13.03.00	Adequate short circuit and over voltage protection shall be provided for the converter and inverter system.
13.04.00	All power converter devices shall include protective devices, snubber networks and dv/dt networks as required.
13.05.00	The current rating of the converter's semi-conductor components shall not be less than 120% of the nominal current flowing through the elements at full load of the VFD

	through the whole speed range. If the parallel connection of semiconductor is applied, the above current rating shall not be less than 140% of the above values.
13.06.00	All power diodes shall be of silicon type with minimum VBO rating at 2.5 times the rated operating voltage.
13.07.00	The power converter circuit shall be designed so that motor can be powered at its full nameplate rating continuously without exceeding its rated temperature rise nor reducing its service factor due to harmonic currents generated by the inverter operation. The conversion devices and associated heat sinks shall be assembled such that individual devices can be replaced without requiring the use of any special precautions / tools.
13.08.00	The cooling system of the electronic components, if provided, shall be monitored and necessary alarms shall be provided to prevent any consequential damage to the power control devices.
14.00.00	**OUTPUT FILTER (AS APPLICABLE):**
14.01.00	Output/ dv/dt filter shall be provided, if required. It shall be an integral part of the VFD system and included within the VFD enclosure. It shall inherently protect motor from high voltage dv/dt stress.
15.00.00	**DC LINK CAPACITOR (AS APPLICABLE):**
15.01.00	Capacitor shall be of self-healing film or electrolytic type having high life time. The capacitor shall be an integral part of VFD system. DC link Capacitors shall have discharge resistors which shall be capable of reducing the residual charges to zero just after the capacitor is disconnected from the supply source. The capacitor shall be suitable for high ripple currents.
16.00.00	AC/**DC Reactor (As applicable)** 1) Type: Dry type, air cored, self cooled, indoor type. Suitable for withstanding earth fault continuously. 2) Insulation: Thermal Class 155(F), temperature rise is limited to thermal class 130 (B). 3) Noise level shall not exceed value specified in NEMA TR-1.
17.00.00	**VFD PANEL REQUIREMENTS**
17.01.00	Enclosure frames and load bearing members shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness 2.0 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness 1.6 mm. Doors and covers shall also be of cold rolled sheet steel of thickness 1.6 mm. Stiffeners shall be provided wherever necessary. The gland plate thickness shall be 3.0 mm for hot / cold-rolled sheet steel and 4.0 mm for non-magnetic material. In case dry type transformer is provided inside VFD panels, the enclosure and in its frame thickness shall be same as indicated in this para.
17.02.00	The cable entry shall be from the bottom of the panel and a removable bolted un-drilled gland plate.
17.03.00	All Panels shall be of dust-proof and vermin-proof construction and shall be provided with a degree of protection of IP: 3X or better for MV VFD and IP: 4X or better for LV VFD as per IS/IEC 60947

17.04.00 Enclosures must be designed to avoid harmonic and inductive heating effects and to shield any outside equipment from interference, enclosing and shielding the complete to eliminate any radio frequency interference. The construction of the panel shall provide effective protection against electromagnetic emissions.

17.05.00 Each panel shall be provided with illuminating lamp, space heater with switch fuse and variable setting thermostat.

17.06.00 Proper ventilation using air filters and fans/pumps shall be provided in the panels to ensure that maximum temperature inside the cubicle is within permissible limits for reliable and continuous operation of the system.

18.00.00 **PAINTING**

Paint shade shall be as follows

a) VFD transformer reactor enclosure : RAL 5012 (Blue), legend in black letter

b) Motors : RAL 5012 (Blue)

c) VFD Panels : Front and rear panels in Grey (RAL9002). End panel sides in blue (RAL 5012)

19.00.00 **HT SWITCHGEAR**

19.01.00 The technical requirements of HT switchgear shall be as per chapter of HT switchgear in Part-B of Technical specifications.

20.00.00 **MOTORS**

20.01.00 VFD shall be used to drive three (3) phase squirrel cage inverter duty Induction motor with VPI insulation (Resin poor) suitable for VFD application. These motors shall be provided with insulated bearing on at least one side.

20.02.00 Motors shall also meet the requirements mentioned in subsection for motors and relevant IS/IEC.

20.03.00 Motor shall be suitable for operation with a solid state power supply consisting of an adjustable frequency inverter for speed control & shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive.

20.04.00 Motor insulation shall be designed to accept the applied voltage waveform, within the Vpeak and dv/dt limits as per IEC-61800.

20.05.00 Drive manufacturer shall coordinate with the motor manufacturer for proper selection of the motor for the given load application and the output characteristics of the drive.

20.06.00 Other requirements of motor shall be as stipulated in technical chapter of Motors in Part-B of technical specifications.

21.00.00 **LT & HT CABLES**

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21.01.00 Contractor’s scope shall also include LT and HT cables suitable for VFD system and Motors.

22.00.00 **CONTROL AND PERFORMANCE REQUIREMENTS**

CLAUSE NO.	`` VARIABLE FREQUENCY DRIVES
22.01.00	The VFD to provide an automatic current limiting feature to control motor currents during startup and provide a “soft start” torque profile for the motor load combination. Current and torque limit adjustments shall be provided to limit the maximum VFD output current and the maximum torque produced by the motor.
22.02.00	It shall be possible to vary the speed of the drive and control it in either Local or Remote mode. Local / Remote selection shall be done from VFD panel unless otherwise specified.
22.03.00	Provision shall be kept for exchange of information between different VFD control system parameters thru PLC/DDCMIS. Man machine interface for (MV) VFD shall have one flat TFT monitor with keyboard (password protected) in the VFD room and a color laser printer for system alarm and monitoring located in control room. Parameter Monitoring: -Input and output voltage of Drive - Input and output current of Drive - Motor speed - Input and output power frequency of Drive - Torque -Input and Output power of Drive system (covering transformer if applicable) - Output kWhr of Drive - Transformer (if applicable) temperature for alarm & trip. - Ambient temperature - Run/stop and local/remote status displayed
22.04.00	Drive shall be equipped with a front mounted operator console panel consisting of a backlit alphanumeric display and a keypad with keys for parameterization and adjusting parameter. Control panel shall be operable with password for changing the protection setting, safety interlock etc.
22.05.00	Operator console/Main Control Card shall have facility / port to connect external hardware such as Lap-Top etc. Console shall have facility for upload and download of all parameter settings from one drive to another drive for start up and operation.
22.06.00	User-friendly licensed software for operation and fault diagnostic shall be loaded in the drive system panel before commissioning.
23.00.00	**PROTECTION FEATURES**
23.01.00	The system offered shall incorporate adequate protection features as per IEC 61800-4: 2002 Table-8, properly coordinated for the drive control and for motor including following: i) Converter transformer: short circuit, over current, earth fault & winding temperature high protection. ii) Incoming and outgoing line surge protection. iii) Under / over voltage protection iv) Phase loss, phase reversal, overload, negative phase sequence, locked rotor protection.

	v) Instantaneous Over current & Earth fault protection
	vi) Converter/Inverter module failure indication.
	vii) Over frequency/speed protection.
	viii) Ventilation failure indication & alarm.
	ix) Over temperature of VFD
	x) Bearing temperature protection.
	xi) System earth fault protection.
	xii) Speed reference loss protection.
23.02.00	Under VFD Bypass Mode (if applicable) all the electrical protections related to the Motor shall remain applicable.
24.00.00	**CONTROL FEATURES**
24.01.00	Following controls shall be provided as a part of the Operator Control Panel or through separate switches on the front panel door.
	i) Start / stop (in local/remote mode)
	ii) Speed control (Raise / lower)
	iii) Acknowledge/Accept/ Test Push Button for annunciation
	iv) Auto / Manual / Test Mode select
	v) Emergency stop
	vi) Trip-Remote Breaker
25.00.00	**DIAGNOSTIC FEATURES**
25.01.00	The VFD shall include a microprocessor/PLC based digital diagnostic system which monitors its own control functions and displays faults and operating conditions.
25.02.00	Fault diagnostic shall be built into the system to supervise the operation and failure of the system. The information regarding failure of any of the system including shut down of the system shall be available. It shall be possible to retrieve the record of events prior to tripping of the system or de-energization. Auxiliary supply to the system components or to the electronics (firmware) for the diagnostics / display shall be taken care of by the manufacturer for this purpose.
26.00.00	**SERVICEABILITY / MAINTAINABILITY**
26.01.00	Power Component Accessibility: All power components in the converter sections shall be designed for rack-out accessibility for ease of maintenance and to minimize repair downtime.

26.02.00	Marking / Labeling: Sleeve type wire marker tags or other acceptable means of permanent identification shall be applied to power and control wiring. Individual labels shall be provided for all major components of the VFD system.
27.00.00	**STORAGE AND PRESERVATION**
27.01.00	The Contractor shall be responsible for the storage and preservation of all the equipments to be supplied under the VFD System, till the time of successful installation and commissioning. The equipment should be suitable for storage for long periods before installation. Contractor should take adequate measures to ensure that no damage happens to the VFD System due to storage and preservation.
28.00.00	**TESTS**
28.01.00	**ROUTINE TESTS**
	All acceptance and routine tests as envisaged in QA section shall be carried out. Charges for these shall be deemed to be included in the equipment price.
28.02.00	**TYPE TESTS**
28.02.01	The Contractor shall carry out the type tests as listed in this specification on the equipment to be supplied under this contract. The bidder shall indicate the charges for each of these type tests separately in the relevant schedule and the same shall be considered for the evaluation of the bids. The type tests charges shall be paid only for the test(s) actually conducted successfully under this contract and upon certification by the employer's engineer.
28.02.02	The type tests shall be carried out in presence of the employer's representative, for which minimum 15 days' notice shall be given by the Contractor. The Contractor shall obtain the employer's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set–up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.
28.02.03	In case the Contractor has conducted such specified type test(s) within last ten years as on the date of bid opening, he may submit during detailed engineering the type test reports to the Employer for waival of conductance of such test(s). These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. The Employer reserves the right to waive conducting of any or all the specified type test(s) under this contract. In case type tests are waived, the type test charges shall not be payable to the Contractor.
28.02.04	Further the Contractor shall only submit the reports of the type tests as listed in "LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED" and carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. However if the Contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the Contractor shall conduct all such tests under this contract at no additional cost to the Employer either at third party lab or in presence of client/Employers representative and submit the reports for approval.

28.03.00 **LIST OF TYPE TESTS TO BE CONDUCTED**

The following type tests shall be conducted under this contract for MV VFD

i) Overall efficiency determination of VFD system including transformer/ Harmonic filters etc at motor full load
ii) Temperature rise test
iii) Noise level
iv) Harmonics of No load current.(Input/Output)

28.04.00 **LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED**

The following type test reports shall be submitted for VFD Panels'

1) VFD panels (For LV VFD)

i. Rated Current/ Output
ii. Temperature rise test
iii. Noise level test
iv. Power Loss Determination Test
v. Power factor measurement.
vi. Degree of Protection Test
vii. EMC Test
viii. The Fast transient SWC tests as per ANSI / IEEE C37.901-2002 / IEC 60255-22-04-2008 / IEC 61800

2) VFD panels (For MV VFD)

i. Rated Current/ Output
ii. Current Sharing
iii. Voltage Division
iv. Power Loss Determination Test
v. Power factor measurement.
vi. Degree of Protection Test
vii. The Fast transient SWC tests as per ANSI / IEEE C37.901-2002 / IEC 60255-22-04-2008 / IEC 61800

3) AC/DC Reactor

i. Lightning impulse test(If applicable)
ii. Heat run test
iii. Short time current test(If applicable)
iv. Noise level test

4) Transformers (In case of non integrated type)

CLAUSE NO.	VARIABLE FREQUENCY DRIVES
	i. As per requirements mentioned in subsection for Transformer chapter in technical specifications.

SUB-SECTION-V-QE13

VFD MODULE

DRY TYPE TRANSFORMER

Attributes / Characteristics / Items/Components Sub Systems	Visual & Dimensional check	Mechanical properties	Electrical strength	Thermal Properties	Chemical Properties	NDT / DP / MPI	Voltage Ratio, Vector Group & Polarity	Make / Type / Rating / Model /TC / General Physical Inspection	WPS & PQR	Routine Test as per relevant standard	Measurement of capacitance & tan delta between winding	Routine Test
Enclosure door, H.V. & L.V. Cable Box / Flange Throat	Y	Y						Y				
Copper Conductor	Y	Y	Y		Y							
Insulating Material	Y			Y	Y							
CRGO Lamination & Built Core	Y											
Bushing /Insulator (IS:2544 / 5621)	Y							Y		Y		
Gasket	Y							Y		Y		
Off-Circuit Tap Changer	Y							Y				
Core Coil Assembly	Y						Y					
Marshalling Box	Y									Y		
WTI, Thermister, Terminal Connector	Y							Y				
Welding									Y			
Complete Transformer (IS:11171 / IEC 60076)	Y										Y	Y

Notes: 1) This is an indicative List of test/checks. The manufacturer is to furnish a detailed Quality Plan indicating his practice and procedure along with relevant supporting documents during QP finalization for all item.

2. All major Bought out Items will be subject to NTPC approval.

VFD PANEL

Attributes Characteristics / Item Components Sub System Assembly	Electrical Properties	Mechanical Properties	Chemical Properties	Dimensions / Finish	Type/ Rating/Functional check	HV/IR	Routine test as per relevant std.	Constructional Features	IS:6005 ,Seven tank process	Paint finish/ shade/thickness	Mountings / BOM/ Make, Completeness	Interlock Functional & Operation Testing / Simulation check	Degree of Protection Test	Final testing as per Relevant
Sheet Steel (IS-513)		Y	Y	Y										
Aluminum / Copper Bus-bar(IS-5082/IS-613/IS-1987)	Y	Y	Y	Y										
Support Insulator (BS-2782/IEC-660/IS-10912)	Y	Y	Y	Y										
Control / Selector Switch(IS-6875)					Y	Y	Y							
Contactor/ MCB(IS-13947)					Y	Y	Y							
O/L Protection relays(IS-3231)					Y		Y							
C.T /V.T/ Indicating Meter(IS-2705/3156/1248)					Y	Y	Y							
Fuse/ Fuse carrier(IS-13703)					Y	Y	Y							
Terminals/lugs/pvc wires(IS-13947//IS-694)	Y			Y	Y	Y	Y							
Timers(IS-3231)					Y	Y	Y							
Push Button/ Lamp/ (IS-6875)					Y	Y	Y							
Control Transformer (IS-12021)					Y	Y	Y							
Mimic, Annunciater					Y		Y							
GASKET(IS-11149)		Y	Y	Y	Y		Y							
Fabrication								Y						
Pretreatment & Painting									Y	Y				
VFD panel										Y	Y	Y	Y	Y

NOTE:

1. This is an indicative list of Test/ Checks. The manufacturer to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. All major Bought Out Items will be subject to NTPC approval.

REVISION HISTORY SHEET

REV. NO.	DATE	NATURE OF CHANGE	REASONS	PREPARED BY	APPROVED BY
00	31-07-2020	FIRST ISSUE	------	GITESH DAS	L SUBBALAKSHMI

TECHNICAL SPECIFICATION OF IGBT/ IGCT/ SGCT BASED VFD FOR SQUIRREL CAGE INDUCTION MOTOR

1. Project Details

Sl. No.	Parameter	Specification
1	Project title	As per attached Annexure to Specification
2	Customer	

2. Environment Specifications

Sl. No.	Parameter	Specification
1	Maximum Ambient Temperature	As per attached Annexure to Specification
2	Minimum Ambient Temperature	
3	Equipment Design Temperature (IS-9676)	
4	Relative Humidity	
5	Altitude	
6	Location of VFD Panels	
7	Seismic Zone	
8	Environment	

3. Input and Transformer Data

Sl. No.	Parameter	Specification
1	System Voltage / Frequency / Phase	Refer attached Annexure to Specification
2	Voltage Variation	
3	Frequency Variation	
4	Combined Voltage and Frequency Variation	
5	Fault Level	
6	Transformer Type	
7	Rating	Transformer must be designed to carry 110% current of calculated VFD rating. Transformer sizing calculation shall be provided along with offer.
8	Power Cables	1. Cable glands (Weatherproof) to be provided by the vendor for Transformer HV side cable termination suitable for Cable size mentioned in Annexure to Specification. The exact no. and size will be intimated during drawing approval stage. Cables and termination kits are in Customer /BHEL scope. 2. All interconnecting cables and cable lugs for VFD panel to Transformer connection to be provided by vendor. Refer attached Annexure to Specification for more details. For VFD with non-integrated Transformer, Power Cables between Transformer & VFD shall also consider adequate derating factor as these cables shall travel through trenches and trays. 3. For VFD panel with non-integrated type transformer, Cables glands and termination kits for connection between Transformer LV side and VFD input side termination shall also be supplied by the vendor.
9	Termination cubicle	Any special termination cubicle, supporting structures, etc. if required for non-integrated type VFD system shall also be supplied by the VFD vendor.

4. Motor Data

Sl. No.	Parameter	Specification
1	Type	Squirrel Cage Induction Motor
2	Scope	Manufactured by BHEL-Bhopal
3	Rating (kW)	Refer attached Annexure to Specification
4	Rated Voltage and Current	Refer attached Annexure to Specification
5	Fed from	Variable Frequency Drive (V/f Control)
6	Duty Class	Continuous - S1
7	Efficiency and Power Factor	Refer attached Annexure to Specification
8	Power Cables	Cable glands (Weatherproof) to be provided by the vendor for VFD Output side cable termination suitable for cable sizes mentioned in the attached Annexure. The exact no. and size will be intimated during drawing approval stage. Cables and termination kits are in Customer /BHEL scope.

5. Scope:

Sl. No.	Scope of Supply	Description
1	Refer Consolidated Scope of Supply and Services in attached Annexure for details.	The vendor shall be responsible for engineering and functioning of the complete VFD system comprising of Dry type Transformer and VFD panel, meeting the intent and requirement of this specification, Customer specification and datasheet. This shall include but not be limited to inverter sizing, transformer sizing, transformer impedance selection, vector group, input and output harmonic filter design and sizing, output dv/dt filter sizing, adequacy of motor cable size selected by BHEL etc. All necessary interlocks as required for safe and reliable operation of VFD system along with Input breaker shall be provided in VFD system. If any special arrangement is required in input breaker, same shall be informed by the vendor in offer. The machine shall continuously run on VFD.
2	a) All interconnecting cables between VFD panel and Transformer panel both for integrated type VFD system and non- Integrated type VFD system. b) Any special cable other than power and control cables from VFD to other equipment. c) Power Cable glands, lugs and hardwares for VFD and transformer. d) Any special tools and tackles.	

6. VFD Specifications:

Sl.No.	Parameter	Specification
1	Drive Application	Refer attached Annexure to Specification
2	Input Voltage	From Dry type Transformer.
3	Power/Torque vs Speed	Torque α Speed^2 , Power α Speed^3
4	Single Line Diagram	Refer attached Annexure to Specification
5	Output Voltage of VFD	
6	Output Current of VFD	
7	Output Frequency	0 to 50Hz , Resolution: +/- 0.01% under transient conditions; +/- 0.5% under steady state conditions
8	Overload capacity	Refer attached Annexure to Specification
9	Speed Regulation & Speed Accuracy	+ 0.5% +1%
10	Drive Control	Sensorless Vector Control
11	Braking Operation	Not Applicable
12	Output LC Sinusoidal Filter	Motor is designed for PWM operation. Distance between VFD and Motor are as per Annexure attached with Specification. Vendor to clarify and offer output Filter, if required.

13	VFD Panel Construction	a) Protection Class: Please refer attached Annexure b) Panel: Free standing, floor mounting type, comprising of rigid welded structural frames with Cold Rolled Sheet Steel enclosure of minimum thickness 2 mm for load bearing and 1.6 mm for other members. All doors and removable covers shall have neoprene gaskets. Ventilating louvers shall have easily removable and washable dust filters. c) Busbar Material – Electrolytic grade Copper, colour coded. Sleeving/shrouding for safety purposes shall be done. d) Cooling: Forced Air Cooled VFD should be considered. Cooling system shall include well dimensioned panel, adequate cooling air flow path. Vendor shall ensure that the panel dimensions and flow paths have been designed for continuous running at the specified ambient without overheating. Suitable thermal switch for exit air temperature monitoring shall also be incorporated. e) Earth Bus – minimum 50*6 mm Copper. f) Door Interlock: The VFD shall have a door interlock for safety. This interlock system should ensure that none of the power cabinets can be opened until the main source of power is disconnected or will cause the main source of power to trip. Additionally the same interlock system should ensure that power cannot be initialized to the drive unless the doors are closed. Suitable shrouding mechanism shall be provided so that the DC capacitors cannot be touched till their voltage is zero. g) Painting: 2 Coats of Primer and 2 Coats of Finish Paint to be given for all surfaces of enclosure. Paint shall be Epoxy Based with Powder Coated Finish - shade RAL9002 front and rear panels, end panel sides RAL5012. Paint Thickness: 80 Microns (minimum). Exact paint shade will be confirmed during drawing approval stage. h) Power and Control Wiring shall be done with Fire retardant (FRLS) cables. i) Double compression type Nickel plated brass cable glands shall be supplied. Height of the terminal from cable gland plate shall be adequate to take care of the cable sizes and quantity mentioned. Minimum space for the power cable termination shall be 600mm clear from the cable gland plate. Cable entry will be from bottom only. Gland Plates shall be blank (undrilled) – to be drilled at site. The gland plate thickness shall be 3.0 mm

13	VFD Panel Construction	for hot / cold-rolled sheet steel and 4.0 mm for non-magnetic material. Gland plate shall be of sufficient strength to handle all the cables. j) All electronic modules and components shall be accessible from front of panel only. Modular assemblies for both the system control electronic equipment and power electronic equipments shall be used. k) All low voltage compartment and cabling shall be electrically and physically separated from the high voltage compartment. l) 20% spare terminals shall be provided for future use.
14	Noise Level	Shall be less than 85dB at a distance of 1 metre from the outline of VFD Panels at a height of 1.5 metres from the floor with all the fans running in the VFD Panels.
15	Storage Temp.	-40°C to +60 °C
16	Vibration	According to IEC68-2-6
17	Interference	According to IEC801 parts 2,3,4 Immunity: The panels shall be designed so as to have low Radio Freq Interference (RFI) & Electromagnetic Interference (EMI).
18	VFD Efficiency	Shall be as per NTPC VFD specification. Exact value to be specified by the Vendor in Datasheet.
19	Duty Cycle	Class I Duty Cycle as per IEC 146-1
20	VFD Requirements	a) Input Choke: Input chokes to be provided, if necessary. b) Local/Remote: Selector switch shall be provided for operator to select type of operation: ➢ Local – Operation from VFD Panel for Speed Control from door mounted interface; ➢ Remote – Operation from DCS. If VFD is set for speed reference from Remote, it shall be possible to program the VFD to either shutdown, go to minimum speed or continue operation at its last known speed reference point whenever a loss of speed reference is detected. c) Local Start/Stop Push Button to be provided either on Panel door or on keypad. d) Door Mounted Lockable Push-Button with cover to be provided with 2NO + 2 NC contact for Emergency Stop. One normally open and close contact to be wired to Terminal Block for external Interlocking / Annunciation. e) Every Panel shall be provided with illumination lamp with limit switch and MCB. Space heater shall be provided in panel with switch fuse and variable setting thermostat. 240V power socket with MCB shall be provided.

Sl. No.	Parameter	Specification
20	VFD Requirements	f) 230V, 1phase, 50Hz (exact rating during drawing approval stage) Power Supply to the motor space heater shall be derived from VFD. Necessary interlocking arrangement for this supply shall also be made available in the VFD panels. g) PLC: PLC shall be provided for Interlocking and Protection (if required) h) The expected life time of the drive system shall be minimum 20 years. The system including all individual components forming part of the system shall have an availability of minimum 0.997 and a minimum MTBF of 4 years. i) Any special requirement regarding CT/ PT, protection relay or any other device, in input breaker, which is required for functioning and protection of VFD system shall be considered by the VFD vendor in their scope.
21	VFD Features	a) Soft Start and Auto Restart b) Auto Speed Search Facility (Catch on Fly) shall be available for starting into rotating loads. c) Power loss ride through (Kinetic Buffering) and for voltage dips over 20% or Power interruption for less than 2 secs. d) Automatic VFD tuning during start-up. e) Flux optimisation function shall be provided to reduce the total energy consumption and noise level in case drive is operated below nominal load. f) Selectable reverse run prohibition g) Adjustable motor overload feature h) Settable minimum and maximum operating frequency i) VFD shall produce not greater than 1% torque pulsation to the shaft of driven equipment. j) Field adjustable Torque limits and acceleration and deceleration ramps k) Accelerate / Decelerate Times to be specified. l) Four (4) user programmable preset speeds. m) The equipment may be stored outdoors for long periods before installation.The packing should also be suitable for outdoor storage areas with heavy rains / high ambient temperatures. n) Vendor shall certify readiness of system fit for commissioning. Vendor's scope shall also include supply of all specialized tools and tackles required. o) VFDs shall be installed in Air-conditioned area but it shall be suitable for operation in non-air-conditioned area also. p) Earthing scheme should be provided by the vendor.

21	VFD Features	q) Any special cable other than power and control cables required to connect VFD to other equipment shall be in vendor scope. r) All electronic PCBs/Modules must have conformal coating to take care of site conditions.
22	Controls and monitoring	a) VFD shall be with an interactive and user-friendly door mounted digital operator interface with LCD display and sealed membrane type keypad. b) The operator interface shall be used for drive programming, drive monitoring and drive trouble shooting. The operator interface must also be able to start and stop the drive, reset VFD faults and manually adjust the VFD's speed reference. c) The operator interface shall have LED indicators for drive fault, drive run, and drive in current limit etc. d) The operator interface shall allow monitoring of inverter operating conditions including speed, current, voltage, torque, power etc. e) Messages shall be alphanumeric in nature. All the fault messages shall be in English. f) Provision shall be made available for remote operation. g) The operator interface shall be able to display all real time operating variables and all drive programming parameters. The operator interface shall be capable of displaying a specific user selected parameter on power-up. This power-up parameter would typically be a parameter that is important to the operator such as motor speed or motor load. h) The following Control signals must be provided: ➢ Local/Remote ➢ Emergency stop ➢ Trip/Close Input breaker These are indicative. Vendor to suggest the interlocking scheme using these and other outputs as required for the system during detailed Engineering. These Outputs shall be provided with individual relay having 3 changeover potential free contacts wired to terminal blocks. i) All VFD operating parameter shall be stored in nonvolatile memory. j) The drive shall have built in monitoring of following parameters as minimum on its digital operator interface and these parameter shall also be displayed at Plant DCS through Modbus link: i) Input & Output Frequency ii) Input & Output Current iii) Motor Speed iv) Input & Output Voltage v) DC Bus Voltage vi) Torque

22	Controls and monitoring	vii) Input & Output Power (It shall be possible to display power output of the drive in kW) viii) Digital Input Status ix) Digital Output Status x) Analog Input Status xi) Drive Thermal state xii) Output kWhr of Drive xiii) Hour run xiv) Transformer Temperature for alarm & trip l) Necessary transducer shall be provided with 4-20 mA output for indicating Motor Speed and Motor Current in the DCS. Transducers shall be capable of driving 500 ohms load. m) The following indications shall be provided on the VFD Panel Door/ Keypad: i) Motor Running/ VFD ON ii) Motor Stopped/Tripped iii) Local/Remote status iv) AC Mains ON v) Auxiliary Control Supply ON vi) VFD Ready vii) VFD Fault viii) External Fault ix) Emergency Stop Activated x) Motor Overspeed xi) Input Breaker Trip xii) Motor zero speed xiii) Rectifier output 'ON' xiv) Transformer winding temperature alarm & trip. n) The VFD shall store fault logs of minimum last 10 faults in memory. o) The interface details of VFD shall be incorporated as required for data communication with DCS system with serial interfaces with RS485 data links. Necessary hardware shall be included in the scope and the interface protocol (i.e. Modbus only) shall be provided.

22	Controls and Monitoring	The following Audio-visual annunciations must be provided. 1) Rectifier fuse failure / drive fault 2) Main AC failure 3) Inverter fuse failure / Drive fault 4) Inverter overload 5) Inverter high temperature / Drive fault 6) Cooling system failure 7) Motor failed to start / Drive fault 8) Transformer fault and alarm 9) Communication and measurement system unhealthy
23	Protection	Following protections shall be built in within the inverter and any other protection as required: a) Motor Overload / Over Torque b) Instantaneous Over current (This device shall monitor the peak output current continuously and shall provide instantaneous shutdown without component failure whenever its trip point is surpassed. The trip point must be greater than or equal to 110% of the VFD's rated full load output current) c) Ground Fault Protection d) Over Voltage/Under Voltage - VFD shall be able to withstand >20% dip in supply voltage for 2 secs without damage to semiconductors or fuses. e) Output Short Circuit f) Output Phase Loss, Phase reversal, Locked rotor protection g) Phase Sequence Protection h) Input Phase Loss/Single Phasing Preventer i) Over Speed/Over frequency of motor j) Heat sink over temperature/VFD Panel Temperature High Stall prevention (During acceleration, deceleration and constant speed operation) k) Loss of Cooling Fans (Ventilation failure Indication and Alarm) l) External faults like Transformer Fault and Alarm m) Incoming and outgoing Line surge protection n) Loss of Speed reference o) Inverter fault (Converter/Inverter module failure indication) p) The system shall be designed to deliver the motor input current and torque for the complete speed torque characteristics of the driven equipment.

23	Protection	q) If the motor load exceeds the limit, the drive shall automatically reduce the frequency and voltage to the motor to guard against overload. If load demands exceed the current limit for more than 1 min, the drive shall shut down to prevent over heating of the motor and damage to the drive. r) The drive shall trip in case the speed exceeds 110% of the maximum operational speed or reduces to 95% of the minimum operational speed for more than 10 seconds.(Speed ref loss protection) s) Fault diagnostic shall be built into the system to supervise the operation and failure of the system. The information regarding failure of any of the system including shut down of the system shall be available for a period of minimum 4 days after a shut down even though no supply available. t) Converter transformer: Short circuit, over current, Earth fault, and Winding temperature high protection.

Sl. No.	Parameter	Specification
24	Dry type Transformer (mounted in panel)	Dry type Transformer a) HV: Taps of ±5% in steps of 2.5% b) LV voltage: Multi secondary type. Number of secondaries and secondary voltage to be indicated by the vendor in technical offer. c) Class of insulation: F or higher. Temperature rise of the transformer shall be as per applicable IEC. d) Winding material : Electrolytic grade Copper **Protection**: RTDs to be provided in each limb for winding temperature measurement. Temperature scanner to be provided for winding temperature measurement of all limbs. Alarm and trip contacts required for annunciation for fault and tripping action. **Connection**: HV Incomer: Termination arrangement and Cable glands to be provided by the vendor. The exact number and sizes will be intimated during drawing approval stage. Cables in BHEL/Customer scope. LV Connection: Cables along with glands, Lugs for connection between LV secondaries and VFD to be supplied by the Vendor. This shall be used for testing of the VFD and later bunched in the panel during dispatch and the same shall be connected at site. Necessary connection and routing arrangements to be made at Vendor's works. For more details please refer Annexure attached with this Specification. In case of non-integrated transformer, Cable termination kits (if required) for LV connection between transformer and VFD shall also be supplied by vendor.

Sl. No.	Parameter	Specification
25	Type of Control:	Completely programmable by the user as: a) Flux vector control with speed feedback b) Flux vector control without speed feedback c) Scalar V/F. VFD shall be capable of maintaining motor speed within ±0.5% without the use of a motor mounted encoder or tachometer. The drive shall have programmable V/F patterns along with user definable custom V/F patterns.
26	Harmonic Limitations – Source	Shall be as per latest IEEE 519 Voltage harmonics: Vendor to inform the values with calculations during detailed engineering stage. Current harmonics: Vendor to inform the source side 5^{th}, 7^{th} & 11^{th} harmonics values with calculations during detailed engineering stage. Vendor to supply harmonic filters, if required, to filter the harmonics generated by VFD at input/ supply side. The above compliance shall be verified by the field measurements of harmonics at the PCC with and without VFDs operation as per NTPC Specification.
27	Harmonics at VFD Output / Motor Input	Shall be as per latest IEC 61800-4 Vendor to specify the maximum amount of voltage and current harmonics at the VFD Output / Motor Input terminals.
28	Switching frequency	To be specified by the vendor in Datasheet.
29	Auxiliary Supply	Refer attached Annexure to Specification

Sl. No.	Parameter	Specification
30	Testing and Quality Plan	a) Routine Tests shall be carried out on all Panels and transformer as per relevant standards and NTPC specifications. b) Type Test Certificates for similar equipment and rating supplied by the Vendor shall be submitted during detailed engineering. Refer clause no. 28.02.00, 28.03.00 & 28.04.00 (2) of NTPC Specification. If valid type test certificates for transformer and VFD panels are not available as per NTPC Specification, vendor shall conduct the type tests without any cost implication to BHEL/NTPC. c) During fabrication, the drive and Transformer shall be subject to inspection by BHEL/ Customer, or by an agency authorized by the BHEL/ Customer to assess the progress of work, as well as to ascertain that only quality raw material is used.
31	Inspection, Training and Commissioning Support	a) Final Inspection: BHEL / Customer representative will be present at manufacturer's works for witnessing of final testing for transformer and VFD. This is to be incorporated in the Quality Plan. No charges shall be applicable for witnessing of final tests. b) Training: Refer attached Annexure to Specification. c) Commissioning: Commissioning of all VFD Systems at site shall be in the scope of Vendor. Final Acceptance shall be based on successful completion of the same. d) Any replacement of failed/damaged items during commissioning shall be exclusively at Vendor's cost. e) Vendor is advised to stock necessary spares and ensure easy availability to facilitate trouble free commissioning.
32	Laptop & Software for Computer Interface	Laptops shall be installed with Latest Compatible Licensed Operating System. The software must be loaded in the laptops & supplied along with interconnecting cables and accessories required for interface with the drive. The software should be an easy to use commissioning tool for drives and shall be provided along with the system. The interface details of VFD shall be incorporated as required for data communication with DCS system with serial interfaces with RS485 data links. Necessary hardware shall be included in the scope and the interface protocol (Modbus only) shall be provided.

Sl. No.	Parameter	Specification
33	Maintenance	The procedure for maintenance of VFD panels and the schedule thereof shall be mentioned in the offer.
34	Spares	Please refer attached Annexure with this Specification.
35	Confirmations/Deviations to Specification	**Point-wise confirmation to this specification and NTPC Specification to be given along with offer**. Deviations, if any, shall be indicated separately. If there are no deviations to the specifications, supplier shall mention the same explicitly. A reply from vendor stating that "**Equipment will generally meet the specifications**" will not be accepted by BHEL. Clause-wise Confirmation / Clarifications of all Clauses in the Purchase Specifications 1 to 34 of Specification shall be furnished in the format below.

Point No.	Page No.	Confirmation / Clarification / Information / Deviation	Details	Remarks, if any

7. Documentation

Sl. No.	Parameter	Specification
1	Attached Documents	a) NTPC specification for VFD System and QA documents b) Motor Datasheet and Curves. c) Single Line Diagram d) "Annexure" to Specification for project specific data. e) Provenness Criteria : Refer "Annexure" attached with the Specification.
2	Technical Information required along with Offer	a) Dimensional Drawing of Panels along with minimum clearance to be maintained for effective cooling, and Weight b) Technical Catalogue of VFD System being offered. c) Reference list for similar rating VFDs giving the following: Model number, Application, Rating, Year of supply and commissioning. Provenness Criteria of Medium Voltage Variable Frequency Drive shall be used as qualifying criteria (if attached with this specification). d) Confirmation / Clarification / Information / Deviation List as per Point 35 in page no. 16. e) Confirmation / Clarification / Deviation List to NTPC Specifications and other documents in Sl No. (1) above. f) Design calculation for sizing of Transformer and VFD. g) Filled up Datasheet for VFD system
3	Information / Confirmations required along with offer	a) Supply of the VFD shall be by OEM only. The name of the country from which the drive is sourced and the location of the manufacturing plant should be mentioned in the offer. b) After Sales Service and Support shall be given by the Vendor for a minimum period of 15 (fifteen) years after commissioning. Address of the Sales and Service Representatives in India with complete contact details: Name/Telephone/Email are to be provided. c) Vendor shall give a notice of at least 1 year to the end user of the equipment and BHEL before phasing out the product / spares to enable the end user for placement of order for spares and services.

Sl. No.	Parameter	Specification
4	Technical (unpriced) and Commercial (priced) Bids – For Evaluation	Refer "Consolidated Scope of Supply & Services" in Annexure attached with this Specification for Unpriced and Priced Bids.
5	Information required for Customer / Consultant Approval (within 3 weeks from the date of Purchase Order)	a) Dimensional Drawing of Panels along with minimum clearance to be maintained for effective cooling, and Weight b) Schematic Diagram c) Bill of Materials for equipment to be supplied d) Feeder Requirements – UPS and 415V supply e) Losses at Rated Load (including Fans) f) Heat Loss for Air Conditioning System sizing g) Technical Catalogue of VFD System being offered h) Test Protocol and Quality Plan i) Type test certificates of similar or higher rating equipment j) Filled up Data sheet for VFD system and Transformer
6	Information Required along with Supply. Maintenance Manuals and Documentation	a) Erection, Commissioning and Maintenance Manuals along with Final Drawings and Documentation b) Test and Guarantee Certificates. c) Complete Bill of Material (item wise) for the equipment supplied. d) 1 no. CD ROM consisting all of the above.

VFD SYSTEM DATA SHEET

A	VFD Data	
1	Manufacturer	
2	Model No.	
3	Manufacturing Location	
4	Rating and Application	
5	Applicable codes /standards	
6	Speed reference	4-20 mA from DCS
7	Speed range	
8	Switching Frequency	
9	No. of Pulse	
10	Total number of Diodes/ IGBTs/ IGCTs	
11	Drive output Voltage	
12	Overload capability	
13	Inrush current 250% In for	
14	Combined efficiency (Transformer & Drive) at:	
	i) 100% Load	
	ii) 75% Load	
	iii) 50% Load	
	iii) 25% Load	
15	Overall power factor at:	
	i) 100% Load	
	ii) 75% Load	
	iii) 50% Load	
	iii) 25% Load	
16	Output voltage range and Accuracy	
17	Output Frequency range and Accuracy	
18	Type of Cooling	
19	Redundancy in Cooling	
20	Type of feedback for speed control	
21	Output Filter/ Choke:	
	i) Manufacturer	
	ii) Type/ Model No.	
	iii) Rated Current and Voltage	
22	Acceleration / Deceleration time	
23	Degree of protection	

24	VFD Panel Dimensions (Dimensional details inclusive of all panels shall be furnished)		
	i) Length (mm)		
	ii) Height (mm)		
	iii) Depth (mm)		
	iv) Weight (kg)		
25	Paint Shade		
26	Heat Load (kW)		
27	Auxiliary Power Requirement:	415V, 3ph, 4Wire	UPS supply
	i) KVA		
	ii) Voltage and Phase		
B	**Transformer Data**		
1	Manufacturer		
2	Manufacturing Location		
3	Type	Dry type Transformer	
4	Integrated / Non-Integrated		
5	Duty	Continuous (Converter Duty)	
6	Rating (Transformer must be designed to carry 110% current of calculated VFD rating.)		
7	Class of insulation and Temperature Rise		
8	Insulation level:		
	P. f withstand		
	i) HV Winding		
	ii) LV Winding		
	Impulse withstand		
	i) HV Winding		
	ii) LV Winding		
9	Fault Level on HV Side		
10	HV Voltage and Phase		
11	LV Voltage/ Current		
12	No. of LV Windings		
13	Rated Frequency	50Hz	
14	Impedance		
15	Cooling Type		
16	Winding Material	Electrolytic grade Copper	
17	Location of Tap Changer	HV Winding	
18	No. of Taps and Type		
19	Vector Group		

20	Neutral CT specification:	
	51G	
	64R	
	Vk	
	Im at Vk/2	
	RCT	
21	Cable Size/Type	
	i) HV Winding	
	ii) LV Winding	
22	No Load Loss	
	i) At 100% Voltage	
	ii) At 110% Voltage	
23	Full Load Copper loss at 75°C	
24	No Load Current	
	i) At 100% Voltage	
	ii) At 110% Voltage	
25	Efficiency at 75°C and unity power factor	
	i) At 100% of Full Load	
	ii) At 75% of Full Load	
	iii) At 50% of Full Load	
	iv) At 25% of Full Load	
26	Efficiency at 75°C and 0.8 power factor	
	i) At 100% of Full Load	
	ii) At 75% of Full Load	
	iii) At 50% of Full Load	
	iv) At 25% of Full Load	
27	Load at which maximum efficiency occurs	
28	Regulation at 75°C at full load	
	i) At 0.8 pf	
	ii) At UPF	
29	Dimensions	
	i) Length (mm)	
	ii) Height (mm)	
	iii) Depth (mm)	
	iv) Weight (kg)	
30	Degree of protection for enclosure.	
31	Paint Shade	
32	Heat Load (kW)	

ANNEXURE-4 TO PS/445/2636

1. Input Data

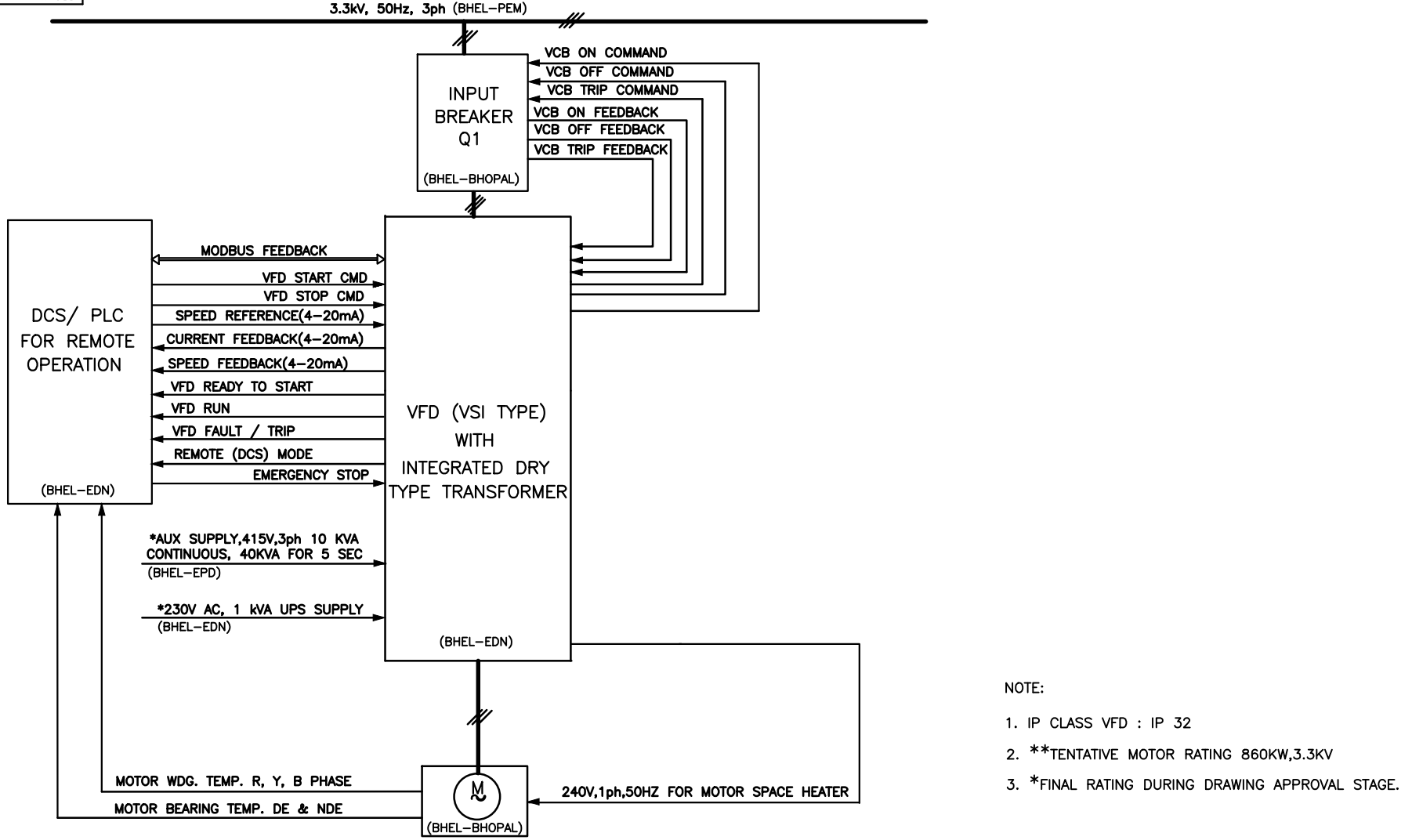
Sl. No.	Parameter	Specification
1	Project Title	**BARH2 FGD Project (2 x 660MW)**
2	Customer	NTPC
3	**Environmental Specifications :**	
	Parameter	**Specification**
	Max. Ambient temperature	50°C
	Min. Ambient temperature	0°C
	Equipment Design temperature	50°C
	Relative Humidity	95% at 40°C
	Altitude	Less than 1000m above mean sea level
	Location of VFD Panels	Indoor, Ventillated Room with Air Conditioning
	Seismic Zone	As per IS-1893-Zone-II
	Environment	All cards/hardware of VFD panel shall be suitable for operation in harsh environmental conditions with respect to high temperature, humidity & dust.
4	Drive Application	Slurry Re-Circulation (RC) Pump
5	System Voltage / Frequency / Phase	3.3kV / 50 Hz / 3-phase
6	Voltage Variation	± 6%
7	Frequency Variation	+3%, -5%
8	Fault Level at 3.3kV input side	40kA for 1 Sec.
9	Combined Voltage and Frequency Variation	10%
10	Output Voltage of VFD	0 to 3.3kV (V/f = Constant)
11	Overload capacity	The overload capacity shall be 110% of rated current for 1 minute at rated voltage.
12	Motor Rating	900kW, 3.3kV, 195 Amps, 1489 rpm
13	Motor Efficiency & Power Factor	95% & 0.85 respectively
14	VFD type	Fully Assembled Units of 3.3kV VFD Panels (IGBT/SGCT/IGCT), Air Cooled with Integrated Dry Type Transformer (DTT)
15	Transformer type	Dry type Integrated Transformer along with VFD. Cables between VFD and transformer shall be in VFD vendor's scope.
16	Degree of Protection	IP:3X or better
17	VFD Output Current	195 A at 50°C (Design Ambient)

18	Distance between VFD & Motor (approx.)	300 meters
19	Cable Sizes between : a) 3.3kV Swbd. & VFD Transformer b) VFD Transformer & VFD c) VFD & Motor	a) 2R x 03C x 150 Sq. mm, Al, XLPE b) In VFD Vendor's scope c) 2R x 03C x 150 Sq. mm, Al, XLPE
20	Auxiliary Supply	a) 230V UPS feeder will be provided by BHEL. KVA rating is to be given by the Vendor. Control supply for electronic modules has to be derived from the UPS. b) Auxiliary Supply – 415V, 3ϕ, 50Hz, 4 wire will be provided by BHEL. Feeder Power rating (short time & continuous) to be specified by the Vendor. c) Other supplies required by the VFD system to be generated internally within the VFD system.
21	Single Line Diagram	Refer Drg. No. 3-661-00-00974
22	Provenness Criteria	Provenness Criteria requirement of Medium Voltage Variable Frequency Drive (3.3 kV VFD) is attached. Vendor to furnish details in line with the document.
23	Mandatory Spares	HV Bushing/Insulator – 2 nos.; LV Bushing/Insulator – 2 nos.; WTI (if applicable) – 2 Nos.;
24	Training	Training for NTPC personnel for 20 Mandays at Manufacturer's works.

2. Consolidated Scope of Supply and Services

Sl. No.	Items For RC Pump BARH2	Quantity (Nos.)
1.	a) Fully Assembled Units of 3.3kV VFD Panels (IGBT/SGCT/IGCT), Air Cooled with integrated Dry type transformer, Termination cubicle, if required	2 Nos.
	b) Cable Accessories	01 Set
2.	Laptop loaded with Drive software	1 No.
3.	Mandatory Spares (Optional price)*	01 Set
4.	Erection Supervision & Commissioning (Vendor to quote lumpsum commissioning charges for 12 days per Drive which shall be considered for bid evaluation) Payment shall be made for actual mandays consumed at Site with per day charges calculated on the basis of the lumpsum charges quoted above. Lumpsum charges quoted shall include travelling, boarding and lodging expenses.	02 Lots
5.	N+1 redundancy of cooling fan for Transformer cubicle with auto c/o arrangement (optional price)*	2 nos.

* : Optional prices shall be considered for bid evaluation.



NOTE:

1. IP CLASS VFD : IP 32
2. **TENTATIVE MOTOR RATING 860KW,3.3KV
3. *FINAL RATING DURING DRAWING APPROVAL STAGE.

PROJECT- BARH FGD Project Stage 2 (2X660MW)
CUSTOMER- NTPC

REV.	DATE			REV.	DATE		
01	08.07.19	ALTERED	KD			ALTERED	
		CHECKED	LSL			CHECKED	
		APPROVED	LSL			APPROVED	
		CUSTOMER COMMENT INCORPORATED.					

	NAME	SIGN	DATE
DRAWN	KD		06.06.19
CHECKED	LSL		06.06.19
APPROVED	LSL		06.06.19

DISTRIBUTION OF PRINTS | DEPT. | CODE

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

CARD CODE

TITLE:
SINGLE LINE DIAGRAM – VFD FOR RC PUMP

No. OF SHEETS	01
SHEET No.	01
REV	01

M.O. No.	CE/1522	AS PER OPEN TOLERANCE TO ED 0230499	DRG. No. 3-661-00-00974

REF. DRG. No.
SIGN. & DATE
INVENTORY No.

BHARAT HEAVY ELECTRICALS LIMITED, BHOPAL
A.C. MACHINES ENGINEERING DIVISION
MOTOR TECHNICAL DATA (REV-00)

CUSTOMER	**M/s NTPC LTD.**	**INSPECTION BY**	**NTPC**
PROJECT	**3X660MW BARH-II FGD**	**WO NO.**	**48211A401-51 & 52**
TD Date	**16-Jul-2020**	**NTPC DOC NO.**	**9560-109-PVE-Y-003**

Note: Data given below is subject to tolerance as per IS/IEC:60034-1 unless specified otherwise as '*' for which the data is guaranteed.

1. GENERAL	**1.**
(i) Manufacturer	(i) BHEL, BHOPAL
(ii) Equipment driven by motor	(ii) RC PUMP
(iii) Motor type	(iii) SCIM
(iv) Country of origin	(iv) INDIA
(v) Quantity	(v) 05 + 05 Nos (TOTAL= 10 NOS.)
2. DESIGN AND PERFORMANCE DATA	**2.**
(i) Frame Size	(i) 1LA7636-4
(ii) Type of duty ***(Note: RC PUMP motors are suitable for both VFD & DOL start / operation)***	(ii) Continuous
(iii) Type of enclosure, Method of Cooling, Degree of Protection	(iii) TETV/IC511/IP55 as per Cl. 10 of IEC: 60034-5
(iv) Applicable standard to which motor generally conforms	(iv) IS/IEC:60034-1
(v) Type of mounting	(v) Horizontal (B3)
(vi) Direction of rotation viewed from driving end.	(vi) CW (Bi-Directional)
(vii) Standard continuous rating at 40deg.C ambient temp.(KW)	(vii) 962
(viii) Derated rating for specified normal condition i.e., ambient temperature of 50 Deg.C (KW)	(viii) 900
(ix) Rated voltage (Volts) / Rated Frequency (Hz)	(ix) 3300 / 50
(x) Permissible variation of (a) Voltage (%) (b) Frequency (%) (c) Combined voltage and frequency	(x) (a) $\pm$ 6 (b) + 3, - 5 (c) 10 % (Abs.)
(xi) Minimum permissible starting voltage (%)	(xi) 85
(xii) Rated speed at rated voltage and frequency (r.p.m.)	(xii) 1489

(xiii) At rated voltage and frequency	(xiii)
(a) Full load current (Amp)	(a) 195
(b) No load current (Amp)	(b) 57
(xiv) Power Factor at	(xiv)
(a) 100% load	(a) 0.85
(b) 75% load	(b) 0.80
(c) 50% load	(c) 0.72
(d) No load	(d) 0.049
(e) Starting	(e) 0.16
(xv) Efficiency (%) at rated voltage and frequency at	(xv)
(a) 100% load	(a) 95.0
(b) 75% load	(b) 94.0
(c) 50% load	(c) 93.0
(xvi) Starting current (%) at	(xvi)
(a) Rated Voltage	(a) 720 % (Maximum)
(b) Minimum starting Voltage	(b) 612 % (Maximum) AT 85 % RV
(xvii) Starting time with minm. Permissible voltage	(xvii)
(a) Without driven equipment coupled	(a) 3 sec
(b) With driven equipment coupled	(b) 5 sec
(xviii)Safe stall time with 100 % rated voltage	(xviii)
(a) From hot condition	(a) 17 Sec
(b) From cold condition	(b) 22 Sec
(xix) Torque at (in % / kg-m)	(xix)
(a) Starting (at minimum permissible voltage)	(a) 53 % / 311.64 kg-m
(b) Pull up at 100% Voltage	(b) 67 % / 393.96 kg-m
(c) Pull out at 100% Voltage	(c) 210 % / 1234.8 kg-m
(d) Rated load (kg-m) at 100 % Voltage	(d) 588 kg-m
(e) Mínimum Accelerating Torque (Kg-m) at 85 % RV	(e) 22 % / 129.36
(xx) Stator winding resistance per phase (ohms) ref. to 20 deg.C.	(xx) 0.05891 +/-5%
(xxi) Flywheel Moment of motor (Kg-m2) (GD2)	(xxi) 124 kg-m²
(xxii) Permissible starts from Hot/ Cold condition	(xxii) 2 / 3
(xxiii)Locked Rotor KVA Input (at Rated Voltage)	(xxiii) 8024.93
(xxiv)Locked Rotor kVA / Rated kW	(xxiv) 8.92 (Maximum)

(xxv) Vibration at No Load (Brg.Housing)	(xxv)
(a) Velocity (mm/s)	(a) 2.3 (rms)
(b) Displacement (Microns)	(b) 37 (p-p)
(xxvi)Noise Level at No Load	(xxvi) 85 dBA at 1.0 metre.
3. CONSTRUCTIONAL FEATURES	3.
(i) Stator winding Insulation	(i)
(a) Class & type	(a) F/EPOXY MICA RESSIN POOR (VPI)
(b) Tropicalised (Yes/No)	(b) YES
(c) Temperature rise over specified ambient of 50 deg C (deg C)	(c) 70
(d) Method of temp. Measurement	(d) BY RESISTANCE
(e) Stator winding connection	(e) STAR
(f) No. of terminals brought out	(f) 6
(ii) Type of terminal box for	(ii)
(a) Stator leads	(a) ELASTIMOLD TB
(b) Space heater	(b) CAST / FABRICATED
(c) Temperature detectors	(c) CAST / FABRICATED
(d) Instrument switches etc.	(d) NIL
(iii) For main terminal box	(iii)
(a) Location (from DE)	(a) RHS
(b) Entry of cables	(b) BOTTOM OF TB
(c) Recommended cable size (Runs/cores/x-section mm^2/ material)	(c) 2R X 3C X 150 Sq.mm.
(d) Fault level (MVA)/ Duration (Sec)	(d) 25 kA / 0.17 sec
(iv)For Bearing	(iv)
(a) Type	(a) ANTIFRICTION
(b) Manufacturer	(b) NTPC APPVD. SUPPLIER
(c) Recommended lubricant	(c) IOC SERVOGEM-3/EQV. GREASE
(d) Guaranteed Life in Hrs.	(d) 40000 Hrs.
(e) Lubrication Type	(e) SELF
(f) Whether Dial Type Thermometer Provided	(f) NO
(v)Type of cooler (CACA/CACW)	(v) NA
(vi)Cooling water requirement for CACW motors	(vi)
(a) Quantity required	(a) NA
(b) Maximum permissible inlet water temperature (deg C)	(b) NA
(c) Pressure of water at inlet to coolers	(c) NA
(d) Outlet temperature of water at full load (anticipated value)	(d) NA
(vii)Weight of	(vii)
(a) Motor Stator (Kg)	(a) 4550
(b) Motor rotor (Kg)	(b) 1100
(c) Cooler (Kg)	(c) NA
(d) Total weight (Kg)	(d) 5650
(ix) Max. Perm. Temp. of Rotor	(ix) 350 Deg. C
(x) Total Temp. of Rotor during I Start	(x) 124 Deg. C
(xi) Total Temp. of Rotor during II Start	(xi) 132 Deg. C
(xii) Surge Withstand Voltage (Stator winding)	(xii) As per IEC:60034-15
(a) 0.3/ 3 Microsecond Surge (kVp)	(a) 11.8
(b) 1.2/ 50 Microsecond Surge (kVp)	(b) 18.2

4.00 LIST OF ACCESSORIES

4.01 RTDs for winding (Type/Nos/Leads /location/make/Res. at 0 Deg.C)	: PT100 SIMPLEX / 12 / 3 Between Coil Sides in slots/ Reputed NTPC Appvd./ 100 Ohms
4.02 RTDs for bearing (Type/Nos./Leads /location/make/Res. at 0 Deg.C)	: PT100 DUPLEX/ 3 nos per bearing side(Total=6) / 4 Wire In Bearing Housing/ Reputed NTPC Appvd./ 100 Ohms
4.03.01 RTDs for Hot Air (Type/No/Leads)	: NA
4.03.02 RTDs for Cold Air (Type/No/Leads)	: NA
4.04 Space Heaters	: YES
4.04.01 Nos.	: 4 Nos. of 630W each.
4.04.02 Power (Watts)	: 630 W
4.04.03 Supply Voltage	: 1 PH. 240VAC
4.04.04 Location	: In air pockets
4.05 Stator Terminal Box	
4.05.01 Type	: ELASTIMOLD T.B.
4.05.02 Fault Level (MVA)	: 25 kA
4.05.03 Fault Level duration (sec)	: 0.17
4.06 Neutral TB	: PHASE SEPARATED T.B.
4.07 Current Transformers	: NA
4.07.01 Nos.	: --
4.07.02 Ratio	: --
4.07.03 Accuracy Class	: --
4.07.04 Vk (V)/Rct	: --
4.07.05 Exciting Current	: --
4.08 Dial Type Thermometer (Type/make Accuracy/ Connection Type & size	: Mercury in Steel/ NTPC Appvd/ + - 1% Full Scale / BSP 3/4"
4.08.01 For Bearings (Nos.)	: NA
4.08.02 For Air Temp (Nos.) a. Hot Air	: NA
b. Cold Air	: NA
4.08.03 Contact Rating	: 5 A AT 240 V AC/ 0. 5 A AT 220 V DC.
4.08.04 Range	: 0 -120 Deg. C.
4.08.05 Supply Voltage	: 240 V, 50 Hz, 1 Phase
4.09 Rotor Terminal Box	: NA
4.10 TBs for RTDs, BTDs & Space Heater	: Yes
4.11 Sole Plate	: NO
4.12 Anchoring items	: Yes (As per OGA)
4.13 Base Frame	: NO
4.14 Speed Switch	: NO
4.14.01 Supply Voltage	: NA

4.15	Insulation of Bearing	: Yes, NDE bearing housing
4.16	Forced Oil lubrication	: NA
4.17	Oil level Indicator	: NA
4.18	Noise Reducer	: Yes
4.19	Water flow Indicator	: NA
4.19.01	No/Contact Rating	: NA
4.20	Water leakage detector	: NA
4.21	Tachogenerator	: NA
4.22	Grounding Pads	
4.22.01	No & Size on motor body	: 2, 6Tk X 25 X 55 mm
4.22.02	Nos on Terminal Box	: 2
4.23	Vibration Pads	: Yes
4.23.01	Nos & Size	: 02 (Total), 80 mm cube
4.23.02	Location	: At DE and NDE endshield.
4.24	Paint Shade	: RAL 5012
4.25	Any other fitments	: Earth Brush at DE
4.26	External Thrust on Motor	: NA

5.00 LIST OF CURVES

5.01	Thermal Withstand Characteristics	: 48211-51 /01
5.02	Torque Vs Speed Curves	: 48211-51 /02
5.03	Current Vs Speed Curves	: 48211-51 /02
5.04	Current Vs Time curves	: 48211-51 /03
5.05	Speed Vs Time curves	: 48211-51 /03
5.06	Efficiency & PF Vs Load Curves	: 48211-51 /04
5.07	Negative sequence curve	: 48211-51 /05
5.08	Calibration curve for RTD/BTD	: 48211-51 /06

PREPARED BY :

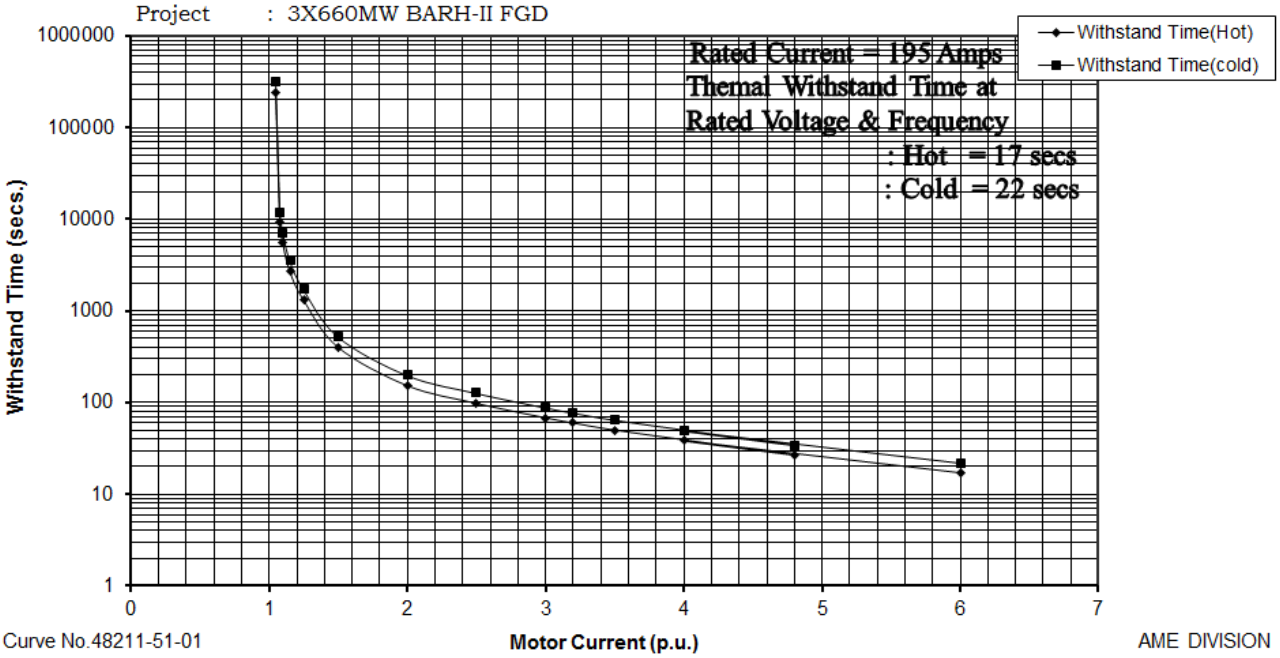
(BHASKAR)
AME Department
BHEL-BHOPAL

BHARAT HEAVY ELECTRICALS LIMITED, BHOPAL
A.C. MACHINES ENGINEERING DIVISION
MOTOR TECHNICAL DATA (REV-00)

WO: 48211A401-51 & 52

Thermal Withstand Curves

Rating : 900 KW, 3.3 kV, 4 P, VFD Cum DOL , TETV , Cage Rotor Asyn. Motor.
Frame : 1LA7636-4
W.O.No. : 48211A401-51 & 52
Customer : M/S NTPC LTD.
Project : 3X660MW BARH-II FGD

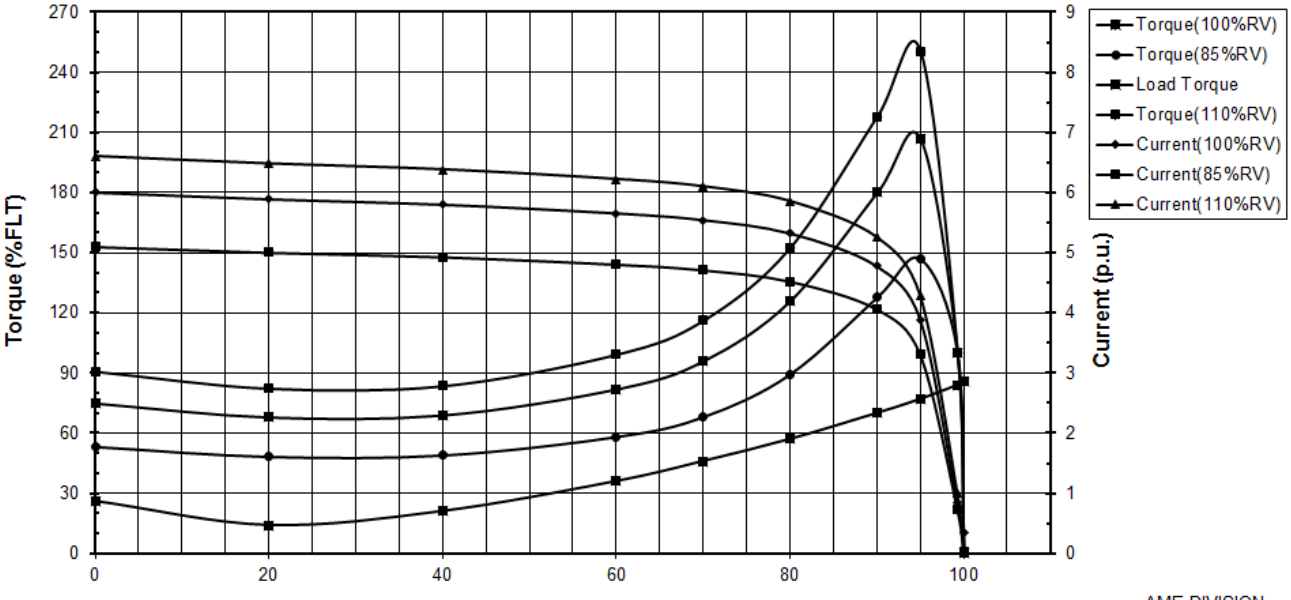


Curve No.48211-51-01 AME DIVISION

Torque & Current Vs Speed Curves

Rating : 900 KW, 3.3 kV, 4 P, VFD Cum DOL , TETV , Cage Rotor Asyn. Motor.
Frame : 1LA7636-4
W.O.No. : 48211A401-51 & 52
Customer : M/S NTPC LTD.
Project : 3X660MW BARH-II FGD

Rated Torque = 588 kg-m
Rated Current = 195 A



Curve No. 48211-51-02 AME DIVISION

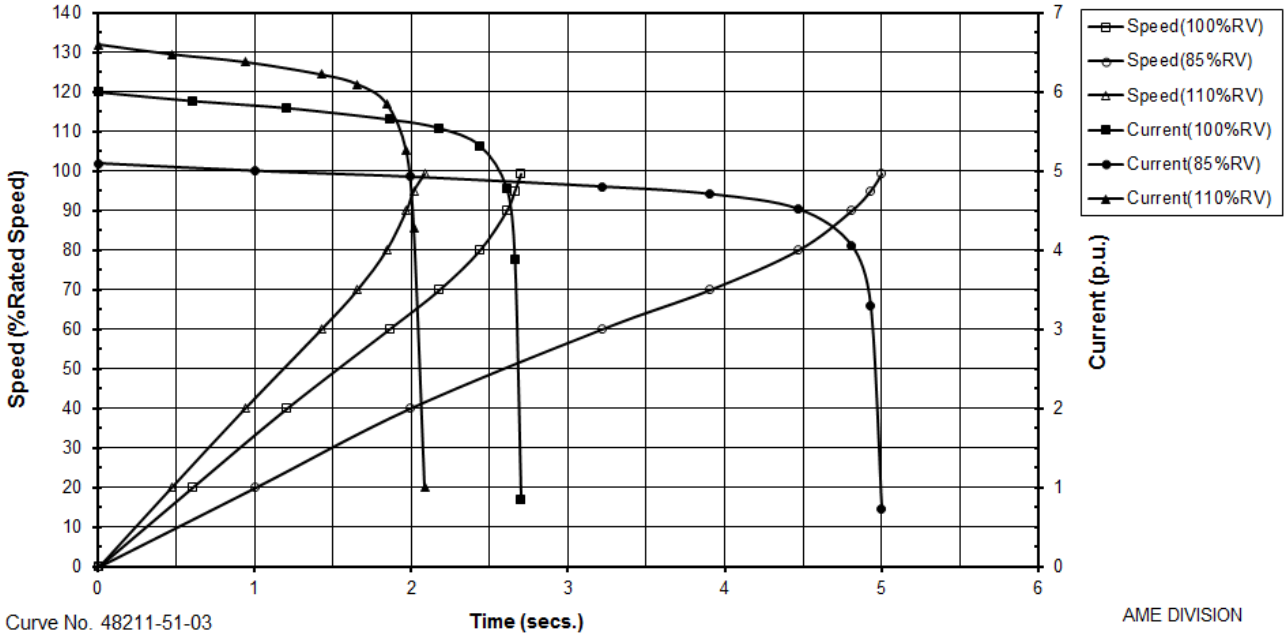
BHARAT HEAVY ELECTRICALS LIMITED, BHOPAL
A.C. MACHINES ENGINEERING DIVISION
MOTOR TECHNICAL DATA (REV-00)

WO: 48211A401-51 & 52

Speed & Current Vs Time Curves

Rating : 900 KW, 3.3 kV, 4 P, VFD Cum DOL , TETV , Cage Rotor Asyn. Motor.
Frame : 1LA7636-4
W.O.No. : 48211A401-51 & 52
Customer : M/S NTPC LTD.
Project : 3X660MW BARH-II FGD

Rated Speed = 1489 RPM
Rated Current = 195 Amps

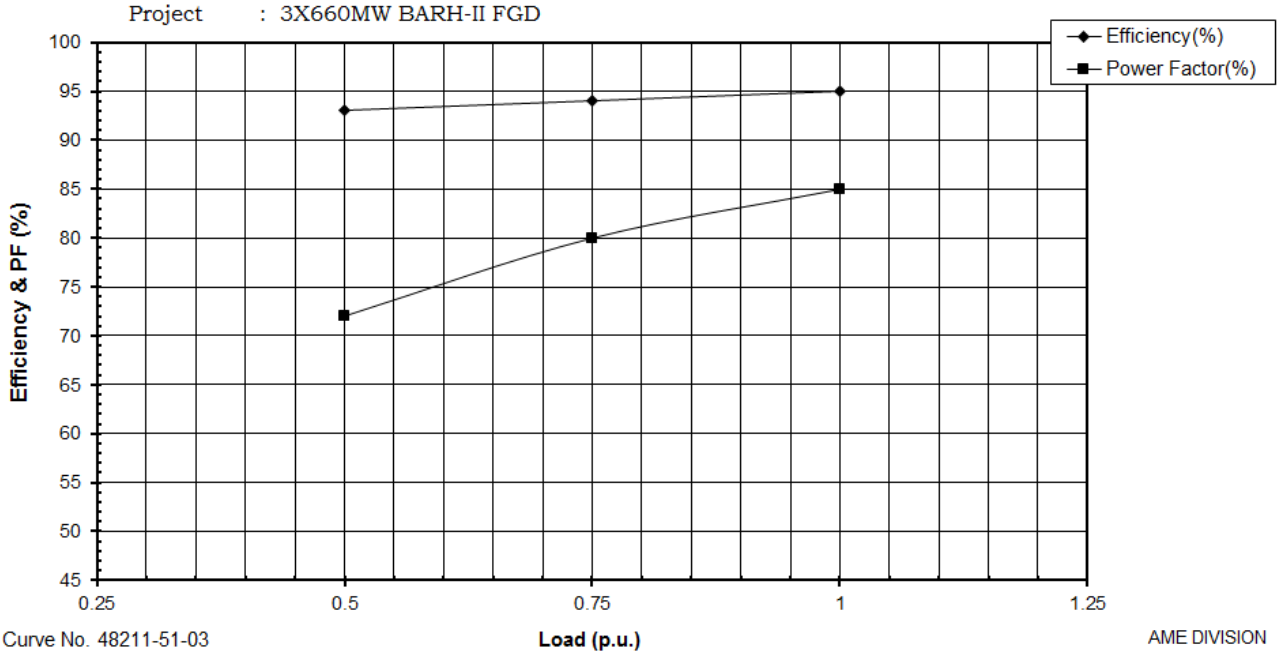


Curve No. 48211-51-03

AME DIVISION

Efficiency, PF Vs Load Curves

Rating : 900 KW, 3.3 kV, 4 P, VFD Cum DOL , TETV , Cage Rotor Asyn. Motor.
Frame : 1LA7636-4
W.O.No. : 48211A401-51 & 52
Customer : M/S NTPC LTD.
Project : 3X660MW BARH-II FGD



Curve No. 48211-51-03

AME DIVISION

BHARAT HEAVY ELECTRICALS LIMITED, BHOPAL

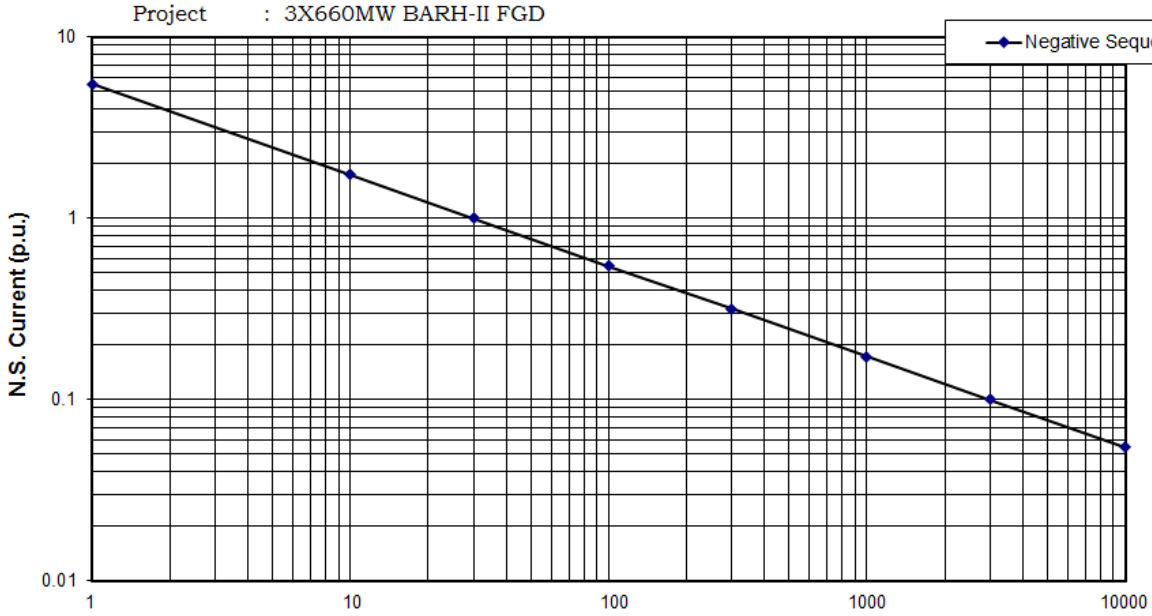
A.C. MACHINES ENGINEERING DIVISION

MOTOR TECHNICAL DATA (REV-00)

WO: 48211A401-51 & 52

NEGATIVE SEQUENCE CURVE

Rating : 900 KW, 3.3 kV, 4 P, VFD Cum DOL , TETV , Cage Rotor Asyn. Motor.
Frame : 1LA7636-4
W.O.No. : 48211A401-51 & 52
Customer : M/S NTPC LTD.
Project : 3X660MW BARH-II FGD

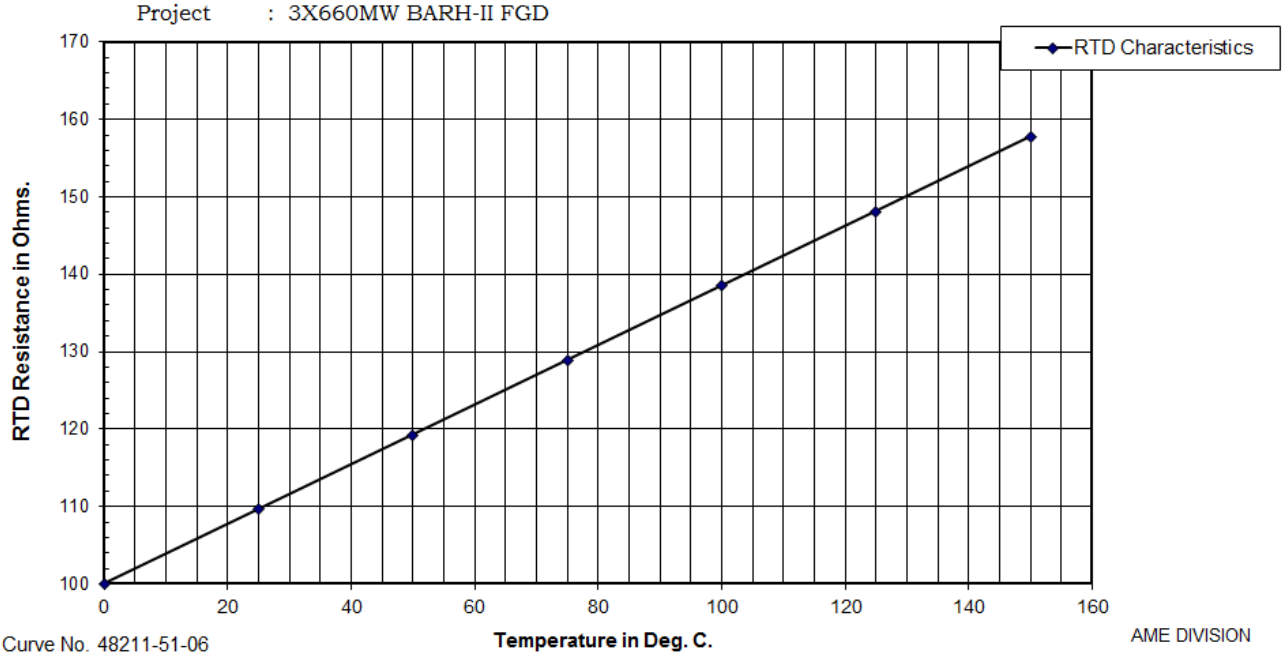


Curve No. 48211-51-05

AME DIVISION

RTD Characteristics(PT-100)

Rating : 900 KW, 3.3 kV, 4 P, VFD Cum DOL , TETV , Cage Rotor Asyn. Motor.
Frame : 1LA7636-4
W.O.No. : 48211A401-51 & 52
Customer : M/S NTPC LTD.
Project : 3X660MW BARH-II FGD



Curve No. 48211-51-06

AME DIVISION

Electrical Annexure-2

Variable Frequency Drive (VFD)

1.00.00 **GENERAL**

The Design, manufacture, erection, testing and performance of items and services provided under this specification shall comply with the latest edition including all applicable official amendments and revisions as on date of award of the following standards. In case of conflict between this specification and code (IS Code, standards, etc.) referred herein, the former shall prevail. All work shall be carried out as per the following codes and standards.

2.00.00 **CODES AND STANDARDS**

HT breaker	IEC:60056
DC reactor	IEC 60289
Transformers	IS:2026, IEC: 60076 IEC 61378
Bushing	IS: 2099, IEC 60137
Adjustable Speed Electrical Power Drive Systems	IEC 61800
Semiconductor converters–General requirements	IEC 60146
IEEE Recommended practices and requirements for harmonic control in electrical power systems	IEEE 519
Degrees of protection provided by enclosures (IP Code)	IEC 60529
Electrostatic immunity test	IEC1000-4-2
Fast transient immunity test	IEC1000-4-4
Surge immunity test	IEC1000-4-5
High-voltage switchgear and controlgear; Pt.102: Alternating current disconnectors and earthing switches	IEC 62271-102
High-voltage switchgear and controlgear; Pt.200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 KV	IS/IEC: 62271-200
AC electricity meters	IS: 722
Metal oxide surge arrestor without gap for AC system	IEC: 60099-4
Terminal blocks for copper conductors	IEC: 60947-7-1
Dry transformer	IS: 11171
Motor	IEC 60034-18-41 &42, IEC60034 / NEMA 30 & 31,
Contactor/Switches/Fuses etc.	IEC:60947, IS: 13947
Harmonics & EM compatibility	IEEE:519/IEC: 61000
VFD	IEC:60034/ IEC: 61800

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 Bidder shall clearly indicate

the standard(s) adopted, furnish a copy in English of the latest revision amendments and revision in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

3.00.00 **OPERATING CONDITIONS**

3.01.00 For the purpose of design of equipment/systems, an ambient temperature of 50 deg. Centigrade and also relative humidity of 95% at 40 deg. Celsius shall be considered.

3.02.00 All equipment shall be suitable for rated frequency of 50 Hz with a variation of +3% & -5%, and 10% combined variation of voltage and frequency unless specifically brought out in the specification.

3.03.00 The auxiliary AC voltage supply arrangement shall have 11/6.6/3.3kV and 415V systems (as applicable). It shall be designed to limit voltage variations as given below under worst operating condition:

1. 11kV/ 3.3 kV/ 6.6 KV : +/- 6%
2. 415V : +/- 10%

Note: The Voltage level mentioned above is the Nominal Voltage available at the input of the VFD System from the MCC/ Switchgear/transformer, based on the system requirement/Availability.

The voltage level for the VFD output to be fed to motor shall be as follows:-

1. Upto 400 kW : 415V/690V, Low Voltage, Three Phase AC
2. Above 400kW and upto 700 KW : 690V, Low Voltage, Three Phase AC
3. Above 700KW : Medium Voltage

From here onwards in the specifications all the VFD Systems consisting of either 415 V or 690 V may be termed as LV VFD while the higher rated VFD System shall be termed as MV VFD. If nothing is mentioned than the Clause is applicable for both the LV and the MV VFD until deliberated otherwise.

4.00.00 **SYSTEM DESCRIPTION**

Type of drive	3-Phase Diode / Thyristor / Multi Stage IGBT / IGCT / SGCT/ IEGT
Type of Cooling of VFD	Naturally air cooled/forced air cooled/Liquid cooled
Converter Type	Full wave diode rectifier/active front end type
Inverter Type	Thyristor/IGBT/IGCT/SGCT/IEGT

5.00.00

GENERAL REQUIREMENTS

5.01.00 **Medium Voltage VFD**: The Variable frequency drive (VFD) system shall be of a modern proven design for similar applications in power plants/industry. The system

	shall be either Current Source Inverter (CSI) or Voltage Source Inverter (VSI) type with minimum eighteen (18) pulse design.
5.02.00	**415 V/690 V LV VFD:** The Variable frequency drive (VFD) system shall be of a modern proven design for similar applications in power plants/industry. The system shall be either Current Source Inverter (CSI) or Voltage Source Inverter (VSI) type with minimum Twelve (12) pulse design. For drives less than 100 KW Six (6) pulse can be offered meeting all other requirements.
5.03.00	The system shall be fully digital, PLC/Microprocessor based, energy efficient, and shall provide very high reliability, high power factor, low harmonic distortion and low vibration and wear and noise. It shall be easy to install in minimum time and expense and no special tools shall be required for routine maintenance.
5.04.00	The offered equipment shall be with state of art technology and proven field track record. No prototype equipment shall be offered.
5.05.00	The VFD manufacturer shall ensure the proper coordination of their VFD with the Driven Motor and the supply system. All the Motors which are to be driven by VFDs will be of Inverter duty type. Also these motors shall comply the requirements stipulated in IEC: 60034-18-41 and IEC: 60034-18-42 as applicable. The VFD operation shall have no inherent detrimental impact on the Motors/ cables & supply system.
6.00.00	**TECHNICAL AND OPERATIONAL REQUIREMENTS**
6.01.00	The system shall be designed to deliver the motor input current and torque for the complete speed torque characteristics of the driven equipment, with worst input supply voltage and frequency variation. The system shall be suitable for the load characteristics and the operational duty of the driven equipment.
6.02.00	The overload capacity of the controller shall be 150% of the rated current of the motor for one minute for constant torque applications and 110% of rated current for one minute for variable torque applications at rated voltage. If the motor load exceeds the limit, the drive shall automatically reduce the frequency and voltage to the motor to guard against overload.
6.03.00	The drive system shall be designed to operate in one or more of the following operating modes as to suit characteristics of the driven equipment or specified by the load: a. Variable torque changing as a function of speed. b. Constant torque over a specific speed range. c. Constant power over a specific speed range. d. Any other as specified in data-sheet
6.04.00	VFDs shall comply with the latest edition of IEEE 519 & IEC 61000 for both individual as well as total harmonic voltage and current distortion limits. The Voltage and Current limits shall be applicable at the Point of Common Coupling (PCC), which shall be the MCC/ Switchgear/ from which the VFD system is fed.

6.05.00	The above compliance shall be verified by the field measurements of harmonics at the PCC with and without VFDs operation.
6.06.00	VFD shall be capable of withstanding the thermal and dynamic stresses and the transient mechanical torque, resulting from short circuit. Any damage resulting from such a short circuit or internal fault shall be limited to the component concerned.
6.07.00	The system shall be suitable to maintain speed variation within range 10-110% or as per the requirement of driven equipment with speed set accuracy of +1% of rated maximum speed and steady state regulation of +0.5% of rated speed as per system requirement.
6.08.00	The VFD System shall maintain a power factor of 0.95 (minimum) (for LV VFD system) and 0.9 (minimum) (for MV VFD system) in the entire operating range.
6.09.00	Maximum allowable audible noise from the VFD system will be 85 dB (A) at a distance of one meter under rated loaded with all cooling fan operating conditions.
6.10.00	All the circuit components shall be suitably protected against over voltages, surges, lightning etc.
6.11.00	The panels shall be designed to provide easy access to hardware, to facilitate replacement of cards in case of any failure.
6.12.00	All the VFDs for particular application shall be of same design so as to ensure 100 % interchangeability of components.
6.13.00	For each programmed warning and fault protection function, the VFD shall display a message in complete English words or Standard English abbreviations. At least 30 time tagged fault messages shall be stored in the drive's fault history.
6.14.00	The VFD cubicles shall be placed in air conditioned environment. However if VFDs of less than 100 kW are designed to operate in non-air condition environment the same shall also be acceptable.
6.15.00	The 3-Phase Thyristor/IGCT/SGCT/ multistage IGBT/IEGT based VFD system shall have minimum number of components to ensure very high reliability. The input side converter shall have 3-Phase Diode/Thyristor bridge configuration modular type and inverter shall be of 3-Phase Thyristor/IGCT/SGCT/multi stage IGBT/IEGT type, using Pulse Width Modulation or better technique for generating near sine wave output to motor.
6.16.00	Fiber optic cable connection shall be provided preferably to ensure high network reliability.
7.00.00	**VFD COMPATIBILITY WITH THE MOTOR**
7.01.00	MV VFD output current waveform, as measured at the motor, shall be inherently sinusoidal at nominal loads, with a total harmonic current and voltage distortion within acceptable/standard limits. VFD with transformers on output side are not acceptable.

7.02.00	The system design shall not have any inherent output harmonic resonance in the operating speed range.
7.03.00	VFD shall provide stable operation of motor from high-voltage dv/dt stress, regardless of cable length to motor. The vendor shall clearly state the limitations in the motor cable distance in his proposal. However, due to system requirements & constraints if the cable length becomes critical, filters/ chokes etc. shall be provided by the VFD manufacturers as an integral part of the VFD to mitigate the reflected wave effect of harmonics.
8.00.00	**BYPASS ARRANGEMENT (OPTIONAL, IF SPECIFIED)**
8.01.00	The VFD System shall have an optional feature to run the motor under bypass arrangement for operation of Motor with VFD bypassed. During starting (under rated conditions) the motor will be switched on in VFD Mode to limit the starting current and after gaining speed, the load would be switched over to bypass mode.
8.02.00	Comprehensive motor protection scheme for protection and control for operation VFD during bypass mode shall be finalized during detailed engineering.
9.00.00	**STANDBY VFD ARRANGEMENT (OPTIONAL, IF SPECIFIED)**
9.01.00	A Common standby arrangement with auto/manual switchover shall be provided in case of failure of any VFD in a group of drives. Complete protection, interlocks & control required shall be provided in the changeover module.
10.00.00	**EFFICIENCY**
10.01.00	Efficiency (Drive only) shall be minimum 98% for both MV VFD and LV VFD. Overall efficiency shall be minimum 96.5% for LV VFD and minimum 94 % for MV VFD at rated load and speed. Overall Efficiency evaluation shall include input transformer, harmonic filters and power factor correction (if applicable), VFD converters, cooling fans and output filter, as applicable in the system. Auxiliary controls, such as internal VFD control boards, cooling fans/pumps.
10.02.00	In absence of valid test report, a factory test shall be performed at the VFD manufacturer's facility verifying the efficiencies. Manufactures who are supplying Drive and transformer from different locations, efficiency test will be conducted separately for Drive and transformer.
11.00.00	**COOLING SYSTEM**
11.01.00	The VFD shall be designed to operate indoor under temperature range of 0 deg C to 50 deg C and relative humidity of 95 %(at 40 deg C).
11.02.00	VFD manufacturer to primarily offer Air cooled Design. However in case of large ratings, liquid cooled drives may be accepted subject to employer's approval. In case of liquid cooled system, there shall be no necessity of continuous water supply system (Closed Loop System).
11.03.00	In case of Air cooled design, the VFD Cooling system shall be such that it puts minimum heat load inside the room and preferably throw the hot air outside the room with ventilation ducts. The Cooling system shall be designed in such a way that the Air Conditioning & Ventilation Air requirements are kept to minimum. The VFD

	Manufacturer shall furnish the data regarding heat load, air flow requirements during the detailed engineering.
11.04.00	Air cooled VFDs shall be provided with cooling fans mounted integral to the VFD/ enclosure. The VFD shall include air-flow pressure switches and temperature detectors to monitor proper operation of the air cooling system. If the fan fails, the system must generate the alarm/trip for the fan failure.
12.00.00	**TRANSFORMER:**
12.01.00	Type: Outdoor Mineral oil filled ONAN type or Indoor natural air-cooled Dry type, Three phase unit, rectifier/converter duty type transformer.
12.02.00	All other components, technical parameters shall be as per applicable IEC/IS.
12.03.00	Enclosure for Dry Type Transformer (as applicable)
	Enclosure shall be of a tested quality sheet steel of minimum thickness 2 mm & shall also accommodate cable terminations. The housing door shall be interlocked such that it should be possible to open the door only when transformer is off. The enclosure shall be provided with lifting lugs and other hardware for floor mounting.
12.04.00	Core — Shall be High grade non-ageing cold rolled grain oriented silicon steel Laminations.
12.05.00	Winding conductor — Shall be electrolytic grade copper. Windings shall be of class F insulation.
12.06.00	Winding temperature Indicator (WTI) — Shall be Platinum resistance type temperature detector in each limb.
12.07.00	Thermistors — Shall be embedded in each limb with alarm and trip contacts for remote annunciation.
12.08.00	Temperature rise: Winding temperature rise shall be as per applicable IEC.
13.00.00	**POWER CONVERTER:**
13.01.00	The static power converter shall consist of a line side converter for operation as a rectifier and a load side power converter for operation as a fully controller inverter. Power converter shall be fast switching, most efficient and low loss type.
13.02.00	The converter shall be coordinated with the transformers. The converter shall be able to withstand a three phase short circuit current until interrupted by normal breaker operation.
13.03.00	Adequate short circuit and over voltage protection shall be provided for the converter and inverter system.
13.04.00	All power converter devices shall include protective devices, snubber networks and dv/dt networks as required.
13.05.00	The current rating of the converter's semi-conductor components shall not be less than 120% of the nominal current flowing through the elements at full load of the VFD

	through the whole speed range. If the parallel connection of semiconductor is applied, the above current rating shall not be less than 140% of the above values.
13.06.00	All power diodes shall be of silicon type with minimum VBO rating at 2.5 times the rated operating voltage.
13.07.00	The power converter circuit shall be designed so that motor can be powered at its full nameplate rating continuously without exceeding its rated temperature rise nor reducing its service factor due to harmonic currents generated by the inverter operation. The conversion devices and associated heat sinks shall be assembled such that individual devices can be replaced without requiring the use of any special precautions / tools.
13.08.00	The cooling system of the electronic components, if provided, shall be monitored and necessary alarms shall be provided to prevent any consequential damage to the power control devices.
14.00.00	**OUTPUT FILTER (AS APPLICABLE):**
14.01.00	Output/ dv/dt filter shall be provided, if required. It shall be an integral part of the VFD system and included within the VFD enclosure. It shall inherently protect motor from high voltage dv/dt stress.
15.00.00	**DC LINK CAPACITOR (AS APPLICABLE):**
15.01.00	Capacitor shall be of self-healing film or electrolytic type having high life time. The capacitor shall be an integral part of VFD system. DC link Capacitors shall have discharge resistors which shall be capable of reducing the residual charges to zero just after the capacitor is disconnected from the supply source. The capacitor shall be suitable for high ripple currents.
16.00.00	AC/**DC Reactor (As applicable)** 1) Type: Dry type, air cored, self cooled, indoor type. Suitable for withstanding earth fault continuously. 2) Insulation: Thermal Class 155(F), temperature rise is limited to thermal class 130 (B). 3) Noise level shall not exceed value specified in NEMA TR-1.
17.00.00	**VFD PANEL REQUIREMENTS**
17.01.00	Enclosure frames and load bearing members shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness 2.0 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness 1.6 mm. Doors and covers shall also be of cold rolled sheet steel of thickness 1.6 mm. Stiffeners shall be provided wherever necessary. The gland plate thickness shall be 3.0 mm for hot / cold-rolled sheet steel and 4.0 mm for non-magnetic material. In case dry type transformer is provided inside VFD panels, the enclosure and in its frame thickness shall be same as indicated in this para.
17.02.00	The cable entry shall be from the bottom of the panel and a removable bolted un-drilled gland plate.
17.03.00	All Panels shall be of dust-proof and vermin-proof construction and shall be provided with a degree of protection of IP: 3X or better for MV VFD and IP: 4X or better for LV VFD as per IS/IEC 60947

17.04.00 Enclosures must be designed to avoid harmonic and inductive heating effects and to shield any outside equipment from interference, enclosing and shielding the complete to eliminate any radio frequency interference. The construction of the panel shall provide effective protection against electromagnetic emissions.

17.05.00 Each panel shall be provided with illuminating lamp, space heater with switch fuse and variable setting thermostat.

17.06.00 Proper ventilation using air filters and fans/pumps shall be provided in the panels to ensure that maximum temperature inside the cubicle is within permissible limits for reliable and continuous operation of the system.

18.00.00 **PAINTING**

Paint shade shall be as follows

a) VFD transformer reactor enclosure : RAL 5012 (Blue), legend in black letter

b) Motors : RAL 5012 (Blue)

c) VFD Panels : Front and rear panels in Grey (RAL9002). End panel sides in blue (RAL 5012)

19.00.00 **HT SWITCHGEAR**

19.01.00 The technical requirements of HT switchgear shall be as per chapter of HT switchgear in Part-B of Technical specifications.

20.00.00 **MOTORS**

20.01.00 VFD shall be used to drive three (3) phase squirrel cage inverter duty Induction motor with VPI insulation (Resin poor) suitable for VFD application. These motors shall be provided with insulated bearing on at least one side.

20.02.00 Motors shall also meet the requirements mentioned in subsection for motors and relevant IS/IEC.

20.03.00 Motor shall be suitable for operation with a solid state power supply consisting of an adjustable frequency inverter for speed control & shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive.

20.04.00 Motor insulation shall be designed to accept the applied voltage waveform, within the Vpeak and dv/dt limits as per IEC-61800.

20.05.00 Drive manufacturer shall coordinate with the motor manufacturer for proper selection of the motor for the given load application and the output characteristics of the drive.

20.06.00 Other requirements of motor shall be as stipulated in technical chapter of Motors in Part-B of technical specifications.

21.00.00 **LT & HT CABLES**

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21.01.00 Contractor’s scope shall also include LT and HT cables suitable for VFD system and Motors.

22.00.00 **CONTROL AND PERFORMANCE REQUIREMENTS**

CLAUSE NO.	`` VARIABLE FREQUENCY DRIVES
22.01.00	The VFD to provide an automatic current limiting feature to control motor currents during startup and provide a “soft start” torque profile for the motor load combination. Current and torque limit adjustments shall be provided to limit the maximum VFD output current and the maximum torque produced by the motor.
22.02.00	It shall be possible to vary the speed of the drive and control it in either Local or Remote mode. Local / Remote selection shall be done from VFD panel unless otherwise specified.
22.03.00	Provision shall be kept for exchange of information between different VFD control system parameters thru PLC/DDCMIS. Man machine interface for (MV) VFD shall have one flat TFT monitor with keyboard (password protected) in the VFD room and a color laser printer for system alarm and monitoring located in control room. Parameter Monitoring: -Input and output voltage of Drive - Input and output current of Drive - Motor speed - Input and output power frequency of Drive - Torque -Input and Output power of Drive system (covering transformer if applicable) - Output kWhr of Drive - Transformer (if applicable) temperature for alarm & trip. - Ambient temperature - Run/stop and local/remote status displayed
22.04.00	Drive shall be equipped with a front mounted operator console panel consisting of a backlit alphanumeric display and a keypad with keys for parameterization and adjusting parameter. Control panel shall be operable with password for changing the protection setting, safety interlock etc.
22.05.00	Operator console/Main Control Card shall have facility / port to connect external hardware such as Lap-Top etc. Console shall have facility for upload and download of all parameter settings from one drive to another drive for start up and operation.
22.06.00	User-friendly licensed software for operation and fault diagnostic shall be loaded in the drive system panel before commissioning.
23.00.00	**PROTECTION FEATURES**
23.01.00	The system offered shall incorporate adequate protection features as per IEC 61800-4: 2002 Table-8, properly coordinated for the drive control and for motor including following: i) Converter transformer: short circuit, over current, earth fault & winding temperature high protection. ii) Incoming and outgoing line surge protection. iii) Under / over voltage protection iv) Phase loss, phase reversal, overload, negative phase sequence, locked rotor protection.

	v) Instantaneous Over current & Earth fault protection
	vi) Converter/Inverter module failure indication.
	vii) Over frequency/speed protection.
	viii) Ventilation failure indication & alarm.
	ix) Over temperature of VFD
	x) Bearing temperature protection.
	xi) System earth fault protection.
	xii) Speed reference loss protection.
23.02.00	Under VFD Bypass Mode (if applicable) all the electrical protections related to the Motor shall remain applicable.
24.00.00	**CONTROL FEATURES**
24.01.00	Following controls shall be provided as a part of the Operator Control Panel or through separate switches on the front panel door.
	i) Start / stop (in local/remote mode)
	ii) Speed control (Raise / lower)
	iii) Acknowledge/Accept/ Test Push Button for annunciation
	iv) Auto / Manual / Test Mode select
	v) Emergency stop
	vi) Trip-Remote Breaker
25.00.00	**DIAGNOSTIC FEATURES**
25.01.00	The VFD shall include a microprocessor/PLC based digital diagnostic system which monitors its own control functions and displays faults and operating conditions.
25.02.00	Fault diagnostic shall be built into the system to supervise the operation and failure of the system. The information regarding failure of any of the system including shut down of the system shall be available. It shall be possible to retrieve the record of events prior to tripping of the system or de-energization. Auxiliary supply to the system components or to the electronics (firmware) for the diagnostics / display shall be taken care of by the manufacturer for this purpose.
26.00.00	**SERVICEABILITY / MAINTAINABILITY**
26.01.00	Power Component Accessibility: All power components in the converter sections shall be designed for rack-out accessibility for ease of maintenance and to minimize repair downtime.

26.02.00	Marking / Labeling: Sleeve type wire marker tags or other acceptable means of permanent identification shall be applied to power and control wiring. Individual labels shall be provided for all major components of the VFD system.
27.00.00	**STORAGE AND PRESERVATION**
27.01.00	The Contractor shall be responsible for the storage and preservation of all the equipments to be supplied under the VFD System, till the time of successful installation and commissioning. The equipment should be suitable for storage for long periods before installation. Contractor should take adequate measures to ensure that no damage happens to the VFD System due to storage and preservation.
28.00.00	**TESTS**
28.01.00	**ROUTINE TESTS**
	All acceptance and routine tests as envisaged in QA section shall be carried out. Charges for these shall be deemed to be included in the equipment price.
28.02.00	**TYPE TESTS**
28.02.01	The Contractor shall carry out the type tests as listed in this specification on the equipment to be supplied under this contract. The bidder shall indicate the charges for each of these type tests separately in the relevant schedule and the same shall be considered for the evaluation of the bids. The type tests charges shall be paid only for the test(s) actually conducted successfully under this contract and upon certification by the employer's engineer.
28.02.02	The type tests shall be carried out in presence of the employer's representative, for which minimum 15 days' notice shall be given by the Contractor. The Contractor shall obtain the employer's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set–up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.
28.02.03	In case the Contractor has conducted such specified type test(s) within last ten years as on the date of bid opening, he may submit during detailed engineering the type test reports to the Employer for waival of conductance of such test(s). These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. The Employer reserves the right to waive conducting of any or all the specified type test(s) under this contract. In case type tests are waived, the type test charges shall not be payable to the Contractor.
28.02.04	Further the Contractor shall only submit the reports of the type tests as listed in "LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED" and carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. However if the Contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the Contractor shall conduct all such tests under this contract at no additional cost to the Employer either at third party lab or in presence of client/Employers representative and submit the reports for approval.

28.03.00 **LIST OF TYPE TESTS TO BE CONDUCTED**

The following type tests shall be conducted under this contract for MV VFD

i) Overall efficiency determination of VFD system including transformer/ Harmonic filters etc at motor full load
ii) Temperature rise test
iii) Noise level
iv) Harmonics of No load current.(Input/Output)

28.04.00 **LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED**

The following type test reports shall be submitted for VFD Panels'

1) VFD panels (For LV VFD)

i. Rated Current/ Output
ii. Temperature rise test
iii. Noise level test
iv. Power Loss Determination Test
v. Power factor measurement.
vi. Degree of Protection Test
vii. EMC Test
viii. The Fast transient SWC tests as per ANSI / IEEE C37.901-2002 / IEC 60255-22-04-2008 / IEC 61800

2) VFD panels (For MV VFD)

i. Rated Current/ Output
ii. Current Sharing
iii. Voltage Division
iv. Power Loss Determination Test
v. Power factor measurement.
vi. Degree of Protection Test
vii. The Fast transient SWC tests as per ANSI / IEEE C37.901-2002 / IEC 60255-22-04-2008 / IEC 61800

3) AC/DC Reactor

i. Lightning impulse test(If applicable)
ii. Heat run test
iii. Short time current test(If applicable)
iv. Noise level test

4) Transformers (In case of non integrated type)

CLAUSE NO.	VARIABLE FREQUENCY DRIVES
	i. As per requirements mentioned in subsection for Transformer chapter in technical specifications.

SUB-SECTION-V-QE13

VFD MODULE

DRY TYPE TRANSFORMER

Attributes / Characteristics / Items/Components Sub Systems	Visual & Dimensional check	Mechanical properties	Electrical strength	Thermal Properties	Chemical Properties	NDT / DP / MPI	Voltage Ratio, Vector Group & Polarity	Make / Type / Rating / Model /TC / General Physical Inspection	WPS & PQR	Routine Test as per relevant standard	Measurement of capacitance & tan delta between winding	Routine Test
Enclosure door, H.V. & L.V. Cable Box / Flange Throat	Y	Y						Y				
Copper Conductor	Y	Y	Y		Y							
Insulating Material	Y			Y	Y							
CRGO Lamination & Built Core	Y											
Bushing /Insulator (IS:2544 / 5621)	Y							Y		Y		
Gasket	Y							Y		Y		
Off-Circuit Tap Changer	Y							Y				
Core Coil Assembly	Y						Y					
Marshalling Box	Y									Y		
WTI, Thermister, Terminal Connector	Y							Y				
Welding									Y			
Complete Transformer (IS:11171 / IEC 60076)	Y										Y	Y

Notes: 1) This is an indicative List of test/checks. The manufacturer is to furnish a detailed Quality Plan indicating his practice and procedure along with relevant supporting documents during QP finalization for all item.

2. All major Bought out Items will be subject to NTPC approval.

VFD PANEL

Attributes Characteristics / Item Components Sub System Assembly	Electrical Properties	Mechanical Properties	Chemical Properties	Dimensions / Finish	Type/ Rating/Functional check	HV/IR	Routine test as per relevant std.	Constructional Features	IS:6005 ,Seven tank process	Paint finish/ shade/thickness	Mountings / BOM/ Make, Completeness	Interlock Functional & Operation Testing / Simulation check	Degree of Protection Test	Final testing as per Relevant
Sheet Steel (IS-513)		Y	Y	Y										
Aluminum / Copper Bus-bar(IS-5082/IS-613/IS-1987)	Y	Y	Y	Y										
Support Insulator (BS-2782/IEC-660/IS-10912)	Y	Y	Y	Y										
Control / Selector Switch(IS-6875)					Y	Y	Y							
Contactor/ MCB(IS-13947)					Y	Y	Y							
O/L Protection relays(IS-3231)					Y		Y							
C.T /V.T/ Indicating Meter(IS-2705/3156/1248)					Y	Y	Y							
Fuse/ Fuse carrier(IS-13703)					Y	Y	Y							
Terminals/lugs/pvc wires(IS-13947//IS-694)	Y			Y	Y	Y	Y							
Timers(IS-3231)					Y	Y	Y							
Push Button/ Lamp/ (IS-6875)					Y	Y	Y							
Control Transformer (IS-12021)					Y	Y	Y							
Mimic, Annunciater					Y		Y							
GASKET(IS-11149)		Y	Y	Y	Y		Y							
Fabrication								Y						
Pretreatment & Painting									Y	Y				
VFD panel										Y	Y	Y	Y	Y

NOTE:

1. This is an indicative list of Test/ Checks. The manufacturer to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. All major Bought Out Items will be subject to NTPC approval.

REVISION HISTORY SHEET

REV. NO.	DATE	NATURE OF CHANGE	REASONS	PREPARED BY	APPROVED BY
00	31-07-2020	FIRST ISSUE	------	GITESH DAS	L SUBBALAKSHMI

TECHNICAL SPECIFICATION OF IGBT/ IGCT/ SGCT BASED VFD FOR SQUIRREL CAGE INDUCTION MOTOR

1. Project Details

Sl. No.	Parameter	Specification
1	Project title	As per attached Annexure to Specification
2	Customer	

2. Environment Specifications

Sl. No.	Parameter	Specification
1	Maximum Ambient Temperature	As per attached Annexure to Specification
2	Minimum Ambient Temperature	
3	Equipment Design Temperature (IS-9676)	
4	Relative Humidity	
5	Altitude	
6	Location of VFD Panels	
7	Seismic Zone	
8	Environment	

3. Input and Transformer Data

Sl. No.	Parameter	Specification
1	System Voltage / Frequency / Phase	Refer attached Annexure to Specification
2	Voltage Variation	
3	Frequency Variation	
4	Combined Voltage and Frequency Variation	
5	Fault Level	
6	Transformer Type	
7	Rating	Transformer must be designed to carry 110% current of calculated VFD rating. Transformer sizing calculation shall be provided along with offer.
8	Power Cables	1. Cable glands (Weatherproof) to be provided by the vendor for Transformer HV side cable termination suitable for Cable size mentioned in Annexure to Specification. The exact no. and size will be intimated during drawing approval stage. Cables and termination kits are in Customer /BHEL scope. 2. All interconnecting cables and cable lugs for VFD panel to Transformer connection to be provided by vendor. Refer attached Annexure to Specification for more details. For VFD with non-integrated Transformer, Power Cables between Transformer & VFD shall also consider adequate derating factor as these cables shall travel through trenches and trays. 3. For VFD panel with non-integrated type transformer, Cables glands and termination kits for connection between Transformer LV side and VFD input side termination shall also be supplied by the vendor.
9	Termination cubicle	Any special termination cubicle, supporting structures, etc. if required for non-integrated type VFD system shall also be supplied by the VFD vendor.

4. Motor Data

Sl. No.	Parameter	Specification
1	Type	Squirrel Cage Induction Motor
2	Scope	Manufactured by BHEL-Bhopal
3	Rating (kW)	Refer attached Annexure to Specification
4	Rated Voltage and Current	Refer attached Annexure to Specification
5	Fed from	Variable Frequency Drive (V/f Control)
6	Duty Class	Continuous - S1
7	Efficiency and Power Factor	Refer attached Annexure to Specification
8	Power Cables	Cable glands (Weatherproof) to be provided by the vendor for VFD Output side cable termination suitable for cable sizes mentioned in the attached Annexure. The exact no. and size will be intimated during drawing approval stage. Cables and termination kits are in Customer /BHEL scope.

5. Scope:

Sl. No.	Scope of Supply	Description
1	Refer Consolidated Scope of Supply and Services in attached Annexure for details.	The vendor shall be responsible for engineering and functioning of the complete VFD system comprising of Dry type Transformer and VFD panel, meeting the intent and requirement of this specification, Customer specification and datasheet. This shall include but not be limited to inverter sizing, transformer sizing, transformer impedance selection, vector group, input and output harmonic filter design and sizing, output dv/dt filter sizing, adequacy of motor cable size selected by BHEL etc. All necessary interlocks as required for safe and reliable operation of VFD system along with Input breaker shall be provided in VFD system. If any special arrangement is required in input breaker, same shall be informed by the vendor in offer. The machine shall continuously run on VFD.
2	a) All interconnecting cables between VFD panel and Transformer panel both for integrated type VFD system and non- Integrated type VFD system. b) Any special cable other than power and control cables from VFD to other equipment. c) Power Cable glands, lugs and hardwares for VFD and transformer. d) Any special tools and tackles.	

6. VFD Specifications:

Sl.No.	Parameter	Specification
1	Drive Application	Refer attached Annexure to Specification
2	Input Voltage	From Dry type Transformer.
3	Power/Torque vs Speed	Torque α Speed^2 , Power α Speed^3
4	Single Line Diagram	Refer attached Annexure to Specification
5	Output Voltage of VFD	
6	Output Current of VFD	
7	Output Frequency	0 to 50Hz , Resolution: +/- 0.01% under transient conditions; +/- 0.5% under steady state conditions
8	Overload capacity	Refer attached Annexure to Specification
9	Speed Regulation & Speed Accuracy	+ 0.5% +1%
10	Drive Control	Sensorless Vector Control
11	Braking Operation	Not Applicable
12	Output LC Sinusoidal Filter	Motor is designed for PWM operation. Distance between VFD and Motor are as per Annexure attached with Specification. Vendor to clarify and offer output Filter, if required.

13	VFD Panel Construction	a) Protection Class: Please refer attached Annexure b) Panel: Free standing, floor mounting type, comprising of rigid welded structural frames with Cold Rolled Sheet Steel enclosure of minimum thickness 2 mm for load bearing and 1.6 mm for other members. All doors and removable covers shall have neoprene gaskets. Ventilating louvers shall have easily removable and washable dust filters. c) Busbar Material – Electrolytic grade Copper, colour coded. Sleeving/shrouding for safety purposes shall be done. d) Cooling: Forced Air Cooled VFD should be considered. Cooling system shall include well dimensioned panel, adequate cooling air flow path. Vendor shall ensure that the panel dimensions and flow paths have been designed for continuous running at the specified ambient without overheating. Suitable thermal switch for exit air temperature monitoring shall also be incorporated. e) Earth Bus – minimum 50*6 mm Copper. f) Door Interlock: The VFD shall have a door interlock for safety. This interlock system should ensure that none of the power cabinets can be opened until the main source of power is disconnected or will cause the main source of power to trip. Additionally the same interlock system should ensure that power cannot be initialized to the drive unless the doors are closed. Suitable shrouding mechanism shall be provided so that the DC capacitors cannot be touched till their voltage is zero. g) Painting: 2 Coats of Primer and 2 Coats of Finish Paint to be given for all surfaces of enclosure. Paint shall be Epoxy Based with Powder Coated Finish - shade RAL9002 front and rear panels, end panel sides RAL5012. Paint Thickness: 80 Microns (minimum). Exact paint shade will be confirmed during drawing approval stage. h) Power and Control Wiring shall be done with Fire retardant (FRLS) cables. i) Double compression type Nickel plated brass cable glands shall be supplied. Height of the terminal from cable gland plate shall be adequate to take care of the cable sizes and quantity mentioned. Minimum space for the power cable termination shall be 600mm clear from the cable gland plate. Cable entry will be from bottom only. Gland Plates shall be blank (undrilled) – to be drilled at site. The gland plate thickness shall be 3.0 mm

13	VFD Panel Construction	for hot / cold-rolled sheet steel and 4.0 mm for non-magnetic material. Gland plate shall be of sufficient strength to handle all the cables. j) All electronic modules and components shall be accessible from front of panel only. Modular assemblies for both the system control electronic equipment and power electronic equipments shall be used. k) All low voltage compartment and cabling shall be electrically and physically separated from the high voltage compartment. l) 20% spare terminals shall be provided for future use.
14	Noise Level	Shall be less than 85dB at a distance of 1 metre from the outline of VFD Panels at a height of 1.5 metres from the floor with all the fans running in the VFD Panels.
15	Storage Temp.	-40°C to +60 °C
16	Vibration	According to IEC68-2-6
17	Interference	According to IEC801 parts 2,3,4 Immunity: The panels shall be designed so as to have low Radio Freq Interference (RFI) & Electromagnetic Interference (EMI).
18	VFD Efficiency	Shall be as per NTPC VFD specification. Exact value to be specified by the Vendor in Datasheet.
19	Duty Cycle	Class I Duty Cycle as per IEC 146-1
20	VFD Requirements	a) Input Choke: Input chokes to be provided, if necessary. b) Local/Remote: Selector switch shall be provided for operator to select type of operation: ➢ Local – Operation from VFD Panel for Speed Control from door mounted interface; ➢ Remote – Operation from DCS. If VFD is set for speed reference from Remote, it shall be possible to program the VFD to either shutdown, go to minimum speed or continue operation at its last known speed reference point whenever a loss of speed reference is detected. c) Local Start/Stop Push Button to be provided either on Panel door or on keypad. d) Door Mounted Lockable Push-Button with cover to be provided with 2NO + 2 NC contact for Emergency Stop. One normally open and close contact to be wired to Terminal Block for external Interlocking / Annunciation. e) Every Panel shall be provided with illumination lamp with limit switch and MCB. Space heater shall be provided in panel with switch fuse and variable setting thermostat. 240V power socket with MCB shall be provided.

Sl. No.	Parameter	Specification
20	VFD Requirements	f) 230V, 1phase, 50Hz (exact rating during drawing approval stage) Power Supply to the motor space heater shall be derived from VFD. Necessary interlocking arrangement for this supply shall also be made available in the VFD panels. g) PLC: PLC shall be provided for Interlocking and Protection (if required) h) The expected life time of the drive system shall be minimum 20 years. The system including all individual components forming part of the system shall have an availability of minimum 0.997 and a minimum MTBF of 4 years. i) Any special requirement regarding CT/ PT, protection relay or any other device, in input breaker, which is required for functioning and protection of VFD system shall be considered by the VFD vendor in their scope.
21	VFD Features	a) Soft Start and Auto Restart b) Auto Speed Search Facility (Catch on Fly) shall be available for starting into rotating loads. c) Power loss ride through (Kinetic Buffering) and for voltage dips over 20% or Power interruption for less than 2 secs. d) Automatic VFD tuning during start-up. e) Flux optimisation function shall be provided to reduce the total energy consumption and noise level in case drive is operated below nominal load. f) Selectable reverse run prohibition g) Adjustable motor overload feature h) Settable minimum and maximum operating frequency i) VFD shall produce not greater than 1% torque pulsation to the shaft of driven equipment. j) Field adjustable Torque limits and acceleration and deceleration ramps k) Accelerate / Decelerate Times to be specified. l) Four (4) user programmable preset speeds. m) The equipment may be stored outdoors for long periods before installation.The packing should also be suitable for outdoor storage areas with heavy rains / high ambient temperatures. n) Vendor shall certify readiness of system fit for commissioning. Vendor's scope shall also include supply of all specialized tools and tackles required. o) VFDs shall be installed in Air-conditioned area but it shall be suitable for operation in non-air-conditioned area also. p) Earthing scheme should be provided by the vendor.

21	VFD Features	q) Any special cable other than power and control cables required to connect VFD to other equipment shall be in vendor scope. r) All electronic PCBs/Modules must have conformal coating to take care of site conditions.
22	Controls and monitoring	a) VFD shall be with an interactive and user-friendly door mounted digital operator interface with LCD display and sealed membrane type keypad. b) The operator interface shall be used for drive programming, drive monitoring and drive trouble shooting. The operator interface must also be able to start and stop the drive, reset VFD faults and manually adjust the VFD's speed reference. c) The operator interface shall have LED indicators for drive fault, drive run, and drive in current limit etc. d) The operator interface shall allow monitoring of inverter operating conditions including speed, current, voltage, torque, power etc. e) Messages shall be alphanumeric in nature. All the fault messages shall be in English. f) Provision shall be made available for remote operation. g) The operator interface shall be able to display all real time operating variables and all drive programming parameters. The operator interface shall be capable of displaying a specific user selected parameter on power-up. This power-up parameter would typically be a parameter that is important to the operator such as motor speed or motor load. h) The following Control signals must be provided: ➢ Local/Remote ➢ Emergency stop ➢ Trip/Close Input breaker These are indicative. Vendor to suggest the interlocking scheme using these and other outputs as required for the system during detailed Engineering. These Outputs shall be provided with individual relay having 3 changeover potential free contacts wired to terminal blocks. i) All VFD operating parameter shall be stored in nonvolatile memory. j) The drive shall have built in monitoring of following parameters as minimum on its digital operator interface and these parameter shall also be displayed at Plant DCS through Modbus link: i) Input & Output Frequency ii) Input & Output Current iii) Motor Speed iv) Input & Output Voltage v) DC Bus Voltage vi) Torque

22	Controls and monitoring	vii) Input & Output Power (It shall be possible to display power output of the drive in kW) viii) Digital Input Status ix) Digital Output Status x) Analog Input Status xi) Drive Thermal state xii) Output kWhr of Drive xiii) Hour run xiv) Transformer Temperature for alarm & trip l) Necessary transducer shall be provided with 4-20 mA output for indicating Motor Speed and Motor Current in the DCS. Transducers shall be capable of driving 500 ohms load. m) The following indications shall be provided on the VFD Panel Door/ Keypad: i) Motor Running/ VFD ON ii) Motor Stopped/Tripped iii) Local/Remote status iv) AC Mains ON v) Auxiliary Control Supply ON vi) VFD Ready vii) VFD Fault viii) External Fault ix) Emergency Stop Activated x) Motor Overspeed xi) Input Breaker Trip xii) Motor zero speed xiii) Rectifier output 'ON' xiv) Transformer winding temperature alarm & trip. n) The VFD shall store fault logs of minimum last 10 faults in memory. o) The interface details of VFD shall be incorporated as required for data communication with DCS system with serial interfaces with RS485 data links. Necessary hardware shall be included in the scope and the interface protocol (i.e. Modbus only) shall be provided.

22	Controls and Monitoring	The following Audio-visual annunciations must be provided. 1) Rectifier fuse failure / drive fault 2) Main AC failure 3) Inverter fuse failure / Drive fault 4) Inverter overload 5) Inverter high temperature / Drive fault 6) Cooling system failure 7) Motor failed to start / Drive fault 8) Transformer fault and alarm 9) Communication and measurement system unhealthy
23	Protection	Following protections shall be built in within the inverter and any other protection as required: a) Motor Overload / Over Torque b) Instantaneous Over current (This device shall monitor the peak output current continuously and shall provide instantaneous shutdown without component failure whenever its trip point is surpassed. The trip point must be greater than or equal to 110% of the VFD's rated full load output current) c) Ground Fault Protection d) Over Voltage/Under Voltage - VFD shall be able to withstand >20% dip in supply voltage for 2 secs without damage to semiconductors or fuses. e) Output Short Circuit f) Output Phase Loss, Phase reversal, Locked rotor protection g) Phase Sequence Protection h) Input Phase Loss/Single Phasing Preventer i) Over Speed/Over frequency of motor j) Heat sink over temperature/VFD Panel Temperature High Stall prevention (During acceleration, deceleration and constant speed operation) k) Loss of Cooling Fans (Ventilation failure Indication and Alarm) l) External faults like Transformer Fault and Alarm m) Incoming and outgoing Line surge protection n) Loss of Speed reference o) Inverter fault (Converter/Inverter module failure indication) p) The system shall be designed to deliver the motor input current and torque for the complete speed torque characteristics of the driven equipment.

23	Protection	q) If the motor load exceeds the limit, the drive shall automatically reduce the frequency and voltage to the motor to guard against overload. If load demands exceed the current limit for more than 1 min, the drive shall shut down to prevent over heating of the motor and damage to the drive. r) The drive shall trip in case the speed exceeds 110% of the maximum operational speed or reduces to 95% of the minimum operational speed for more than 10 seconds.(Speed ref loss protection) s) Fault diagnostic shall be built into the system to supervise the operation and failure of the system. The information regarding failure of any of the system including shut down of the system shall be available for a period of minimum 4 days after a shut down even though no supply available. t) Converter transformer: Short circuit, over current, Earth fault, and Winding temperature high protection.

Sl. No.	Parameter	Specification
24	Dry type Transformer (mounted in panel)	Dry type Transformer a) HV: Taps of ±5% in steps of 2.5% b) LV voltage: Multi secondary type. Number of secondaries and secondary voltage to be indicated by the vendor in technical offer. c) Class of insulation: F or higher. Temperature rise of the transformer shall be as per applicable IEC. d) Winding material : Electrolytic grade Copper **Protection**: RTDs to be provided in each limb for winding temperature measurement. Temperature scanner to be provided for winding temperature measurement of all limbs. Alarm and trip contacts required for annunciation for fault and tripping action. **Connection**: HV Incomer: Termination arrangement and Cable glands to be provided by the vendor. The exact number and sizes will be intimated during drawing approval stage. Cables in BHEL/Customer scope. LV Connection: Cables along with glands, Lugs for connection between LV secondaries and VFD to be supplied by the Vendor. This shall be used for testing of the VFD and later bunched in the panel during dispatch and the same shall be connected at site. Necessary connection and routing arrangements to be made at Vendor's works. For more details please refer Annexure attached with this Specification. In case of non-integrated transformer, Cable termination kits (if required) for LV connection between transformer and VFD shall also be supplied by vendor.

Sl. No.	Parameter	Specification
25	Type of Control:	Completely programmable by the user as: a) Flux vector control with speed feedback b) Flux vector control without speed feedback c) Scalar V/F. VFD shall be capable of maintaining motor speed within ±0.5% without the use of a motor mounted encoder or tachometer. The drive shall have programmable V/F patterns along with user definable custom V/F patterns.
26	Harmonic Limitations – Source	Shall be as per latest IEEE 519 Voltage harmonics: Vendor to inform the values with calculations during detailed engineering stage. Current harmonics: Vendor to inform the source side 5^{th}, 7^{th} & 11^{th} harmonics values with calculations during detailed engineering stage. Vendor to supply harmonic filters, if required, to filter the harmonics generated by VFD at input/ supply side. The above compliance shall be verified by the field measurements of harmonics at the PCC with and without VFDs operation as per NTPC Specification.
27	Harmonics at VFD Output / Motor Input	Shall be as per latest IEC 61800-4 Vendor to specify the maximum amount of voltage and current harmonics at the VFD Output / Motor Input terminals.
28	Switching frequency	To be specified by the vendor in Datasheet.
29	Auxiliary Supply	Refer attached Annexure to Specification

Sl. No.	Parameter	Specification
30	Testing and Quality Plan	a) Routine Tests shall be carried out on all Panels and transformer as per relevant standards and NTPC specifications. b) Type Test Certificates for similar equipment and rating supplied by the Vendor shall be submitted during detailed engineering. Refer clause no. 28.02.00, 28.03.00 & 28.04.00 (2) of NTPC Specification. If valid type test certificates for transformer and VFD panels are not available as per NTPC Specification, vendor shall conduct the type tests without any cost implication to BHEL/NTPC. c) During fabrication, the drive and Transformer shall be subject to inspection by BHEL/ Customer, or by an agency authorized by the BHEL/ Customer to assess the progress of work, as well as to ascertain that only quality raw material is used.
31	Inspection, Training and Commissioning Support	a) Final Inspection: BHEL / Customer representative will be present at manufacturer's works for witnessing of final testing for transformer and VFD. This is to be incorporated in the Quality Plan. No charges shall be applicable for witnessing of final tests. b) Training: Refer attached Annexure to Specification. c) Commissioning: Commissioning of all VFD Systems at site shall be in the scope of Vendor. Final Acceptance shall be based on successful completion of the same. d) Any replacement of failed/damaged items during commissioning shall be exclusively at Vendor's cost. e) Vendor is advised to stock necessary spares and ensure easy availability to facilitate trouble free commissioning.
32	Laptop & Software for Computer Interface	Laptops shall be installed with Latest Compatible Licensed Operating System. The software must be loaded in the laptops & supplied along with interconnecting cables and accessories required for interface with the drive. The software should be an easy to use commissioning tool for drives and shall be provided along with the system. The interface details of VFD shall be incorporated as required for data communication with DCS system with serial interfaces with RS485 data links. Necessary hardware shall be included in the scope and the interface protocol (Modbus only) shall be provided.

Sl. No.	Parameter	Specification
33	Maintenance	The procedure for maintenance of VFD panels and the schedule thereof shall be mentioned in the offer.
34	Spares	Please refer attached Annexure with this Specification.
35	Confirmations/Deviations to Specification	**Point-wise confirmation to this specification and NTPC Specification to be given along with offer**. Deviations, if any, shall be indicated separately. If there are no deviations to the specifications, supplier shall mention the same explicitly. A reply from vendor stating that "**Equipment will generally meet the specifications**" will not be accepted by BHEL. Clause-wise Confirmation / Clarifications of all Clauses in the Purchase Specifications 1 to 34 of Specification shall be furnished in the format below.

Point No.	Page No.	Confirmation / Clarification / Information / Deviation	Details	Remarks, if any

7. Documentation

Sl. No.	Parameter	Specification
1	Attached Documents	a) NTPC specification for VFD System and QA documents b) Motor Datasheet and Curves. c) Single Line Diagram d) "Annexure" to Specification for project specific data. e) Provenness Criteria : Refer "Annexure" attached with the Specification.
2	Technical Information required along with Offer	a) Dimensional Drawing of Panels along with minimum clearance to be maintained for effective cooling, and Weight b) Technical Catalogue of VFD System being offered. c) Reference list for similar rating VFDs giving the following: Model number, Application, Rating, Year of supply and commissioning. Provenness Criteria of Medium Voltage Variable Frequency Drive shall be used as qualifying criteria (if attached with this specification). d) Confirmation / Clarification / Information / Deviation List as per Point 35 in page no. 16. e) Confirmation / Clarification / Deviation List to NTPC Specifications and other documents in Sl No. (1) above. f) Design calculation for sizing of Transformer and VFD. g) Filled up Datasheet for VFD system
3	Information / Confirmations required along with offer	a) Supply of the VFD shall be by OEM only. The name of the country from which the drive is sourced and the location of the manufacturing plant should be mentioned in the offer. b) After Sales Service and Support shall be given by the Vendor for a minimum period of 15 (fifteen) years after commissioning. Address of the Sales and Service Representatives in India with complete contact details: Name/Telephone/Email are to be provided. c) Vendor shall give a notice of at least 1 year to the end user of the equipment and BHEL before phasing out the product / spares to enable the end user for placement of order for spares and services.

Sl. No.	Parameter	Specification
4	Technical (unpriced) and Commercial (priced) Bids – For Evaluation	Refer "Consolidated Scope of Supply & Services" in Annexure attached with this Specification for Unpriced and Priced Bids.
5	Information required for Customer / Consultant Approval (within 3 weeks from the date of Purchase Order)	a) Dimensional Drawing of Panels along with minimum clearance to be maintained for effective cooling, and Weight b) Schematic Diagram c) Bill of Materials for equipment to be supplied d) Feeder Requirements – UPS and 415V supply e) Losses at Rated Load (including Fans) f) Heat Loss for Air Conditioning System sizing g) Technical Catalogue of VFD System being offered h) Test Protocol and Quality Plan i) Type test certificates of similar or higher rating equipment j) Filled up Data sheet for VFD system and Transformer
6	Information Required along with Supply. Maintenance Manuals and Documentation	a) Erection, Commissioning and Maintenance Manuals along with Final Drawings and Documentation b) Test and Guarantee Certificates. c) Complete Bill of Material (item wise) for the equipment supplied. d) 1 no. CD ROM consisting all of the above.

VFD SYSTEM DATA SHEET

A	VFD Data	
1	Manufacturer	
2	Model No.	
3	Manufacturing Location	
4	Rating and Application	
5	Applicable codes /standards	
6	Speed reference	4-20 mA from DCS
7	Speed range	
8	Switching Frequency	
9	No. of Pulse	
10	Total number of Diodes/ IGBTs/ IGCTs	
11	Drive output Voltage	
12	Overload capability	
13	Inrush current 250% In for	
14	Combined efficiency (Transformer & Drive) at:	
	i) 100% Load	
	ii) 75% Load	
	iii) 50% Load	
	iii) 25% Load	
15	Overall power factor at:	
	i) 100% Load	
	ii) 75% Load	
	iii) 50% Load	
	iii) 25% Load	
16	Output voltage range and Accuracy	
17	Output Frequency range and Accuracy	
18	Type of Cooling	
19	Redundancy in Cooling	
20	Type of feedback for speed control	
21	Output Filter/ Choke:	
	i) Manufacturer	
	ii) Type/ Model No.	
	iii) Rated Current and Voltage	
22	Acceleration / Deceleration time	
23	Degree of protection	

24	VFD Panel Dimensions (Dimensional details inclusive of all panels shall be furnished)		
	i) Length (mm)		
	ii) Height (mm)		
	iii) Depth (mm)		
	iv) Weight (kg)		
25	Paint Shade		
26	Heat Load (kW)		
27	Auxiliary Power Requirement:	415V, 3ph, 4Wire	UPS supply
	i) KVA		
	ii) Voltage and Phase		
B	**Transformer Data**		
1	Manufacturer		
2	Manufacturing Location		
3	Type	Dry type Transformer	
4	Integrated / Non-Integrated		
5	Duty	Continuous (Converter Duty)	
6	Rating (Transformer must be designed to carry 110% current of calculated VFD rating.)		
7	Class of insulation and Temperature Rise		
8	Insulation level:		
	P. f withstand		
	i) HV Winding		
	ii) LV Winding		
	Impulse withstand		
	i) HV Winding		
	ii) LV Winding		
9	Fault Level on HV Side		
10	HV Voltage and Phase		
11	LV Voltage/ Current		
12	No. of LV Windings		
13	Rated Frequency	50Hz	
14	Impedance		
15	Cooling Type		
16	Winding Material	Electrolytic grade Copper	
17	Location of Tap Changer	HV Winding	
18	No. of Taps and Type		

19	Vector Group	
20	Neutral CT specification:	
	51G	
	64R	
	Vk	
	Im at Vk/2	
	RCT	
21	Cable Size/Type	
	i) HV Winding	
	ii) LV Winding	
22	No Load Loss	
	i) At 100% Voltage	
	ii) At 110% Voltage	
23	Full Load Copper loss at 75°C	
24	No Load Current	
	i) At 100% Voltage	
	ii) At 110% Voltage	
25	Efficiency at 75°C and unity power factor	
	i) At 100% of Full Load	
	ii) At 75% of Full Load	
	iii) At 50% of Full Load	
	iv) At 25% of Full Load	
26	Efficiency at 75°C and 0.8 power factor	
	i) At 100% of Full Load	
	ii) At 75% of Full Load	
	iii) At 50% of Full Load	
	iv) At 25% of Full Load	
27	Load at which maximum efficiency occurs	
28	Regulation at 75°C at full load	
	i) At 0.8 pf	
	ii) At UPF	
29	Dimensions	
	i) Length (mm)	
	ii) Height (mm)	
	iii) Depth (mm)	
	iv) Weight (kg)	
30	Degree of protection for enclosure.	
31	Paint Shade	
32	Heat Load (kW)	

ANNEXURE-2 TO PS/445/2636

1. Input Data

Sl. No.	Parameter	Specification
1	Project Title	Mauda FGD Project (2 x 500MW)
2	Customer	NTPC
3	Environmental Specifications :	
4	Drive Application	Slurry Re-Circulation (RC) Pump
5	System Voltage / Frequency / Phase	3.3kV / 50 Hz / 3-phase
6	Voltage Variation	± 6%
7	Frequency Variation	+3%, -5%
8	Fault Level at 3.3kV input side	40kA for 1 Sec.
9	Combined Voltage and Frequency Variation	10%
10	Output Voltage of VFD	0 to 3.3kV (V/f = Constant)
11	Overload capacity	The overload capacity shall be 110% of rated current for 1 minute at rated voltage.
12	Motor Rating	900kW, 3.3kV, 195 Amps, 1489 rpm
13	Motor Efficiency & Power Factor	95% & 0.85 respectively
14	VFD type	Fully Assembled Units of 3.3kV VFD Panels (IGBT/SGCT/IGCT), Air Cooled with Integrated Dry Type Transformer (DTT)
15	Transformer type	Dry type Integrated Transformer along with VFD. Cables between VFD and transformer shall be in VFD vendor's scope.
16	Degree of Protection	IP:3X or better
17	VFD Output Current	195 A at 50°C (Design Ambient)

Environmental Specifications :

Parameter	Specification
Max. Ambient temperature	50℃
Min. Ambient temperature	0℃
Equipment Design temperature	50℃
Relative Humidity	95% at 40℃
Altitude	Less than 1000m above mean sea level
Location of VFD Panels	Indoor, Ventillated Room with Air Conditioning
Seismic Zone	As per IS-1893-Zone-II
Environment	All cards/hardware of VFD panel shall be suitable for operation in harsh environmental conditions with respect to high temperature, humidity & dust.

18	Distance between VFD & Motor (approx.)	265 meters
19	Cable Sizes between : a) 3.3kV Swbd. & VFD Transformer b) VFD Transformer & VFD c) VFD & Motor	a) 2R x 03C x 150 Sq. mm, Al, XLPE b) In VFD Vendor's scope c) 2R x 03C x 150 Sq. mm, Al, XLPE
20	Auxiliary Supply	a) 230V UPS feeder will be provided by BHEL. KVA rating is to be given by the Vendor. Control supply for electronic modules has to be derived from the UPS. b) Auxiliary Supply – 415V, 3ϕ, 50Hz, 4 wire will be provided by BHEL. Feeder Power rating (short time & continuous) to be specified by the Vendor. c) Other supplies required by the VFD system to be generated internally within the VFD system.
21	Single Line Diagram	Refer Drg. No. 3-661-00-00975
22	Provenness Criteria	Provenness Criteria requirement of Medium Voltage Variable Frequency Drive (3.3 kV VFD) is attached. Vendor to furnish details in line with the document.
23	Mandatory Spares	HV Bushing/Insulator – 2 nos.; LV Bushing/Insulator – 2 nos.; WTI – 2 Nos.;
24	Training	Training for NTPC personnel for 20 Mandays at Manufacturer's works

2. Consolidated Scope of Supply and Services

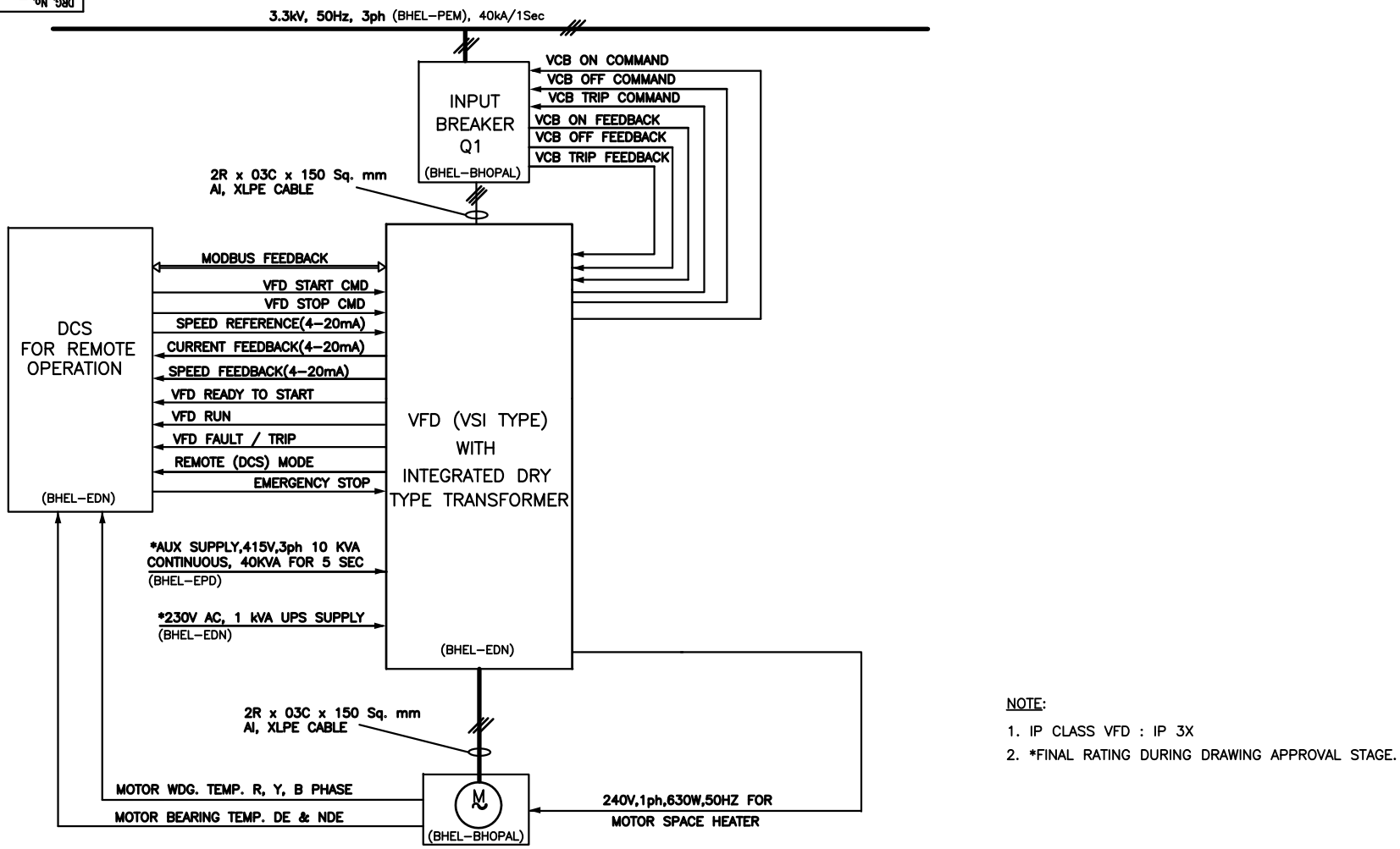
Sl. No.	Items For RC Pump Mauda	Quantity (Nos.)
1.	a) Fully Assembled Units of 3.3kV VFD Panels (IGBT/SGCT/IGCT), Air Cooled with integrated Dry type transformer, Termination cubicle, if required	2 Nos.
	b) Cable Accessories	01 Set
2.	Laptop loaded with Drive software	1 No.
3.	Mandatory Spares (optional price)*	01 Set
4.	Erection Supervision & Commissioning (Vendor to quote lumpsum commissioning charges for 12 days per Drive which shall be considered for bid evaluation) Payment shall be made for actual mandays consumed at Site with per day charges calculated on the basis of the lumpsum charges quoted above. Lumpsum charges quoted shall include travelling, boarding and lodging expenses.	02 Set
5.	N+1 redundancy of cooling fan for Transformer cubicle with auto c/o arrangement (optional price)*	2 nos.

* : Optional prices shall be considered for bid evaluation.

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG. No. 3-661-00-00975



3.3kV, 900 KW 50HZ,
SQUIRREL CAGE INDUCTION MOTOR

NOTE:

1. IP CLASS VFD : IP 3X
2. *FINAL RATING DURING DRAWING APPROVAL STAGE.

PROJECT- MAUDA FGD PROJECT STAGE-I (2x500MW)

CUSTOMER- NTPC

REV.	DATE	ALTERED / CHECKED / APPROVED	REV.	DATE	ALTERED / CHECKED / APPROVED

	NAME	SIGN	DATE
DRAWN	GD		30.06.20
CHECKED	LSL		30.06.20
APPROVED	LSL		30.06.20

DISTRIBUTION OF PRINTS — DEPT. — CODE

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

CARD CODE

TITLE:
SINGLE LINE DIAGRAM – VFD FOR RC PUMP
NTPC DRG. NO. 9561-109-EDN-PVI-W-703

No. OF SHEETS	01
SHEET No.	01
REV	00

M.O. No.	CE/1481	AS PER OPEN TOLERANCE TO ED 0230499	DRG. No. 3-661-00-00975

REF. DRG. No.

SIGN. & DATE

INVENTORY No.

FORM No. A3-03

A3 SIZE

CUSTOMER	**M/s NTPC**	**INSPECTION BY**	**NTPC**
PROJECT	**MOUDA FGD**	**WO NO.**	**48200A40131& 48200A40132**
TD Date	**29.04.20**	**NTPC DOC NO.**	**9561-109-BPL-PVE-Y-678**

Note 1: Data given below is subject to tolerance as per IS/IEC:60034-1 unless specified otherwise as '*' for which the data is guaranteed.

1. GENERAL	**1.**
(i) Manufacturer	(i) BHEL, BHOPAL
(ii) Equipment driven by motor	(ii) RC PUMP
(iii) Motor type	(iii) SCIM
(iv) Country of origin	(iv) INDIA
(v) Quantity	(v) 08 Nos TOTAL. (04 NOS FOR EACH UNIT)
2. DESIGN AND PERFORMANCE DATA	**2.**
(i) Frame Size	(i) 1LA7636-4
(ii) Type of duty **Note : These motors are suitable both for DOL & VFD operation/start.**	(ii) CONTINUOUS
(iii) Type of enclosure, Method of Cooling, Degree of Protection	(iii) TETV/IC511/IP55 AS PER CL. 10 OF IEC: 60034-5
(iv) Applicable standard to which motor generally conforms	(iv) IS/IEC:60034-1
(v) Type of mounting	(v) Horizontal (B3)
(vi) Direction of rotation viewed from driving end.	(vi) CW (BI-DIRECTIONAL)
(vii) Standard continuous rating at 40deg.C ambient temp.(KW)	(vii) 962
(viii) (a) Derated rating for specified normal condition i.e., ambient temperature of 50 Deg.C (KW)	(viii) 900
(b) Continuous maximum mechanical power requirement	(viii)(b) 810
(ix) Rated voltage (Volts)/ Rated Frequency (Hz)	(ix) 3300 / 50
(x) Permissible variation of	(x)
(a) Voltage (%)	(a) ± 6
(b) Frequency (%)	(b) + 3 - 5
(c) Combined voltage and frequency	(c) 10 % (Abs.)
(xi) Minimum permissible starting voltage (%)	(xi) 85
(xii) Rated speed at rated voltage and frequency (r.p.m.)	(xii) 1489

(xiii) At rated voltage and frequency	(xiii)
(a) Full load current (Amp)	(a) 195
(b) No load current (Amp)	(b) 57
(xiv) Power Factor at	(xiv)
(a) 100% load	(a) 0.85
(b) 75% load	(b) 0.80
(c) 50% load	(c) 0.72
(d) No load	(d) 0.040
(e) Starting	(e) 0.16
(xv) Efficiency (%) at rated voltage and frequency at	(xv)
(a) 100% load	(a) 95.0
(b) 75% load	(b) 94.0
(c) 50% load	(c) 93.0
(xvi) Starting current (%) at	(xvi)
(a) Rated Voltage	(a) 720 % (Maximum)
(b) Minimum starting Voltage	(b) 612 (Maximum) AT 85 % RV
(xvii) Starting time with minm. Permissible voltage	(xvii)
(a) Without driven equipment coupled	(a) 2.35 Sec
(b) With driven equipment coupled	(b) 11.4 Sec
(xviii)Safe stall time with 100 % rated voltage	(xviii)
(a) From hot condition	(a) 17 Sec
(b) From cold condition	(b) 22 Sec
(xix) Torque at (in % / kg-m)	(xix)
(a) Starting (at minimum permissible voltage)	(a) 53 % / 311.64 kg-m
(b) Pull up at 100% Voltage	(b) 67 % / 393.96 kg-m
(c) Pull out at 100% Voltage	(c) 210 % / **1234.8 kg-m**
(d) Rated load (kg-m) at 100 % Voltage	(d) 588 kg-m
(e) Mínimum Accelerating Torque (Kg-m) at 85 % RV	(e) 26 % / 152.88 kg-m
(xx) Stator winding resistance per phase (ohms) ref. to 20 deg.C.	(xx) 0.05891 +/-5%
(xxi) Flywheel Moment of motor (Kg-m2) (GD2)	(xxi) 124 kg-m²
(xxii) No. of permissible starts from Hot/ Cold condition	(xxii) 2 / 3
(xxiii)Locked Rotor KVA Input (at Rated Voltage)	(xxiii) 8024.93
(xxiv)Locked Rotor kVA / Rated kW	(xxiv) 8.92(maximum)

(xxv) Vibration at No Load (Brg.Housing)	(xxv)
(a) Velocity (mm/s)	(a) 2.3 (rms)
(b) Displacement (Microns)	(b) 37 (p-p)
(xxvi)Noise Level at No Load	(xxvi) 85 dBA at 1.0 metre.
3. CONSTRUCTIONAL FEATURES	3.
(i) Stator winding Insulation	(i)
(a) Class & type	(a) F/EPOXY MICA RESSIN POOR (VPI)
(b) Tropicalised (Yes/No)	(b) YES
(c) Temperature rise over specified ambient of 50 deg C (deg C)	(c) 70
(d) Method of temp. Measurement	(d) BY RESISTANCE
(e) Stator winding connection	(e) STAR
(f) No. of terminals brought out	(f) 6
(ii) Type of terminal box for	(ii)
(a) Stator leads	(a) PHASE SEPARATED T.B.
(b) Space heater	(b) CAST / FABRICATED
(c) Temperature detectors	(c) CAST / FABRICATED
(d) Instrument switches etc.	(d) NIL
(iii) For main terminal box	(iii)
(a) Location (from DE)	(a) RHS
(b) Entry of cables	(b) BOTTOM OF TB
(c) Recommended cable size (Runs/cores/x-section mm^2/ material)	(c) 1R X 3C X 150 Sq.mm.
(d) Fault level (MVA)/ Duration (Sec)	(d) 250 / 0.25
(iv)For Bearing	(iv)
(a) Type	(a) ANTIFRICTION
(b) Manufacturer	(b) NTPC APPVD. SUPPLIER
(c) Recommended lubricant	(c) IOC SERVOGEM-3/EQV. GREASE
(d) Guaranteed Life in Hrs.	(d) 40000 Hrs.
(e) Lubrication Type	(e) SELF
(f) Whether Dial Type Thermometer Provided	(f) YES
(v)Type of cooler (CACA/CACW)	(v) NA
(vi)Cooling water requirement for CACW motors	(vi)
(a) Quantity required	(a) NA
(b) Maximum permissible inlet water temperature (deg C)	(b) NA
(c) Pressure of water at inlet to coolers	(c) NA
(d) Outlet temperature of water at full load (anticipated value)	(d) NA
(vii)Weight of	(vii)
(a) Motor Stator (Kg)	(a) 4550
(b) Motor rotor (Kg)	(b) 1100
(c) Cooler (Kg)	(c) NA
(d) Total weight (Kg)	(d) 5650
(ix) Max. Perm. Temp. of Rotor	(ix) 350 Deg. C
(x) Total Temp. of Rotor during I Start	(x) 124 Deg. C
(xi) Total Temp. of Rotor during II Start	(xi) 132 Deg. C
(xii) Surge Withstand Voltage (Stator winding)	(xii) As per IEC:60034-15
(a) 0.3/ 3 Microsecond Surge (kVp)	(a) 11.8
(b) 1.2/ 50 Microsecond Surge (kVp)	(b) 18.2

4.00 LIST OF ACCESSORIES

4.01 RTDs for winding (Type/Nos/Leads /location/make/Res. at 0 Deg.C)	: PT100 SIMPLEX / 12 / 3 Between Coil Sides in slots/ Reputed NTPC Appvd./ 100 Ohms
4.02 RTDs for bearing (Type/Nos./Leads /location/make/Res. at 0 Deg.C)	: PT100 DUPLEX/ 3 nos per bearing side / 4 In Bearing Housing/ Reputed NTPC Appvd./ 100 Ohms
4.03.01 RTDs for Hot Air (Type/No/Leads)	: NA
4.03.02 RTDs for Cold Air (Type/No/Leads)	: NA
4.04 Space Heaters	: YES
4.04.01 Nos.	: 4 nos of 630W each.
4.04.02 Power (Watts)	: 630 W
4.04.03 Supply Voltage	: 1 PH. 240VAC
4.04.04 Location	: In Air pockets
4.05 Stator Terminal Box	
4.05.01 Type	: PHASE SEPARATED T.B.
4.05.02 Fault Level (MVA)	: 250
4.05.03 Fault Level duration (sec)	: 0.25
4.06 Neutral TB	: PHASE SEPARATED T.B.
4.07 Current Transformers	: NA
4.07.01 Nos.	: --
4.07.02 Ratio	: --
4.07.03 Accuracy Class	: --
4.07.04 Vk (V)/Rct	: --
4.07.05 Exciting Current	: --
4.08 Dial Type Thermometer (Type/make: Mercury in Steel/ NTPC Appvd/ Accuracy/ Connection Type & size	+ - 1% Full Scale / BSP 3/4"
4.08.01For Bearings (Nos.)	: NA
4.08.02For Air Temp (Nos.) a. Hot Air	: NA
b. Cold Air	: NA
4.08.03Contact Rating	: 5 A AT 240 V AC/ 0. 5 A AT 220 V DC.
4.08.04Range	: 0 -120 Deg. C.
4.08.05Supply Voltage	: 240 V, 50 Hz, 1 Phase
4.09 Rotor Terminal Box	: NA
4.10 TBs for RTDs, BTDs & Space Heater	: YES
4.11 Sole Plate	: NO
4.12 Anchoring items	: YES (As per OGA)
4.13 Base Frame	: NO
4.14 Speed Switch	: NO
4.14.01 Supply Voltage	: NA

4.15	Insulation of Bearing	: YES AT NDE SIDE.
4.16	Forced Oil lubrication	: NA
4.17	Oil level Indicator	: NA
4.18	Noise Reducer	: NO
4.19	Water flow Indicator	: NA
4.19.01	No/Contact Rating	: NA
4.20	Water leakage detector	: NA
4.21	Tachogenerator	: NA
4.22	Grounding Pads	
4.22.01	No & Size on motor body	: 2
4.22.02	Nos on Terminal Box	: 2
4.23	Vibration Pads	: YES
4.23.01	Nos & Size	: 04 (Total) , 60 mm cube
4.23.02	Location	: On DE and NDE endshield.
4.24	Paint Shade	: RAL 5012
4.25	Any other fitments	: EARTH BRUSH AT DE.
4.26	External Thrust on Motor	: NA

5.00 LIST OF CURVES

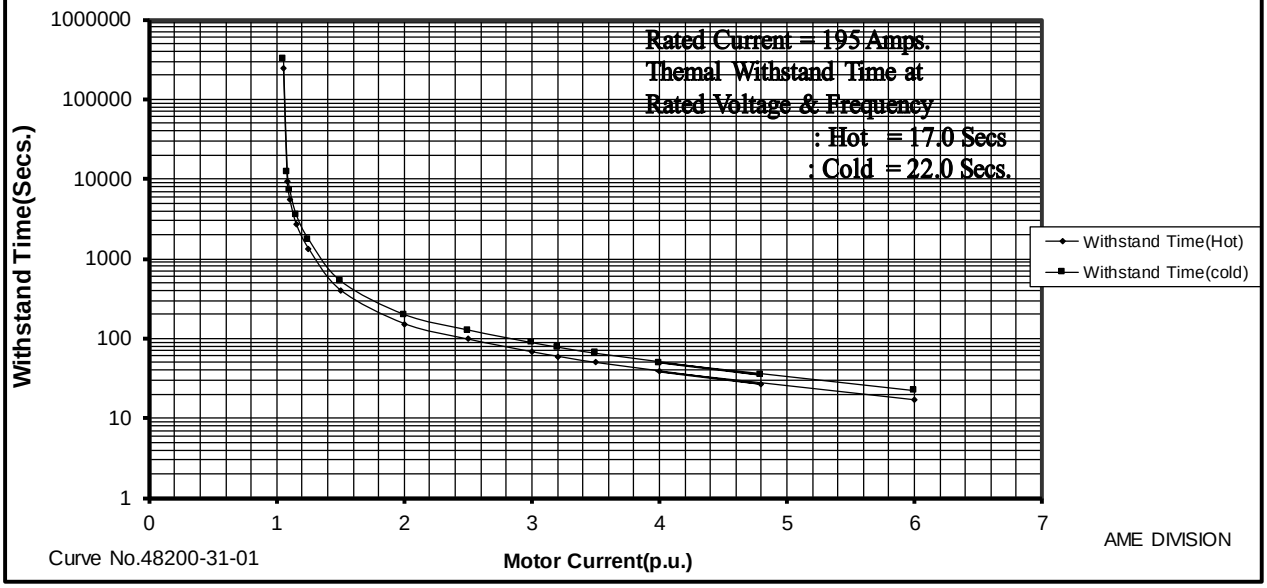
5.01	Thermal Withstand Characteristics	: 48200-31 /01
5.02	Torque Vs Speed Curves	: 48200-31 /02
5.03	Current Vs Speed Curves	: 48200-31 /02
5.04	Current Vs Time curves	: 48200-31 /03
5.05	Speed Vs Time curves	: 48200-31 /03
5.06	Efficiency & PF Vs Load Curves	: 48200-31 /04
5.07	Negative sequence curve	: 48200-31 /05
5.08	Calibration curve for RTD/BTD	: 48200-31 /06

PREPARED BY:

(B N Jena)
AME
BHEL-BHOPAL

Thermal Withstand Curves

Rating : 900 KW, 3.3 kV, 4P , Cage Rotor Induction Motor.
W.O.No. : 48200A40131 & 32
Frame : 1LA7636-4
Customer : M/S NTPC



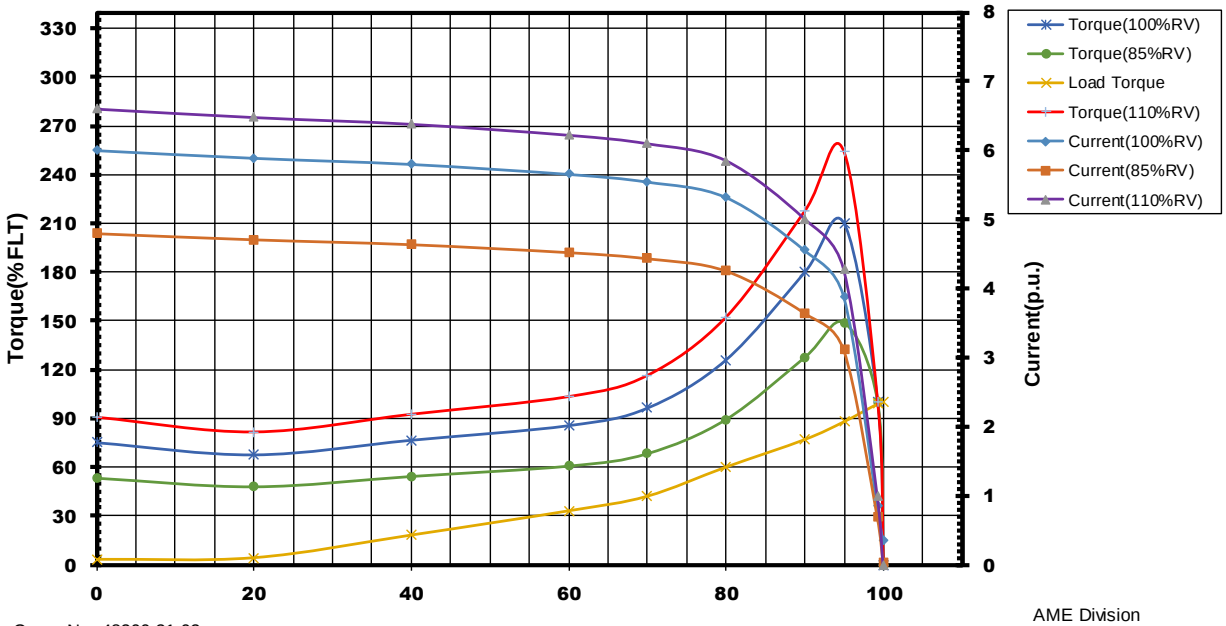
Curve No.48200-31-01

AME DIVISION

Torque & Current Vs Speed Curves

Rating : 900 KW, 3.3 kV, 4P , Cage Rotor Induction Motor.
W.O.No. : 48200A40131 & 32
Frame : 1LA7636-4
Customer : M/S NTPC

Rated Torque = 588 kg-m
Rated Current = 195 A



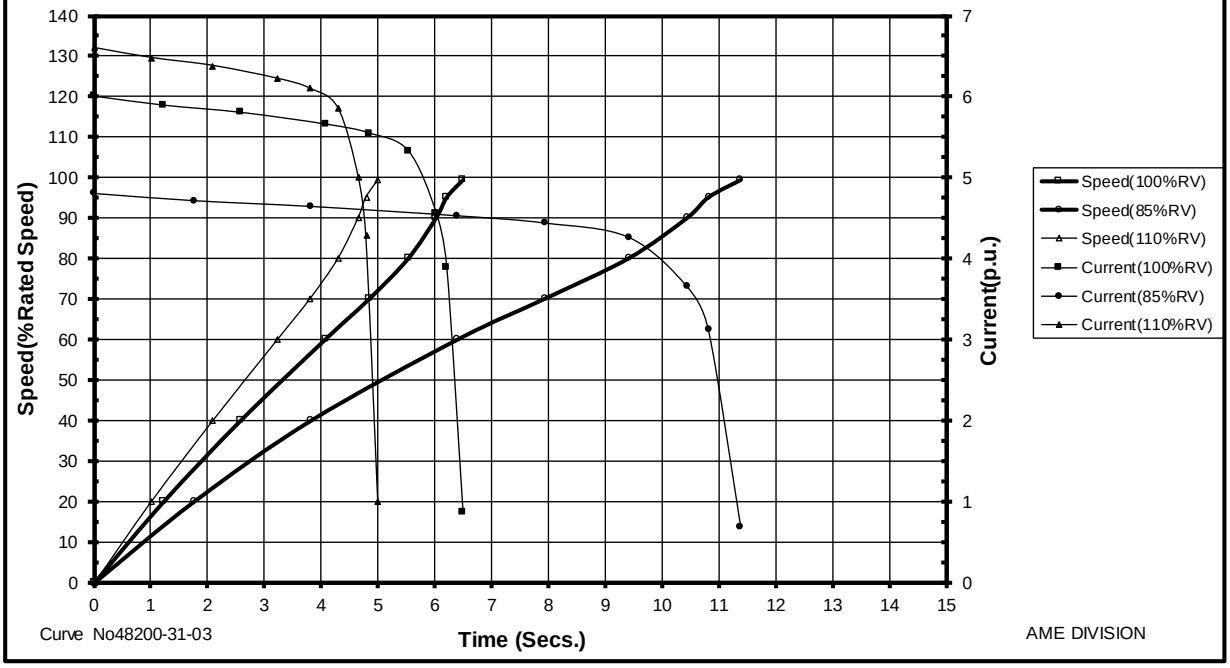
Curve No. 48200-31-02

AME Division

Speed & Current Vs Time Curves

Rating : 900 KW, 3.3 kV, 4P , Cage Rotor Induction Motor.
W.O.No. : 48200A40131 & 32
Frame : 1LA7636-4
Customer : M/S NTPC

Rated Speed = 1489 RPM.
Rated Current = 195 Amps.

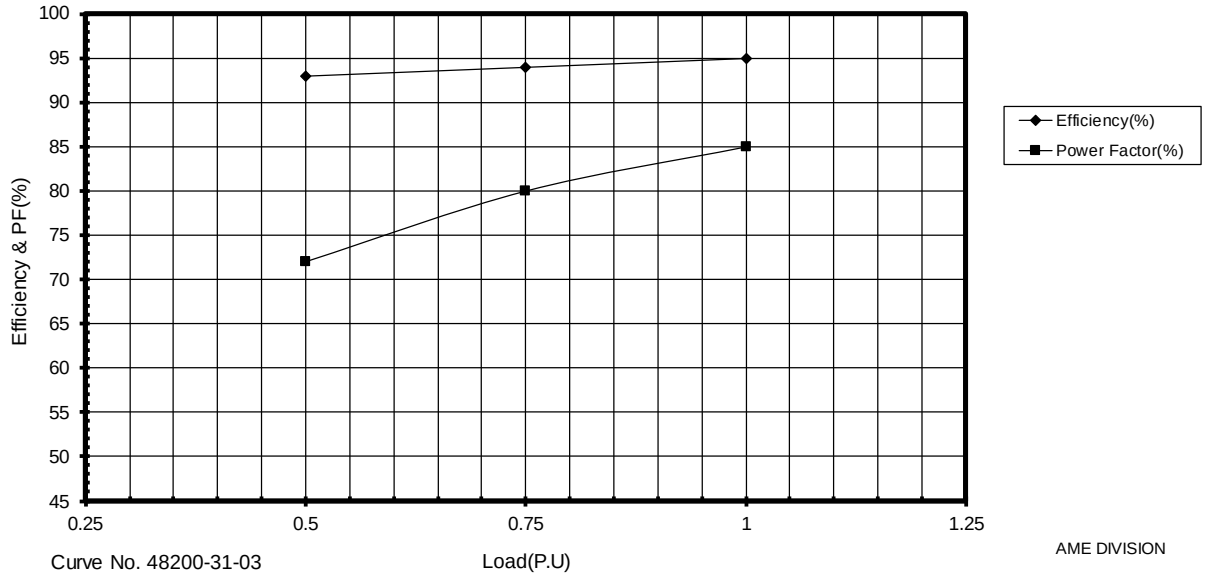


Curve No48200-31-03

AME DIVISION

Efficiency, PF Vs Load Curves

Rating : 900 KW, 3.3 kV, 4P , Cage Rotor Induction Motor.
W.O.No. : 48200A40131 & 32
Frame : 1LA7636-4
Customer : M/S NTPC

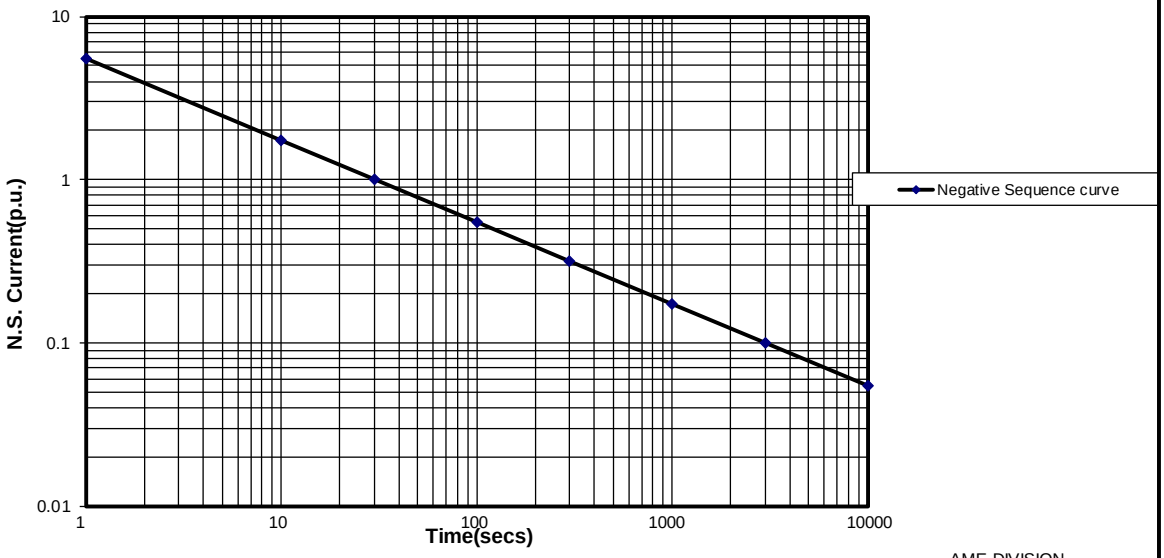


Curve No. 48200-31-03

AME DIVISION

NEGATIVE SEQUENCE CURVE

Rating : 900 KW, 3.3 kV, 4P , Cage Rotor Induction Motor.
W.O.No. : 48200A40131 & 32
Frame : 1LA7636-4
Customer : M/S NTPC

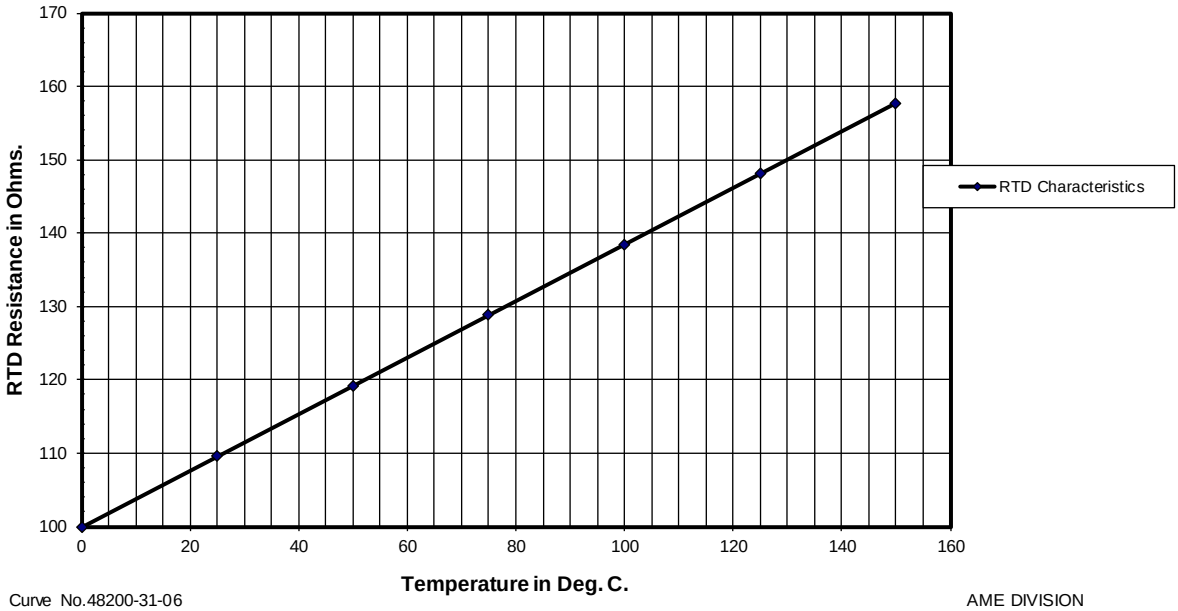


Curve No.48200-31-05

AME DIVISION

RTD Characteristics(PT-100)

Rating : 900 KW, 3.3 kV, 4P , Cage Rotor Induction Motor.
W.O.No. : 48200A40131 & 32
Frame : 1LA7636-4
Customer : M/S NTPC



Curve No.48200-31-06

AME DIVISION

Electrical Annexure-2

Variable Frequency Drive (VFD)

1.00.00 **GENERAL**

The Design, manufacture, erection, testing and performance of items and services provided under this specification shall comply with the latest edition including all applicable official amendments and revisions as on date of award of the following standards. In case of conflict between this specification and code (IS Code, standards, etc.) referred herein, the former shall prevail. All work shall be carried out as per the following codes and standards.

2.00.00 **CODES AND STANDARDS**

HT breaker	IEC:60056
DC reactor	IEC 60289
Transformers	IS:2026, IEC: 60076 IEC 61378
Bushing	IS: 2099, IEC 60137
Adjustable Speed Electrical Power Drive Systems	IEC 61800
Semiconductor converters–General requirements	IEC 60146
IEEE Recommended practices and requirements for harmonic control in electrical power systems	IEEE 519
Degrees of protection provided by enclosures (IP Code)	IEC 60529
Electrostatic immunity test	IEC1000-4-2
Fast transient immunity test	IEC1000-4-4
Surge immunity test	IEC1000-4-5
High-voltage switchgear and controlgear; Pt.102: Alternating current disconnectors and earthing switches	IEC 62271-102
High-voltage switchgear and controlgear; Pt.200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 KV	IS/IEC: 62271-200
AC electricity meters	IS: 722
Metal oxide surge arrestor without gap for AC system	IEC: 60099-4
Terminal blocks for copper conductors	IEC: 60947-7-1
Dry transformer	IS: 11171
Motor	IEC 60034-18-41 &42, IEC60034 / NEMA 30 & 31,
Contactor/Switches/Fuses etc.	IEC:60947, IS: 13947
Harmonics & EM compatibility	IEEE:519/IEC: 61000
VFD	IEC:60034/ IEC: 61800

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 Bidder shall clearly indicate

the standard(s) adopted, furnish a copy in English of the latest revision amendments and revision in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

3.00.00 **OPERATING CONDITIONS**

3.01.00 For the purpose of design of equipment/systems, an ambient temperature of 50 deg. Centigrade and also relative humidity of 95% at 40 deg. Celsius shall be considered.

3.02.00 All equipment shall be suitable for rated frequency of 50 Hz with a variation of +3% & -5%, and 10% combined variation of voltage and frequency unless specifically brought out in the specification.

3.03.00 The auxiliary AC voltage supply arrangement shall have 11/6.6/3.3kV and 415V systems (as applicable). It shall be designed to limit voltage variations as given below under worst operating condition:

1. 11kV/ 3.3 kV/ 6.6 KV : +/- 6%
2. 415V : +/- 10%

Note: The Voltage level mentioned above is the Nominal Voltage available at the input of the VFD System from the MCC/ Switchgear/transformer, based on the system requirement/Availability.

The voltage level for the VFD output to be fed to motor shall be as follows:-

1. Upto 400 kW : 415V/690V, Low Voltage, Three Phase AC
2. Above 400kW and upto 700 KW : 690V, Low Voltage, Three Phase AC
3. Above 700KW : Medium Voltage

From here onwards in the specifications all the VFD Systems consisting of either 415 V or 690 V may be termed as LV VFD while the higher rated VFD System shall be termed as MV VFD. If nothing is mentioned than the Clause is applicable for both the LV and the MV VFD until deliberated otherwise.

4.00.00 **SYSTEM DESCRIPTION**

Type of drive	3-Phase Diode / Thyristor / Multi Stage IGBT / IGCT / SGCT/ IEGT
Type of Cooling of VFD	Naturally air cooled/forced air cooled/Liquid cooled
Converter Type	Full wave diode rectifier/active front end type
Inverter Type	Thyristor/IGBT/IGCT/SGCT/IEGT

5.00.00

GENERAL REQUIREMENTS

5.01.00 **Medium Voltage VFD**: The Variable frequency drive (VFD) system shall be of a modern proven design for similar applications in power plants/industry. The system

	shall be either Current Source Inverter (CSI) or Voltage Source Inverter (VSI) type with minimum eighteen (18) pulse design.
5.02.00	**415 V/690 V LV VFD:** The Variable frequency drive (VFD) system shall be of a modern proven design for similar applications in power plants/industry. The system shall be either Current Source Inverter (CSI) or Voltage Source Inverter (VSI) type with minimum Twelve (12) pulse design. For drives less than 100 KW Six (6) pulse can be offered meeting all other requirements.
5.03.00	The system shall be fully digital, PLC/Microprocessor based, energy efficient, and shall provide very high reliability, high power factor, low harmonic distortion and low vibration and wear and noise. It shall be easy to install in minimum time and expense and no special tools shall be required for routine maintenance.
5.04.00	The offered equipment shall be with state of art technology and proven field track record. No prototype equipment shall be offered.
5.05.00	The VFD manufacturer shall ensure the proper coordination of their VFD with the Driven Motor and the supply system. All the Motors which are to be driven by VFDs will be of Inverter duty type. Also these motors shall comply the requirements stipulated in IEC: 60034-18-41 and IEC: 60034-18-42 as applicable. The VFD operation shall have no inherent detrimental impact on the Motors/ cables & supply system.
6.00.00	**TECHNICAL AND OPERATIONAL REQUIREMENTS**
6.01.00	The system shall be designed to deliver the motor input current and torque for the complete speed torque characteristics of the driven equipment, with worst input supply voltage and frequency variation. The system shall be suitable for the load characteristics and the operational duty of the driven equipment.
6.02.00	The overload capacity of the controller shall be 150% of the rated current of the motor for one minute for constant torque applications and 110% of rated current for one minute for variable torque applications at rated voltage. If the motor load exceeds the limit, the drive shall automatically reduce the frequency and voltage to the motor to guard against overload.
6.03.00	The drive system shall be designed to operate in one or more of the following operating modes as to suit characteristics of the driven equipment or specified by the load: a. Variable torque changing as a function of speed. b. Constant torque over a specific speed range. c. Constant power over a specific speed range. d. Any other as specified in data-sheet
6.04.00	VFDs shall comply with the latest edition of IEEE 519 & IEC 61000 for both individual as well as total harmonic voltage and current distortion limits. The Voltage and Current limits shall be applicable at the Point of Common Coupling (PCC), which shall be the MCC/ Switchgear/ from which the VFD system is fed.

6.05.00	The above compliance shall be verified by the field measurements of harmonics at the PCC with and without VFDs operation.
6.06.00	VFD shall be capable of withstanding the thermal and dynamic stresses and the transient mechanical torque, resulting from short circuit. Any damage resulting from such a short circuit or internal fault shall be limited to the component concerned.
6.07.00	The system shall be suitable to maintain speed variation within range 10-110% or as per the requirement of driven equipment with speed set accuracy of +1% of rated maximum speed and steady state regulation of +0.5% of rated speed as per system requirement.
6.08.00	The VFD System shall maintain a power factor of 0.95 (minimum) (for LV VFD system) and 0.9 (minimum) (for MV VFD system) in the entire operating range.
6.09.00	Maximum allowable audible noise from the VFD system will be 85 dB (A) at a distance of one meter under rated loaded with all cooling fan operating conditions.
6.10.00	All the circuit components shall be suitably protected against over voltages, surges, lightning etc.
6.11.00	The panels shall be designed to provide easy access to hardware, to facilitate replacement of cards in case of any failure.
6.12.00	All the VFDs for particular application shall be of same design so as to ensure 100 % interchangeability of components.
6.13.00	For each programmed warning and fault protection function, the VFD shall display a message in complete English words or Standard English abbreviations. At least 30 time tagged fault messages shall be stored in the drive's fault history.
6.14.00	The VFD cubicles shall be placed in air conditioned environment. However if VFDs of less than 100 kW are designed to operate in non-air condition environment the same shall also be acceptable.
6.15.00	The 3-Phase Thyristor/IGCT/SGCT/ multistage IGBT/IEGT based VFD system shall have minimum number of components to ensure very high reliability. The input side converter shall have 3-Phase Diode/Thyristor bridge configuration modular type and inverter shall be of 3-Phase Thyristor/IGCT/SGCT/multi stage IGBT/IEGT type, using Pulse Width Modulation or better technique for generating near sine wave output to motor.
6.16.00	Fiber optic cable connection shall be provided preferably to ensure high network reliability.
7.00.00	**VFD COMPATIBILITY WITH THE MOTOR**
7.01.00	MV VFD output current waveform, as measured at the motor, shall be inherently sinusoidal at nominal loads, with a total harmonic current and voltage distortion within acceptable/standard limits. VFD with transformers on output side are not acceptable.

7.02.00	The system design shall not have any inherent output harmonic resonance in the operating speed range.
7.03.00	VFD shall provide stable operation of motor from high-voltage dv/dt stress, regardless of cable length to motor. The vendor shall clearly state the limitations in the motor cable distance in his proposal. However, due to system requirements & constraints if the cable length becomes critical, filters/ chokes etc. shall be provided by the VFD manufacturers as an integral part of the VFD to mitigate the reflected wave effect of harmonics.
8.00.00	**BYPASS ARRANGEMENT (OPTIONAL, IF SPECIFIED)**
8.01.00	The VFD System shall have an optional feature to run the motor under bypass arrangement for operation of Motor with VFD bypassed. During starting (under rated conditions) the motor will be switched on in VFD Mode to limit the starting current and after gaining speed, the load would be switched over to bypass mode.
8.02.00	Comprehensive motor protection scheme for protection and control for operation VFD during bypass mode shall be finalized during detailed engineering.
9.00.00	**STANDBY VFD ARRANGEMENT (OPTIONAL, IF SPECIFIED)**
9.01.00	A Common standby arrangement with auto/manual switchover shall be provided in case of failure of any VFD in a group of drives. Complete protection, interlocks & control required shall be provided in the changeover module.
10.00.00	**EFFICIENCY**
10.01.00	Efficiency (Drive only) shall be minimum 98% for both MV VFD and LV VFD. Overall efficiency shall be minimum 96.5% for LV VFD and minimum 94 % for MV VFD at rated load and speed. Overall Efficiency evaluation shall include input transformer, harmonic filters and power factor correction (if applicable), VFD converters, cooling fans and output filter, as applicable in the system. Auxiliary controls, such as internal VFD control boards, cooling fans/pumps.
10.02.00	In absence of valid test report, a factory test shall be performed at the VFD manufacturer's facility verifying the efficiencies. Manufactures who are supplying Drive and transformer from different locations, efficiency test will be conducted separately for Drive and transformer.
11.00.00	**COOLING SYSTEM**
11.01.00	The VFD shall be designed to operate indoor under temperature range of 0 deg C to 50 deg C and relative humidity of 95 %(at 40 deg C).
11.02.00	VFD manufacturer to primarily offer Air cooled Design. However in case of large ratings, liquid cooled drives may be accepted subject to employer's approval. In case of liquid cooled system, there shall be no necessity of continuous water supply system (Closed Loop System).
11.03.00	In case of Air cooled design, the VFD Cooling system shall be such that it puts minimum heat load inside the room and preferably throw the hot air outside the room with ventilation ducts. The Cooling system shall be designed in such a way that the Air Conditioning & Ventilation Air requirements are kept to minimum. The VFD

Manufacturer shall furnish the data regarding heat load, air flow requirements during the detailed engineering.

11.04.00 Air cooled VFDs shall be provided with cooling fans mounted integral to the VFD/ enclosure. The VFD shall include air-flow pressure switches and temperature detectors to monitor proper operation of the air cooling system. If the fan fails, the system must generate the alarm/trip for the fan failure.

12.00.00 **TRANSFORMER:**

12.01.00 Type: Outdoor Mineral oil filled ONAN type or Indoor natural air-cooled Dry type, Three phase unit, rectifier/converter duty type transformer.

12.02.00 All other components, technical parameters shall be as per applicable IEC/IS.

12.03.00 Enclosure for Dry Type Transformer (as applicable)

Enclosure shall be of a tested quality sheet steel of minimum thickness 2 mm & shall also accommodate cable terminations. The housing door shall be interlocked such that it should be possible to open the door only when transformer is off. The enclosure shall be provided with lifting lugs and other hardware for floor mounting.

12.04.00	Core	Shall be High grade non-ageing cold rolled grain oriented silicon steel Laminations.
12.05.00	Winding conductor	Shall be electrolytic grade copper. Windings shall be of class F insulation.
12.06.00	Winding temperature Indicator (WTI)	Shall be Platinum resistance type temperature detector in each limb.
12.07.00	Thermistors	Shall be embedded in each limb with alarm and trip contacts for remote annunciation.
12.08.00	Temperature rise:	Winding temperature rise shall be as per applicable IEC.

13.00.00 **POWER CONVERTER:**

13.01.00 The static power converter shall consist of a line side converter for operation as a rectifier and a load side power converter for operation as a fully controller inverter. Power converter shall be fast switching, most efficient and low loss type.

13.02.00 The converter shall be coordinated with the transformers. The converter shall be able to withstand a three phase short circuit current until interrupted by normal breaker operation.

13.03.00 Adequate short circuit and over voltage protection shall be provided for the converter and inverter system.

13.04.00 All power converter devices shall include protective devices, snubber networks and dv/dt networks as required.

13.05.00 The current rating of the converter's semi-conductor components shall not be less than 120% of the nominal current flowing through the elements at full load of the VFD

	through the whole speed range. If the parallel connection of semiconductor is applied, the above current rating shall not be less than 140% of the above values.
13.06.00	All power diodes shall be of silicon type with minimum VBO rating at 2.5 times the rated operating voltage.
13.07.00	The power converter circuit shall be designed so that motor can be powered at its full nameplate rating continuously without exceeding its rated temperature rise nor reducing its service factor due to harmonic currents generated by the inverter operation. The conversion devices and associated heat sinks shall be assembled such that individual devices can be replaced without requiring the use of any special precautions / tools.
13.08.00	The cooling system of the electronic components, if provided, shall be monitored and necessary alarms shall be provided to prevent any consequential damage to the power control devices.
14.00.00	**OUTPUT FILTER (AS APPLICABLE):**
14.01.00	Output/ dv/dt filter shall be provided, if required. It shall be an integral part of the VFD system and included within the VFD enclosure. It shall inherently protect motor from high voltage dv/dt stress.
15.00.00	**DC LINK CAPACITOR (AS APPLICABLE):**
15.01.00	Capacitor shall be of self-healing film or electrolytic type having high life time. The capacitor shall be an integral part of VFD system. DC link Capacitors shall have discharge resistors which shall be capable of reducing the residual charges to zero just after the capacitor is disconnected from the supply source. The capacitor shall be suitable for high ripple currents.
16.00.00	AC/**DC Reactor (As applicable)** 1) Type: Dry type, air cored, self cooled, indoor type. Suitable for withstanding earth fault continuously. 2) Insulation: Thermal Class 155(F), temperature rise is limited to thermal class 130 (B). 3) Noise level shall not exceed value specified in NEMA TR-1.
17.00.00	**VFD PANEL REQUIREMENTS**
17.01.00	Enclosure frames and load bearing members shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness 2.0 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness 1.6 mm. Doors and covers shall also be of cold rolled sheet steel of thickness 1.6 mm. Stiffeners shall be provided wherever necessary. The gland plate thickness shall be 3.0 mm for hot / cold-rolled sheet steel and 4.0 mm for non-magnetic material. In case dry type transformer is provided inside VFD panels, the enclosure and in its frame thickness shall be same as indicated in this para.
17.02.00	The cable entry shall be from the bottom of the panel and a removable bolted un-drilled gland plate.
17.03.00	All Panels shall be of dust-proof and vermin-proof construction and shall be provided with a degree of protection of IP: 3X or better for MV VFD and IP: 4X or better for LV VFD as per IS/IEC 60947

17.04.00 Enclosures must be designed to avoid harmonic and inductive heating effects and to shield any outside equipment from interference, enclosing and shielding the complete to eliminate any radio frequency interference. The construction of the panel shall provide effective protection against electromagnetic emissions.

17.05.00 Each panel shall be provided with illuminating lamp, space heater with switch fuse and variable setting thermostat.

17.06.00 Proper ventilation using air filters and fans/pumps shall be provided in the panels to ensure that maximum temperature inside the cubicle is within permissible limits for reliable and continuous operation of the system.

18.00.00 **PAINTING**

Paint shade shall be as follows

a) VFD transformer reactor enclosure : RAL 5012 (Blue), legend in black letter

b) Motors : RAL 5012 (Blue)

c) VFD Panels : Front and rear panels in Grey (RAL9002). End panel sides in blue (RAL 5012)

19.00.00 **HT SWITCHGEAR**

19.01.00 The technical requirements of HT switchgear shall be as per chapter of HT switchgear in Part-B of Technical specifications.

20.00.00 **MOTORS**

20.01.00 VFD shall be used to drive three (3) phase squirrel cage inverter duty Induction motor with VPI insulation (Resin poor) suitable for VFD application. These motors shall be provided with insulated bearing on at least one side.

20.02.00 Motors shall also meet the requirements mentioned in subsection for motors and relevant IS/IEC.

20.03.00 Motor shall be suitable for operation with a solid state power supply consisting of an adjustable frequency inverter for speed control & shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive.

20.04.00 Motor insulation shall be designed to accept the applied voltage waveform, within the Vpeak and dv/dt limits as per IEC-61800.

20.05.00 Drive manufacturer shall coordinate with the motor manufacturer for proper selection of the motor for the given load application and the output characteristics of the drive.

20.06.00 Other requirements of motor shall be as stipulated in technical chapter of Motors in Part-B of technical specifications.

21.00.00 **LT & HT CABLES**

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21.01.00 Contractor's scope shall also include LT and HT cables suitable for VFD system and Motors.

22.00.00 **CONTROL AND PERFORMANCE REQUIREMENTS**

CLAUSE NO.	`` VARIABLE FREQUENCY DRIVES
22.01.00	The VFD to provide an automatic current limiting feature to control motor currents during startup and provide a “soft start” torque profile for the motor load combination. Current and torque limit adjustments shall be provided to limit the maximum VFD output current and the maximum torque produced by the motor.
22.02.00	It shall be possible to vary the speed of the drive and control it in either Local or Remote mode. Local / Remote selection shall be done from VFD panel unless otherwise specified.
22.03.00	Provision shall be kept for exchange of information between different VFD control system parameters thru PLC/DDCMIS. Man machine interface for (MV) VFD shall have one flat TFT monitor with keyboard (password protected) in the VFD room and a color laser printer for system alarm and monitoring located in control room. Parameter Monitoring: -Input and output voltage of Drive - Input and output current of Drive - Motor speed - Input and output power frequency of Drive - Torque -Input and Output power of Drive system (covering transformer if applicable) - Output kWhr of Drive - Transformer (if applicable) temperature for alarm & trip. - Ambient temperature - Run/stop and local/remote status displayed
22.04.00	Drive shall be equipped with a front mounted operator console panel consisting of a backlit alphanumeric display and a keypad with keys for parameterization and adjusting parameter. Control panel shall be operable with password for changing the protection setting, safety interlock etc.
22.05.00	Operator console/Main Control Card shall have facility / port to connect external hardware such as Lap-Top etc. Console shall have facility for upload and download of all parameter settings from one drive to another drive for start up and operation.
22.06.00	User-friendly licensed software for operation and fault diagnostic shall be loaded in the drive system panel before commissioning.
23.00.00	**PROTECTION FEATURES**
23.01.00	The system offered shall incorporate adequate protection features as per IEC 61800-4: 2002 Table-8, properly coordinated for the drive control and for motor including following: i) Converter transformer: short circuit, over current, earth fault & winding temperature high protection. ii) Incoming and outgoing line surge protection. iii) Under / over voltage protection iv) Phase loss, phase reversal, overload, negative phase sequence, locked rotor protection.

	v) Instantaneous Over current & Earth fault protection vi) Converter/Inverter module failure indication. vii) Over frequency/speed protection. viii) Ventilation failure indication & alarm. ix) Over temperature of VFD x) Bearing temperature protection. xi) System earth fault protection. xii) Speed reference loss protection.
23.02.00	Under VFD Bypass Mode (if applicable) all the electrical protections related to the Motor shall remain applicable.
24.00.00	**CONTROL FEATURES**
24.01.00	Following controls shall be provided as a part of the Operator Control Panel or through separate switches on the front panel door. i) Start / stop (in local/remote mode) ii) Speed control (Raise / lower) iii) Acknowledge/Accept/ Test Push Button for annunciation iv) Auto / Manual / Test Mode select v) Emergency stop vi) Trip-Remote Breaker
25.00.00	**DIAGNOSTIC FEATURES**
25.01.00	The VFD shall include a microprocessor/PLC based digital diagnostic system which monitors its own control functions and displays faults and operating conditions.
25.02.00	Fault diagnostic shall be built into the system to supervise the operation and failure of the system. The information regarding failure of any of the system including shut down of the system shall be available. It shall be possible to retrieve the record of events prior to tripping of the system or de-energization. Auxiliary supply to the system components or to the electronics (firmware) for the diagnostics / display shall be taken care of by the manufacturer for this purpose.
26.00.00	**SERVICEABILITY / MAINTAINABILITY**
26.01.00	Power Component Accessibility: All power components in the converter sections shall be designed for rack-out accessibility for ease of maintenance and to minimize repair downtime.

26.02.00	Marking / Labeling: Sleeve type wire marker tags or other acceptable means of permanent identification shall be applied to power and control wiring. Individual labels shall be provided for all major components of the VFD system.
27.00.00	**STORAGE AND PRESERVATION**
27.01.00	The Contractor shall be responsible for the storage and preservation of all the equipments to be supplied under the VFD System, till the time of successful installation and commissioning. The equipment should be suitable for storage for long periods before installation. Contractor should take adequate measures to ensure that no damage happens to the VFD System due to storage and preservation.
28.00.00	**TESTS**
28.01.00	**ROUTINE TESTS**
	All acceptance and routine tests as envisaged in QA section shall be carried out. Charges for these shall be deemed to be included in the equipment price.
28.02.00	**TYPE TESTS**
28.02.01	The Contractor shall carry out the type tests as listed in this specification on the equipment to be supplied under this contract. The bidder shall indicate the charges for each of these type tests separately in the relevant schedule and the same shall be considered for the evaluation of the bids. The type tests charges shall be paid only for the test(s) actually conducted successfully under this contract and upon certification by the employer's engineer.
28.02.02	The type tests shall be carried out in presence of the employer's representative, for which minimum 15 days' notice shall be given by the Contractor. The Contractor shall obtain the employer's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set–up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.
28.02.03	In case the Contractor has conducted such specified type test(s) within last ten years as on the date of bid opening, he may submit during detailed engineering the type test reports to the Employer for waival of conductance of such test(s). These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. The Employer reserves the right to waive conducting of any or all the specified type test(s) under this contract. In case type tests are waived, the type test charges shall not be payable to the Contractor.
28.02.04	Further the Contractor shall only submit the reports of the type tests as listed in "LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED" and carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. However if the Contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the Contractor shall conduct all such tests under this contract at no additional cost to the Employer either at third party lab or in presence of client/Employers representative and submit the reports for approval.

28.03.00 **LIST OF TYPE TESTS TO BE CONDUCTED**

The following type tests shall be conducted under this contract for MV VFD

i) Overall efficiency determination of VFD system including transformer/ Harmonic filters etc at motor full load
ii) Temperature rise test
iii) Noise level
iv) Harmonics of No load current.(Input/Output)

28.04.00 **LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED**

The following type test reports shall be submitted for VFD Panels'

1) VFD panels (For LV VFD)

i. Rated Current/ Output
ii. Temperature rise test
iii. Noise level test
iv. Power Loss Determination Test
v. Power factor measurement.
vi. Degree of Protection Test
vii. EMC Test
viii. The Fast transient SWC tests as per ANSI / IEEE C37.901-2002 / IEC 60255-22-04-2008 / IEC 61800

2) VFD panels (For MV VFD)

i. Rated Current/ Output
ii. Current Sharing
iii. Voltage Division
iv. Power Loss Determination Test
v. Power factor measurement.
vi. Degree of Protection Test
vii. The Fast transient SWC tests as per ANSI / IEEE C37.901-2002 / IEC 60255-22-04-2008 / IEC 61800

3) AC/DC Reactor

i. Lightning impulse test(If applicable)
ii. Heat run test
iii. Short time current test(If applicable)
iv. Noise level test

4) Transformers (In case of non integrated type)

CLAUSE NO.	VARIABLE FREQUENCY DRIVES
	i. As per requirements mentioned in subsection for Transformer chapter in technical specifications.

SUB-SECTION-V-QE13

VFD MODULE

DRY TYPE TRANSFORMER

Attributes / Characteristics / Items/Components Sub Systems	Visual & Dimensional check	Mechanical properties	Electrical strength	Thermal Properties	Chemical Properties	NDT / DP / MPI	Voltage Ratio, Vector Group & Polarity	Make / Type / Rating / Model /TC / General Physical Inspection	WPS & PQR	Routine Test as per relevant standard	Measurement of capacitance & tan delta between winding	Routine Test
Enclosure door, H.V. & L.V. Cable Box / Flange Throat	Y	Y						Y				
Copper Conductor	Y	Y	Y		Y							
Insulating Material	Y			Y	Y							
CRGO Lamination & Built Core	Y											
Bushing /Insulator (IS:2544 / 5621)	Y							Y		Y		
Gasket	Y							Y		Y		
Off-Circuit Tap Changer	Y							Y				
Core Coil Assembly	Y						Y					
Marshalling Box	Y									Y		
WTI, Thermister, Terminal Connector	Y							Y				
Welding									Y			
Complete Transformer (IS:11171 / IEC 60076)	Y										Y	Y

Notes: 1) This is an indicative List of test/checks. The manufacturer is to furnish a detailed Quality Plan indicating his practice and procedure along with relevant supporting documents during QP finalization for all item.

2. All major Bought out Items will be subject to NTPC approval.

VFD PANEL

Attributes / Characteristics / Item Components / Sub System Assembly	Electrical Properties	Mechanical Properties	Chemical Properties	Dimensions / Finish	Type/ Rating/Functional check	HV/IR	Routine test as per relevant std.	Constructional Features	IS:6005 ,Seven tank process	Paint finish/ shade/thickness	Mountings / BOM/ Make, Completeness	Interlock Functional & Operation Testing / Simulation check	Degree of Protection Test	Final testing as per Relevant
Sheet Steel (IS-513)		Y	Y	Y										
Aluminum / Copper Bus-bar(IS-5082/IS-613/IS-1987)	Y	Y	Y	Y										
Support Insulator (BS-2782/IEC-660/IS-10912)	Y	Y	Y	Y										
Control / Selector Switch(IS-6875)					Y	Y	Y							
Contactor/ MCB(IS-13947)					Y	Y	Y							
O/L Protection relays(IS-3231)					Y		Y							
C.T /V.T/ Indicating Meter(IS-2705/3156/1248)					Y	Y	Y							
Fuse/ Fuse carrier(IS-13703)					Y	Y	Y							
Terminals/lugs/pvc wires(IS-13947//IS-694)	Y			Y	Y	Y	Y							
Timers(IS-3231)					Y	Y	Y							
Push Button/ Lamp/ (IS-6875)					Y	Y	Y							
Control Transformer (IS-12021)					Y	Y	Y							
Mimic, Annunciater					Y		Y							
GASKET(IS-11149)		Y	Y	Y	Y		Y							
Fabrication								Y						
Pretreatment & Painting									Y	Y				
VFD panel										Y	Y	Y	Y	Y

NOTE:

1. This is an indicative list of Test/ Checks. The manufacturer to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. All major Bought Out Items will be subject to NTPC approval.

REVISION HISTORY SHEET

REV. NO.	DATE	NATURE OF CHANGE	REASONS	PREPARED BY	APPROVED BY
00	31-07-2020	FIRST ISSUE	------	GITESH DAS	L SUBBALAKSHMI

TECHNICAL SPECIFICATION OF IGBT/ IGCT/ SGCT BASED VFD FOR SQUIRREL CAGE INDUCTION MOTOR

1. Project Details

Sl. No.	Parameter	Specification
1	Project title	As per attached Annexure to Specification
2	Customer	

2. Environment Specifications

Sl. No.	Parameter	Specification
1	Maximum Ambient Temperature	As per attached Annexure to Specification
2	Minimum Ambient Temperature	
3	Equipment Design Temperature (IS-9676)	
4	Relative Humidity	
5	Altitude	
6	Location of VFD Panels	
7	Seismic Zone	
8	Environment	

3. Input and Transformer Data

Sl. No.	Parameter	Specification
1	System Voltage / Frequency / Phase	Refer attached Annexure to Specification
2	Voltage Variation	
3	Frequency Variation	
4	Combined Voltage and Frequency Variation	
5	Fault Level	
6	Transformer Type	
7	Rating	Transformer must be designed to carry 110% current of calculated VFD rating. Transformer sizing calculation shall be provided along with offer.
8	Power Cables	1. Cable glands (Weatherproof) to be provided by the vendor for Transformer HV side cable termination suitable for Cable size mentioned in Annexure to Specification. The exact no. and size will be intimated during drawing approval stage. Cables and termination kits are in Customer /BHEL scope. 2. All interconnecting cables and cable lugs for VFD panel to Transformer connection to be provided by vendor. Refer attached Annexure to Specification for more details. For VFD with non-integrated Transformer, Power Cables between Transformer & VFD shall also consider adequate derating factor as these cables shall travel through trenches and trays. 3. For VFD panel with non-integrated type transformer, Cables glands and termination kits for connection between Transformer LV side and VFD input side termination shall also be supplied by the vendor.
9	Termination cubicle	Any special termination cubicle, supporting structures, etc. if required for non-integrated type VFD system shall also be supplied by the VFD vendor.

4. Motor Data

Sl. No.	Parameter	Specification
1	Type	Squirrel Cage Induction Motor
2	Scope	Manufactured by BHEL-Bhopal
3	Rating (kW)	Refer attached Annexure to Specification
4	Rated Voltage and Current	Refer attached Annexure to Specification
5	Fed from	Variable Frequency Drive (V/f Control)
6	Duty Class	Continuous - S1
7	Efficiency and Power Factor	Refer attached Annexure to Specification
8	Power Cables	Cable glands (Weatherproof) to be provided by the vendor for VFD Output side cable termination suitable for cable sizes mentioned in the attached Annexure. The exact no. and size will be intimated during drawing approval stage. Cables and termination kits are in Customer /BHEL scope.

5. Scope:

Sl. No.	Scope of Supply	Description
1	Refer Consolidated Scope of Supply and Services in attached Annexure for details.	The vendor shall be responsible for engineering and functioning of the complete VFD system comprising of Dry type Transformer and VFD panel, meeting the intent and requirement of this specification, Customer specification and datasheet. This shall include but not be limited to inverter sizing, transformer sizing, transformer impedance selection, vector group, input and output harmonic filter design and sizing, output dv/dt filter sizing, adequacy of motor cable size selected by BHEL etc. All necessary interlocks as required for safe and reliable operation of VFD system along with Input breaker shall be provided in VFD system. If any special arrangement is required in input breaker, same shall be informed by the vendor in offer. The machine shall continuously run on VFD.
2	a) All interconnecting cables between VFD panel and Transformer panel both for integrated type VFD system and non- Integrated type VFD system. b) Any special cable other than power and control cables from VFD to other equipment. c) Power Cable glands, lugs and hardwares for VFD and transformer. d) Any special tools and tackles.	

6. VFD Specifications:

Sl.No.	Parameter	Specification
1	Drive Application	Refer attached Annexure to Specification
2	Input Voltage	From Dry type Transformer.
3	Power/Torque vs Speed	Torque α Speed^2 , Power α Speed^3
4	Single Line Diagram	Refer attached Annexure to Specification
5	Output Voltage of VFD	
6	Output Current of VFD	
7	Output Frequency	0 to 50Hz , Resolution: +/- 0.01% under transient conditions; +/- 0.5% under steady state conditions
8	Overload capacity	Refer attached Annexure to Specification
9	Speed Regulation & Speed Accuracy	+ 0.5% +1%
10	Drive Control	Sensorless Vector Control
11	Braking Operation	Not Applicable
12	Output LC Sinusoidal Filter	Motor is designed for PWM operation. Distance between VFD and Motor are as per Annexure attached with Specification. Vendor to clarify and offer output Filter, if required.

13	VFD Panel Construction	a) Protection Class: Please refer attached Annexure b) Panel: Free standing, floor mounting type, comprising of rigid welded structural frames with Cold Rolled Sheet Steel enclosure of minimum thickness 2 mm for load bearing and 1.6 mm for other members. All doors and removable covers shall have neoprene gaskets. Ventilating louvers shall have easily removable and washable dust filters. c) Busbar Material – Electrolytic grade Copper, colour coded. Sleeving/shrouding for safety purposes shall be done. d) Cooling: Forced Air Cooled VFD should be considered. Cooling system shall include well dimensioned panel, adequate cooling air flow path. Vendor shall ensure that the panel dimensions and flow paths have been designed for continuous running at the specified ambient without overheating. Suitable thermal switch for exit air temperature monitoring shall also be incorporated. e) Earth Bus – minimum 50*6 mm Copper. f) Door Interlock: The VFD shall have a door interlock for safety. This interlock system should ensure that none of the power cabinets can be opened until the main source of power is disconnected or will cause the main source of power to trip. Additionally the same interlock system should ensure that power cannot be initialized to the drive unless the doors are closed. Suitable shrouding mechanism shall be provided so that the DC capacitors cannot be touched till their voltage is zero. g) Painting: 2 Coats of Primer and 2 Coats of Finish Paint to be given for all surfaces of enclosure. Paint shall be Epoxy Based with Powder Coated Finish - shade RAL9002 front and rear panels, end panel sides RAL5012. Paint Thickness: 80 Microns (minimum). Exact paint shade will be confirmed during drawing approval stage. h) Power and Control Wiring shall be done with Fire retardant (FRLS) cables. i) Double compression type Nickel plated brass cable glands shall be supplied. Height of the terminal from cable gland plate shall be adequate to take care of the cable sizes and quantity mentioned. Minimum space for the power cable termination shall be 600mm clear from the cable gland plate. Cable entry will be from bottom only. Gland Plates shall be blank (undrilled) – to be drilled at site. The gland plate thickness shall be 3.0 mm

13	VFD Panel Construction	for hot / cold-rolled sheet steel and 4.0 mm for non-magnetic material. Gland plate shall be of sufficient strength to handle all the cables. j) All electronic modules and components shall be accessible from front of panel only. Modular assemblies for both the system control electronic equipment and power electronic equipments shall be used. k) All low voltage compartment and cabling shall be electrically and physically separated from the high voltage compartment. l) 20% spare terminals shall be provided for future use.
14	Noise Level	Shall be less than 85dB at a distance of 1 metre from the outline of VFD Panels at a height of 1.5 metres from the floor with all the fans running in the VFD Panels.
15	Storage Temp.	-40°C to +60 °C
16	Vibration	According to IEC68-2-6
17	Interference	According to IEC801 parts 2,3,4 Immunity: The panels shall be designed so as to have low Radio Freq Interference (RFI) & Electromagnetic Interference (EMI).
18	VFD Efficiency	Shall be as per NTPC VFD specification. Exact value to be specified by the Vendor in Datasheet.
19	Duty Cycle	Class I Duty Cycle as per IEC 146-1
20	VFD Requirements	a) Input Choke: Input chokes to be provided, if necessary. b) Local/Remote: Selector switch shall be provided for operator to select type of operation: ➢ Local – Operation from VFD Panel for Speed Control from door mounted interface; ➢ Remote – Operation from DCS. If VFD is set for speed reference from Remote, it shall be possible to program the VFD to either shutdown, go to minimum speed or continue operation at its last known speed reference point whenever a loss of speed reference is detected. c) Local Start/Stop Push Button to be provided either on Panel door or on keypad. d) Door Mounted Lockable Push-Button with cover to be provided with 2NO + 2 NC contact for Emergency Stop. One normally open and close contact to be wired to Terminal Block for external Interlocking / Annunciation. e) Every Panel shall be provided with illumination lamp with limit switch and MCB. Space heater shall be provided in panel with switch fuse and variable setting thermostat. 240V power socket with MCB shall be provided.

Sl. No.	Parameter	Specification
20	VFD Requirements	f) 230V, 1phase, 50Hz (exact rating during drawing approval stage) Power Supply to the motor space heater shall be derived from VFD. Necessary interlocking arrangement for this supply shall also be made available in the VFD panels. g) PLC: PLC shall be provided for Interlocking and Protection (if required) h) The expected life time of the drive system shall be minimum 20 years. The system including all individual components forming part of the system shall have an availability of minimum 0.997 and a minimum MTBF of 4 years. i) Any special requirement regarding CT/ PT, protection relay or any other device, in input breaker, which is required for functioning and protection of VFD system shall be considered by the VFD vendor in their scope.
21	VFD Features	a) Soft Start and Auto Restart b) Auto Speed Search Facility (Catch on Fly) shall be available for starting into rotating loads. c) Power loss ride through (Kinetic Buffering) and for voltage dips over 20% or Power interruption for less than 2 secs. d) Automatic VFD tuning during start-up. e) Flux optimisation function shall be provided to reduce the total energy consumption and noise level in case drive is operated below nominal load. f) Selectable reverse run prohibition g) Adjustable motor overload feature h) Settable minimum and maximum operating frequency i) VFD shall produce not greater than 1% torque pulsation to the shaft of driven equipment. j) Field adjustable Torque limits and acceleration and deceleration ramps k) Accelerate / Decelerate Times to be specified. l) Four (4) user programmable preset speeds. m) The equipment may be stored outdoors for long periods before installation.The packing should also be suitable for outdoor storage areas with heavy rains / high ambient temperatures. n) Vendor shall certify readiness of system fit for commissioning. Vendor's scope shall also include supply of all specialized tools and tackles required. o) VFDs shall be installed in Air-conditioned area but it shall be suitable for operation in non-air-conditioned area also. p) Earthing scheme should be provided by the vendor.

21	VFD Features	q) Any special cable other than power and control cables required to connect VFD to other equipment shall be in vendor scope. r) All electronic PCBs/Modules must have conformal coating to take care of site conditions.
22	Controls and monitoring	a) VFD shall be with an interactive and user-friendly door mounted digital operator interface with LCD display and sealed membrane type keypad. b) The operator interface shall be used for drive programming, drive monitoring and drive trouble shooting. The operator interface must also be able to start and stop the drive, reset VFD faults and manually adjust the VFD's speed reference. c) The operator interface shall have LED indicators for drive fault, drive run, and drive in current limit etc. d) The operator interface shall allow monitoring of inverter operating conditions including speed, current, voltage, torque, power etc. e) Messages shall be alphanumeric in nature. All the fault messages shall be in English. f) Provision shall be made available for remote operation. g) The operator interface shall be able to display all real time operating variables and all drive programming parameters. The operator interface shall be capable of displaying a specific user selected parameter on power-up. This power-up parameter would typically be a parameter that is important to the operator such as motor speed or motor load. h) The following Control signals must be provided: ➢ Local/Remote ➢ Emergency stop ➢ Trip/Close Input breaker These are indicative. Vendor to suggest the interlocking scheme using these and other outputs as required for the system during detailed Engineering. These Outputs shall be provided with individual relay having 3 changeover potential free contacts wired to terminal blocks. i) All VFD operating parameter shall be stored in nonvolatile memory. j) The drive shall have built in monitoring of following parameters as minimum on its digital operator interface and these parameter shall also be displayed at Plant DCS through Modbus link: i) Input & Output Frequency ii) Input & Output Current iii) Motor Speed iv) Input & Output Voltage v) DC Bus Voltage vi) Torque

22	Controls and monitoring	vii) Input & Output Power (It shall be possible to display power output of the drive in kW) viii) Digital Input Status ix) Digital Output Status x) Analog Input Status xi) Drive Thermal state xii) Output kWhr of Drive xiii) Hour run xiv) Transformer Temperature for alarm & trip l) Necessary transducer shall be provided with 4-20 mA output for indicating Motor Speed and Motor Current in the DCS. Transducers shall be capable of driving 500 ohms load. m) The following indications shall be provided on the VFD Panel Door/ Keypad: i) Motor Running/ VFD ON ii) Motor Stopped/Tripped iii) Local/Remote status iv) AC Mains ON v) Auxiliary Control Supply ON vi) VFD Ready vii) VFD Fault viii) External Fault ix) Emergency Stop Activated x) Motor Overspeed xi) Input Breaker Trip xii) Motor zero speed xiii) Rectifier output 'ON' xiv) Transformer winding temperature alarm & trip. n) The VFD shall store fault logs of minimum last 10 faults in memory. o) The interface details of VFD shall be incorporated as required for data communication with DCS system with serial interfaces with RS485 data links. Necessary hardware shall be included in the scope and the interface protocol (i.e. Modbus only) shall be provided.

22	Controls and Monitoring	The following Audio-visual annunciations must be provided. 1) Rectifier fuse failure / drive fault 2) Main AC failure 3) Inverter fuse failure / Drive fault 4) Inverter overload 5) Inverter high temperature / Drive fault 6) Cooling system failure 7) Motor failed to start / Drive fault 8) Transformer fault and alarm 9) Communication and measurement system unhealthy
23	Protection	Following protections shall be built in within the inverter and any other protection as required: a) Motor Overload / Over Torque b) Instantaneous Over current (This device shall monitor the peak output current continuously and shall provide instantaneous shutdown without component failure whenever its trip point is surpassed. The trip point must be greater than or equal to 110% of the VFD's rated full load output current) c) Ground Fault Protection d) Over Voltage/Under Voltage - VFD shall be able to withstand >20% dip in supply voltage for 2 secs without damage to semiconductors or fuses. e) Output Short Circuit f) Output Phase Loss, Phase reversal, Locked rotor protection g) Phase Sequence Protection h) Input Phase Loss/Single Phasing Preventer i) Over Speed/Over frequency of motor j) Heat sink over temperature/VFD Panel Temperature High Stall prevention (During acceleration, deceleration and constant speed operation) k) Loss of Cooling Fans (Ventilation failure Indication and Alarm) l) External faults like Transformer Fault and Alarm m) Incoming and outgoing Line surge protection n) Loss of Speed reference o) Inverter fault (Converter/Inverter module failure indication) p) The system shall be designed to deliver the motor input current and torque for the complete speed torque characteristics of the driven equipment.

23	Protection	q) If the motor load exceeds the limit, the drive shall automatically reduce the frequency and voltage to the motor to guard against overload. If load demands exceed the current limit for more than 1 min, the drive shall shut down to prevent over heating of the motor and damage to the drive. r) The drive shall trip in case the speed exceeds 110% of the maximum operational speed or reduces to 95% of the minimum operational speed for more than 10 seconds.(Speed ref loss protection) s) Fault diagnostic shall be built into the system to supervise the operation and failure of the system. The information regarding failure of any of the system including shut down of the system shall be available for a period of minimum 4 days after a shut down even though no supply available. t) Converter transformer: Short circuit, over current, Earth fault, and Winding temperature high protection.

Sl. No.	Parameter	Specification
24	Dry type Transformer (mounted in panel)	Dry type Transformer a) HV: Taps of ±5% in steps of 2.5% b) LV voltage: Multi secondary type. Number of secondaries and secondary voltage to be indicated by the vendor in technical offer. c) Class of insulation: F or higher. Temperature rise of the transformer shall be as per applicable IEC. d) Winding material : Electrolytic grade Copper **Protection**: RTDs to be provided in each limb for winding temperature measurement. Temperature scanner to be provided for winding temperature measurement of all limbs. Alarm and trip contacts required for annunciation for fault and tripping action. **Connection**: HV Incomer: Termination arrangement and Cable glands to be provided by the vendor. The exact number and sizes will be intimated during drawing approval stage. Cables in BHEL/Customer scope. LV Connection: Cables along with glands, Lugs for connection between LV secondaries and VFD to be supplied by the Vendor. This shall be used for testing of the VFD and later bunched in the panel during dispatch and the same shall be connected at site. Necessary connection and routing arrangements to be made at Vendor's works. For more details please refer Annexure attached with this Specification. In case of non-integrated transformer, Cable termination kits (if required) for LV connection between transformer and VFD shall also be supplied by vendor.

Sl. No.	Parameter	Specification
25	Type of Control:	Completely programmable by the user as: a) Flux vector control with speed feedback b) Flux vector control without speed feedback c) Scalar V/F. VFD shall be capable of maintaining motor speed within ±0.5% without the use of a motor mounted encoder or tachometer. The drive shall have programmable V/F patterns along with user definable custom V/F patterns.
26	Harmonic Limitations – Source	Shall be as per latest IEEE 519 Voltage harmonics: Vendor to inform the values with calculations during detailed engineering stage. Current harmonics: Vendor to inform the source side 5^{th}, 7^{th} & 11^{th} harmonics values with calculations during detailed engineering stage. Vendor to supply harmonic filters, if required, to filter the harmonics generated by VFD at input/ supply side. The above compliance shall be verified by the field measurements of harmonics at the PCC with and without VFDs operation as per NTPC Specification.
27	Harmonics at VFD Output / Motor Input	Shall be as per latest IEC 61800-4 Vendor to specify the maximum amount of voltage and current harmonics at the VFD Output / Motor Input terminals.
28	Switching frequency	To be specified by the vendor in Datasheet.
29	Auxiliary Supply	Refer attached Annexure to Specification

Sl. No.	Parameter	Specification
30	Testing and Quality Plan	a) Routine Tests shall be carried out on all Panels and transformer as per relevant standards and NTPC specifications. b) Type Test Certificates for similar equipment and rating supplied by the Vendor shall be submitted during detailed engineering. Refer clause no. 28.02.00, 28.03.00 & 28.04.00 (2) of NTPC Specification. If valid type test certificates for transformer and VFD panels are not available as per NTPC Specification, vendor shall conduct the type tests without any cost implication to BHEL/NTPC. c) During fabrication, the drive and Transformer shall be subject to inspection by BHEL/ Customer, or by an agency authorized by the BHEL/ Customer to assess the progress of work, as well as to ascertain that only quality raw material is used.
31	Inspection, Training and Commissioning Support	a) Final Inspection: BHEL / Customer representative will be present at manufacturer's works for witnessing of final testing for transformer and VFD. This is to be incorporated in the Quality Plan. No charges shall be applicable for witnessing of final tests. b) Training: Refer attached Annexure to Specification. c) Commissioning: Commissioning of all VFD Systems at site shall be in the scope of Vendor. Final Acceptance shall be based on successful completion of the same. d) Any replacement of failed/damaged items during commissioning shall be exclusively at Vendor's cost. e) Vendor is advised to stock necessary spares and ensure easy availability to facilitate trouble free commissioning.
32	Laptop & Software for Computer Interface	Laptops shall be installed with Latest Compatible Licensed Operating System. The software must be loaded in the laptops & supplied along with interconnecting cables and accessories required for interface with the drive. The software should be an easy to use commissioning tool for drives and shall be provided along with the system. The interface details of VFD shall be incorporated as required for data communication with DCS system with serial interfaces with RS485 data links. Necessary hardware shall be included in the scope and the interface protocol (Modbus only) shall be provided.

Sl. No.	Parameter	Specification
33	Maintenance	The procedure for maintenance of VFD panels and the schedule thereof shall be mentioned in the offer.
34	Spares	Please refer attached Annexure with this Specification.
35	Confirmations/Deviations to Specification	**Point-wise confirmation to this specification and NTPC Specification to be given along with offer**. Deviations, if any, shall be indicated separately. If there are no deviations to the specifications, supplier shall mention the same explicitly. A reply from vendor stating that "**Equipment will generally meet the specifications**" will not be accepted by BHEL. Clause-wise Confirmation / Clarifications of all Clauses in the Purchase Specifications 1 to 34 of Specification shall be furnished in the format below.

Point No.	Page No.	Confirmation / Clarification / Information / Deviation	Details	Remarks, if any

7. Documentation

Sl. No.	Parameter	Specification
1	Attached Documents	a) NTPC specification for VFD System and QA documents b) Motor Datasheet and Curves. c) Single Line Diagram d) "Annexure" to Specification for project specific data. e) Provenness Criteria : Refer "Annexure" attached with the Specification.
2	Technical Information required along with Offer	a) Dimensional Drawing of Panels along with minimum clearance to be maintained for effective cooling, and Weight b) Technical Catalogue of VFD System being offered. c) Reference list for similar rating VFDs giving the following: Model number, Application, Rating, Year of supply and commissioning. Provenness Criteria of Medium Voltage Variable Frequency Drive shall be used as qualifying criteria (if attached with this specification). d) Confirmation / Clarification / Information / Deviation List as per Point 35 in page no. 16. e) Confirmation / Clarification / Deviation List to NTPC Specifications and other documents in Sl No. (1) above. f) Design calculation for sizing of Transformer and VFD. g) Filled up Datasheet for VFD system
3	Information / Confirmations required along with offer	a) Supply of the VFD shall be by OEM only. The name of the country from which the drive is sourced and the location of the manufacturing plant should be mentioned in the offer. b) After Sales Service and Support shall be given by the Vendor for a minimum period of 15 (fifteen) years after commissioning. Address of the Sales and Service Representatives in India with complete contact details: Name/Telephone/Email are to be provided. c) Vendor shall give a notice of at least 1 year to the end user of the equipment and BHEL before phasing out the product / spares to enable the end user for placement of order for spares and services.

Sl. No.	Parameter	Specification
4	Technical (unpriced) and Commercial (priced) Bids – For Evaluation	Refer "Consolidated Scope of Supply & Services" in Annexure attached with this Specification for Unpriced and Priced Bids.
5	Information required for Customer / Consultant Approval (within 3 weeks from the date of Purchase Order)	a) Dimensional Drawing of Panels along with minimum clearance to be maintained for effective cooling, and Weight b) Schematic Diagram c) Bill of Materials for equipment to be supplied d) Feeder Requirements – UPS and 415V supply e) Losses at Rated Load (including Fans) f) Heat Loss for Air Conditioning System sizing g) Technical Catalogue of VFD System being offered h) Test Protocol and Quality Plan i) Type test certificates of similar or higher rating equipment j) Filled up Data sheet for VFD system and Transformer
6	Information Required along with Supply. Maintenance Manuals and Documentation	a) Erection, Commissioning and Maintenance Manuals along with Final Drawings and Documentation b) Test and Guarantee Certificates. c) Complete Bill of Material (item wise) for the equipment supplied. d) 1 no. CD ROM consisting all of the above.

VFD SYSTEM DATA SHEET

A	VFD Data	
1	Manufacturer	
2	Model No.	
3	Manufacturing Location	
4	Rating and Application	
5	Applicable codes /standards	
6	Speed reference	4-20 mA from DCS
7	Speed range	
8	Switching Frequency	
9	No. of Pulse	
10	Total number of Diodes/ IGBTs/ IGCTs	
11	Drive output Voltage	
12	Overload capability	
13	Inrush current 250% In for	
14	Combined efficiency (Transformer & Drive) at:	
	i) 100% Load	
	ii) 75% Load	
	iii) 50% Load	
	iii) 25% Load	
15	Overall power factor at:	
	i) 100% Load	
	ii) 75% Load	
	iii) 50% Load	
	iii) 25% Load	
16	Output voltage range and Accuracy	
17	Output Frequency range and Accuracy	
18	Type of Cooling	
19	Redundancy in Cooling	
20	Type of feedback for speed control	
21	Output Filter/ Choke:	
	i) Manufacturer	
	ii) Type/ Model No.	
	iii) Rated Current and Voltage	
22	Acceleration / Deceleration time	
23	Degree of protection	

24	VFD Panel Dimensions (Dimensional details inclusive of all panels shall be furnished)		
	i) Length (mm)		
	ii) Height (mm)		
	iii) Depth (mm)		
	iv) Weight (kg)		
25	Paint Shade		
26	Heat Load (kW)		
27	Auxiliary Power Requirement:	415V, 3ph, 4Wire	UPS supply
	i) KVA		
	ii) Voltage and Phase		
B	**Transformer Data**		
1	Manufacturer		
2	Manufacturing Location		
3	Type	Dry type Transformer	
4	Integrated / Non-Integrated		
5	Duty	Continuous (Converter Duty)	
6	Rating (Transformer must be designed to carry 110% current of calculated VFD rating.)		
7	Class of insulation and Temperature Rise		
8	Insulation level:		
	P. f withstand		
	i) HV Winding		
	ii) LV Winding		
	Impulse withstand		
	i) HV Winding		
	ii) LV Winding		
9	Fault Level on HV Side		
10	HV Voltage and Phase		
11	LV Voltage/ Current		
12	No. of LV Windings		
13	Rated Frequency	50Hz	
14	Impedance		
15	Cooling Type		
16	Winding Material	Electrolytic grade Copper	
17	Location of Tap Changer	HV Winding	
18	No. of Taps and Type		

19	Vector Group	
20	Neutral CT specification:	
	51G	
	64R	
	Vk	
	Im at Vk/2	
	RCT	
21	Cable Size/Type	
	i) HV Winding	
	ii) LV Winding	
22	No Load Loss	
	i) At 100% Voltage	
	ii) At 110% Voltage	
23	Full Load Copper loss at 75°C	
24	No Load Current	
	i) At 100% Voltage	
	ii) At 110% Voltage	
25	Efficiency at 75°C and unity power factor	
	i) At 100% of Full Load	
	ii) At 75% of Full Load	
	iii) At 50% of Full Load	
	iv) At 25% of Full Load	
26	Efficiency at 75°C and 0.8 power factor	
	i) At 100% of Full Load	
	ii) At 75% of Full Load	
	iii) At 50% of Full Load	
	iv) At 25% of Full Load	
27	Load at which maximum efficiency occurs	
28	Regulation at 75°C at full load	
	i) At 0.8 pf	
	ii) At UPF	
29	Dimensions	
	i) Length (mm)	
	ii) Height (mm)	
	iii) Depth (mm)	
	iv) Weight (kg)	
30	Degree of protection for enclosure.	
31	Paint Shade	
32	Heat Load (kW)	

ANNEXURE-1 TO PS/445/2636

1. Input Data

Sl. No.	Parameter	Specification
1	Project Title	North Karanpura FGD Project (3 x 660MW)
2	Customer	NTPC
3	Environmental Specifications :	
	Max. Ambient temperature	50℃
	Min. Ambient temperature	0℃
	Equipment Design temperature	50℃
	Relative Humidity	95% at 40℃
	Altitude	Less than 1000m above mean sea level
	Location of VFD Panels	Indoor, Ventillated Room with Air Conditioning
	Seismic Zone	As per IS-1893-Zone-II
	Environment	All cards/hardware of VFD panel shall be suitable for operation in harsh environmental conditions with respect to high temperature, humidity & dust.
4	Drive Application	Slurry Re-Circulation (RC) Pump
5	System Voltage / Frequency / Phase	3.3kV / 50 Hz / 3-phase
6	Voltage Variation	± 6%
7	Frequency Variation	+3%, -5%
8	Fault Level at 3.3kV input side	40kA for 1 Sec.
9	Combined Voltage and Frequency Variation	10%
10	Output Voltage of VFD	0 to 3.3kV (V/f = Constant)
11	Overload capacity	The overload capacity shall be 110% of rated current for 1 minute at rated voltage.
12	Motor Rating	1250kW, 3.3kV, 264 Amps, 1489 rpm
13	Motor Efficiency & Power Factor	95.2% & 0.87 respectively
14	VFD type	Fully Assembled Units of 3.3kV VFD Panels (IGBT/SGCT/IGCT), Air Cooled with non-integrated Dry Type Transformer
15	Transformer type	Dry type non-integrated Transformer (in VFD Vendor's scope). Transformer will be placed in non-AC ventilated area. Maximum distance between VFD and transformer shall be 50m. Cables between VFD and transformer shall be in VFD vendor's scope.
16	Degree of Protection	IP:3X or better
17	VFD Output Current	264 A at 50°C (Design Ambient)

18	Distance between VFD & Motor (approx.)	260 meters
19	Cable Sizes between : a) 3.3kV Swbd. & VFD Transformer b) VFD Transformer & VFD c) VFD & Motor	a) 2R x 03C x 185 Sq. mm, Al, XLPE b) In VFD Vendor's scope c) 2R x 03C x 185 Sq. mm, Al, XLPE
20	Auxiliary Supply	a) 230V UPS feeder will be provided by BHEL. KVA rating is to be given by the Vendor. Control supply for electronic modules has to be derived from the UPS. b) Auxiliary Supply – 415V, 3ϕ, 50Hz, 4 wire will be provided by BHEL. Feeder Power rating (short time & continuous) to be specified by the Vendor. c) Other supplies required by the VFD system to be generated internally within the VFD system.
21	Single Line Diagram	Refer Drg. No. 3-661-00-00977
22	Provenness Criteria	Provenness Criteria requirement of Medium Voltage Variable Frequency Drive (3.3 kV VFD) is attached. Vendor to furnish details in line with the document.
23	Mandatory Spares	HV Bushing/Insulator – 3 nos.; LV Bushing/Insulator – 3 nos.; WTI – 3 Nos.; RTD with associated leads for complete Transformer– 3 sets
24	Training	Training for NTPC personnel for 20 Mandays at Manufacturer's works

2. Consolidated Scope of Supply and Services

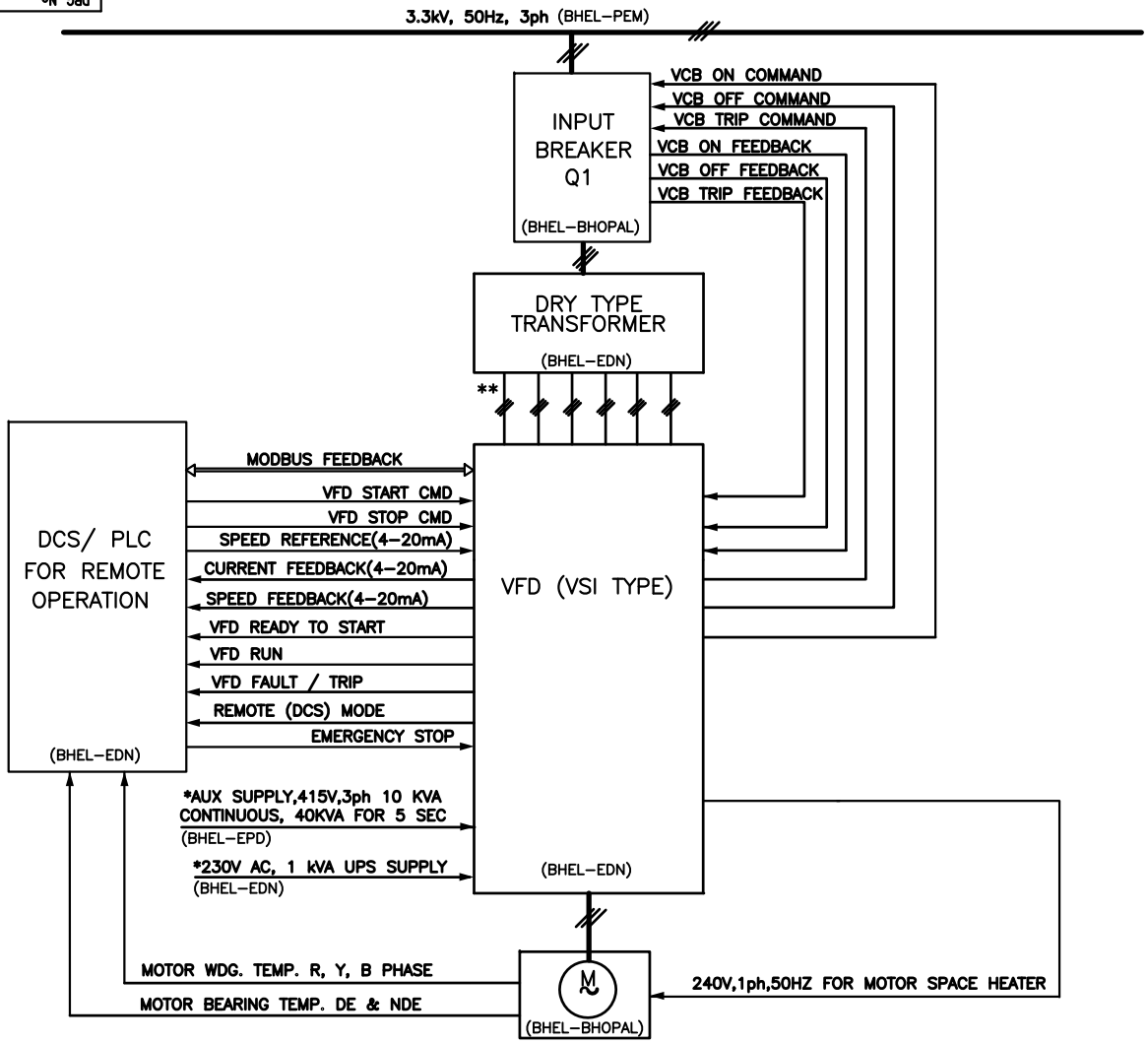
Sl. No.	Items For RC Pump North Karanpura	Quantity (Nos.)
1.	a) Fully Assembled Units of 3.3kV VFD Panels (IGBT/SGCT/IGCT), Air Cooled with non-integrated Dry type transformer, Power cable and control cable between VFD & Transformer, Termination cubicle (if required)	3 Nos.
	b) Cable Accessories	01 Set
2.	Laptop loaded with Drive software	1 No.
3.	Mandatory Spares (optional price)*	01 Set
4.	Erection Supervision & Commissioning (Vendor to quote lumpsum commissioning charges for 12 days per Drive which shall be considered for bid evaluation) Payment shall be made for actual mandays consumed at Site with per day charges calculated on the basis of the lumpsum charges quoted above. Lumpsum charges quoted shall include travelling, boarding and lodging expenses.	03 Sets
5.	N+1 redundancy of cooling fan for Transformer cubicle with auto c/o arrangement (optional price)*	3 nos.

* : Optional prices shall be considered for bid evaluation.

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG. No. 3-661-00-00977



3.3kV, 1250 KW 50HZ,
SQUIRREL CAGE INDUCTION MOTOR

NOTE:

1. IP CLASS VFD : IP 32
2. *FINAL RATING DURING DRAWING APPROVAL STAGE.
3. **NOS. OF SECONDARY WINDINGS DURING DRAWING APPROVAL STAGE.

PROJECT– NORTH KARANPURA FGD PROJECT (3 x 660MW)
CUSTOMER– NTPC

REV.	DATE	ALTERED / CHECKED / APPROVED	REV.	DATE	ALTERED / CHECKED / APPROVED

	NAME	SIGN	DATE
DRAWN	GD		28.05.20
CHECKED	LSL		28.05.20
APPROVED	LSL		28.05.20
DISTRIBUTION OF PRINTS			DEPT. / CODE

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

CARD CODE

TITLE:
SINGLE LINE DIAGRAM – VFD FOR RC PUMP

No. OF SHEETS	01
SHEET No.	01
REV	00

M.O. No. CE/1481

AS PER OPEN TOLERANCE TO ED 0230499

DRG. No. 3-661-00-00977

SHEET 25 OF 49

REF. DRG. No.

SIGN. & DATE

INVENTORY No.

FORM No. A3-03

A3 SIZE

CUSTOMER	**M/s NTPC**	**INSPECTION BY**	**NTPC**
PROJECT	**3X660MW Northkaranpura FGD**	**WO NO.**	**48154P40171 /72/73**
TD Date	**21.02.2020**	**NTPC DOC NO.**	**4410-109-BPL-PVE-Y-006**

Note 1: Data given below is subject to tolerance as per IS/IEC:60034 unless specified otherwise as '*' for which the data is guaranteed.

1. GENERAL	**1.**
(i) Manufacturer	(i) BHEL, BHOPAL
(ii) Equipment driven by motor	(ii) RC PUMP
(iii) Motor type	(iii) SCIM
(iv) Country of origin	(iv) INDIA
(v) Quantity	(v) 05 Nos . for each Unit (Total 15 Nos.)
2. DESIGN AND PERFORMANCE DATA	**2.**
(i) Frame Size ***(Note : TheseRC PUMP motors are suitable for both VFD & DOL application)***	(i) 1LA7716-4
(ii) Type of duty	(ii) CONTINUOUS
(iii) Type of enclosure, Method of Cooling, Degree of Protection	(iii) TETV/IC511/IP55 AS PER CL. 10 OF IEC: 34-5
(iv) Applicable standard to which motor generally conforms	(iv) IS/IEC:60034
(v) Type of mounting	(v) Horizontal (B3)
(vi) Direction of rotation viewed from driving end.	(vi) CW (BI-DIRECTIONAL)
(vii) Standard continuous rating at 40deg.C ambient temp.(KW)	(vii) 1336
(viii) (a)Derated rating for specified normal condition i.e., ambient temperature of 50 Deg.C (KW)	(viii) 1250
(ix) Rated voltage (Volts)/ Rated Frequency (Hz)	(ix) 3300 / 50
(x) Permissible variation of	(x)
(a) Voltage (%)	(a) ± 6
(b) Frequency (%)	(b) + 3 - 5
(c) Combined voltage and frequency	(c) 10 % (Abs.)
(xi) Minimum permissible starting voltage (%)	(xi) 80
(xii) Rated speed at rated voltage and frequency (r.p.m.)	(xii) 1489

(xiii) At rated voltage and frequency	(xiii)
(a) Full load current (Amp)	(a) 264
(b) No load current (Amp)	(b) 68
(xiv) Power Factor at	(xiv)
(a) 100% load	(a) 0.87
(b) 75% load	(b) 0.82
(c) 50% load	(c) 0.75
(d) No load	(d) 0.045
(e) Starting	(e) 0.17
(xv) Efficiency (%) at rated voltage and frequency at	(xv)
(a) 100% load	(a) 95.2
(b) 75% load	(b) 94.5
(c) 50% load	(c) 93.0
(xvi) Starting current (%) at	(xvi)
(a) Rated Voltage	(a) 720 % (Maximum)
(b) Minimum starting Voltage	(b) 576 (Maximum) AT 80 % RV
(xvii) Starting time with minm. Permissible voltage	(xvii)
(a) Without driven equipment coupled	(a) 2.8 Sec
(b) With driven equipment coupled	(b) 9.26 Sec
(xviii)Safe stall time with 100 % rated voltage	(xviii)
(a) From hot condition	(a) 15 Sec
(b) From cold condition	(b) 20 Sec
(xix) Torque at (in % / kg-m)	(xix)
(a) Starting (at minimum permissible voltage)	(a) 57 % / 465.69 kg-m
(b) Pull up at 100% Voltage	(b) 85 % / 694.45 kg-m
(c) Pull out at 100% Voltage	(c) 210 % / **1715.7 kg-m**
(d) Rated load (kg-m) at 100 % Voltage	(d) 817 kg-m
(e) Mínimum Accelerating Torque (Kg-m) at 80 % RV	(e) 26 % / 212.42 kg-m
(xx) Stator winding resistance per phase (ohms) ref. to 20 deg.C.	(xx) 0.04139 +/- 5%
(xxi) Flywheel Moment of motor (Kg-m2) (GD2)	(xxi) 204 kg-m²
(xxii) No. of permissible starts from Hot/Cold condition	(xxii) 2 / 3
(xxiii)Locked Rotor KVA Input (at Rated Voltage)	(xxiii) 10864.53
(xxiv)Locked Rotor kVA / Rated kW	(xxiv) 8.7 (maximum)

(xxv) Vibration at No Load (Brg.Housing)	(xxv)
(a) Velocity (mm/s)	(a) 2.3 (rms)
(b) Displacement (Microns)	(b) 37 (p-p)
(xxvi)Noise Level at No Load	(xxvi) 85 dBA at 1.0 metre.
3. CONSTRUCTIONAL FEATURES	3.
(i) Stator winding Insulation	(i)
(a) Class & type	(a) F/EPOXY MICA RESSIN POOR (VPI)
(b) Tropicalised (Yes/No)	(b) YES
(c) Temperature rise over specified ambient of 50 deg C (deg C)	(c) 70
(d) Method of temp. Measurement	(d) BY RESISTANCE
(e) Stator winding connection	(e) STAR
(f) No. of terminals brought out	(f) 6
(ii) Type of terminal box for	(ii)
(a) Stator leads	(a) ELASTIMOULD TB
(b) Space heater	(b) CAST / FABRICATED
(c) Temperature detectors	(c) CAST / FABRICATED
(d) Instrument switches etc.	(d) NIL
(iii) For main terminal box	(iii)
(a) Location (from DE)	(a) RHS
(b) Entry of cables	(b) BOTTOM OF TB
(c) Recommended cable size (Runs/cores/x-section mm^2/ material)	(c) 2R X 3C X 185 Sq.mm. (Shall be as per approved sizing calculation)
(d) Fault level (MVA)/ Duration (Sec)	(d) 25 KA / 0.17 SEC
(iv)For Bearing	(iv)
(a) Type	(a) ANTIFRICTION
(b) Manufacturer	(b) NTPC APPVD. SUPPLIER
(c) Recommended lubricant	(c) IOC SERVOGEM-3/EQV. GREASE
(d) Guaranteed Life in Hrs.	(d) 40000 Hrs.
(e) Lubrication Type	(e) SELF
(f) Whether Dial Type Thermometer Provided	(f) YES
(v)Type of cooler (CACA/CACW)	(v) NA
(vi)Cooling water requirement for CACW motors	(vi)
(a) Quantity required	(a) NA
(b) Maximum permissible inlet water temperature (deg C)	(b) NA
(c) Pressure of water at inlet to coolers	(c) NA
(d) Outlet temperature of water at full load (anticipated value)	(d) NA
(vii)Weight of	(vii)
(a) Motor Stator (Kg)	(a) 6150
(b) Motor rotor (Kg)	(b) 1500
(c) Cooler (Kg)	(c) NA
(d) Total weight (Kg)	(d) 7650
(ix) Max. Perm. Temp. of Rotor	(ix) 350 Deg. C
(x) Total Temp. of Rotor during I Start	(x) 132 Deg. C
(xi) Total Temp. of Rotor during II Start	(xi) 144 Deg. C
(xii) Surge Withstand Voltage (Stator winding)	(xii) As per IEC: 60034-15
(a) 0.3/ 3 Microsecond Surge (kVp)	(a) 11.8
(b) 1.2/ 50 Microsecond Surge (kVp)	(b) 18.2

4.00 LIST OF ACCESSORIES

4.01 RTDs for winding (Type/Nos/Leads /location/make/Res. at 0 Deg.C)	: PT100 SIMPLEX / 12 / 3 Wire Between Coil Sides in slots/ Reputed NTPC Appvd./ 100 Ohms
4.02 RTDs for bearing (Type/Nos./Leads /location/make/Res. at 0 Deg.C)	: PT100 DUPLEX/ 3 nos per bearing side(Total=6) / 4 Wire In Bearing Housing/ Reputed NTPC Appvd./ 100 Ohms
4.03.01 RTDs for Hot Air (Type/No/Leads)	: NA
4.03.02 RTDs for Cold Air (Type/No/Leads)	: NA
4.04 Space Heaters	: YES
4.04.01 Nos.	: 4 nos of 800W each.
4.04.02 Power (Watts)	: 800 W
4.04.03 Supply Voltage	: 1 PH. 240VAC
4.04.04 Location	: In Air pockets
4.05 Stator Terminal Box	
4.05.01 Type	: Elastimould Terminal
4.05.02 Short time current rating	: 25 KA
4.05.03 Duration (sec)	: 0.17
4.06 Neutral TB	: PHASE SEPARATED T.B.
4.07 Current Transformers	: NA
4.07.01 Nos.	: --
4.07.02 Ratio	: --
4.07.03 Accuracy Class	: --
4.07.04 Vk (V)/Rct	: --
4.07.05 Exciting Current	: --
4.08 Dial Type Thermometer (Type/make: Mercury in Steel/ NTPC Appvd/ Accuracy/ Connection Type & size	+ - 1% Full Scale / BSP 3/4"
4.08.01For Bearings (Nos.)	: NA
4.08.02For Air Temp (Nos.) a. Hot Air	: NA
b. Cold Air	: NA
4.08.03Contact Rating	: 5 A AT 240 V AC/ 0. 5 A AT 220 V DC.
4.08.04Range	: 0 -120 Deg. C.
4.08.05Supply Voltage	: 240 V, 50 Hz, 1 Phase
4.09 Rotor Terminal Box	: NA
4.10 TBs for RTDs, BTDs & Space Heater	: YES
4.11 Sole Plate	: NO
4.12 Anchoring items	: YES (As per OGA)
4.13 Base Frame	: NO
4.14 Speed Switch	: NO
4.14.01 Supply Voltage	: NA

4.15	Insulation of Bearing	: NA
4.16	Forced Oil lubrication	: NA
4.17	Oil level Indicator	: NA
4.18	Noise Reducer	: NO
4.19	Water flow Indicator	: NA
4.19.01	No/Contact Rating	: NA
4.20	Water leakage detector	: NA
4.21	Tachogenerator	: NA
4.22	Grounding Pads	
4.22.01	No & Size on motor body	: 2
4.22.02	Nos on Terminal Box	: 2
4.23	Vibration Pads	: YES
4.23.01	Nos & Size	: 02 (total) , 80 mm cube
4.23.02	Location	: On DE and NDE endshield.
4.24	Paint Shade	: RAL 5012
4.25	Any other fitments	: NO
4.26	External Thrust on Motor	: NA

NOTE: The motor is suitable for both VFD and DOL start/operation.

5.00 LIST OF CURVES

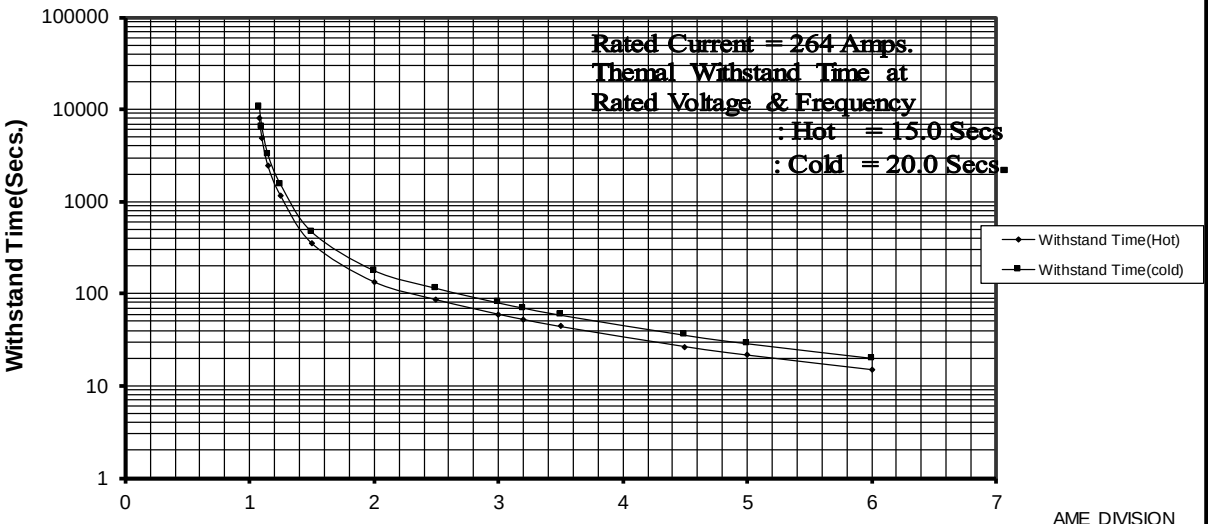
5.01	Thermal Withstand Characteristics	: 48154-71 /01
5.02	Torque Vs Speed Curves	: 48154-71 /02
5.03	Current Vs Speed Curves	: 48154-71 /02
5.04	Current Vs Time curves	: 48154-71 /03
5.05	Speed Vs Time curves	: 48154-71 /03
5.06	Efficiency & PF Vs Load Curves	: 48154-71 /04
5.07	Negative sequence curve	: 48154-71 /05
5.08	Calibration curve for RTD/BTD	: 48154-71 /06

PREPARED BY:

(B N Jena)
AME
BHEL-BHOPAL

Thermal Withstand Curves

Rating : 1250 KW, 3300 V, 4 P, TETV , Cage Rotor Asyn. Motor.
Frame : 1LA7716-4
W.O.No. : 48154P40171
Customer : M/S NTPC

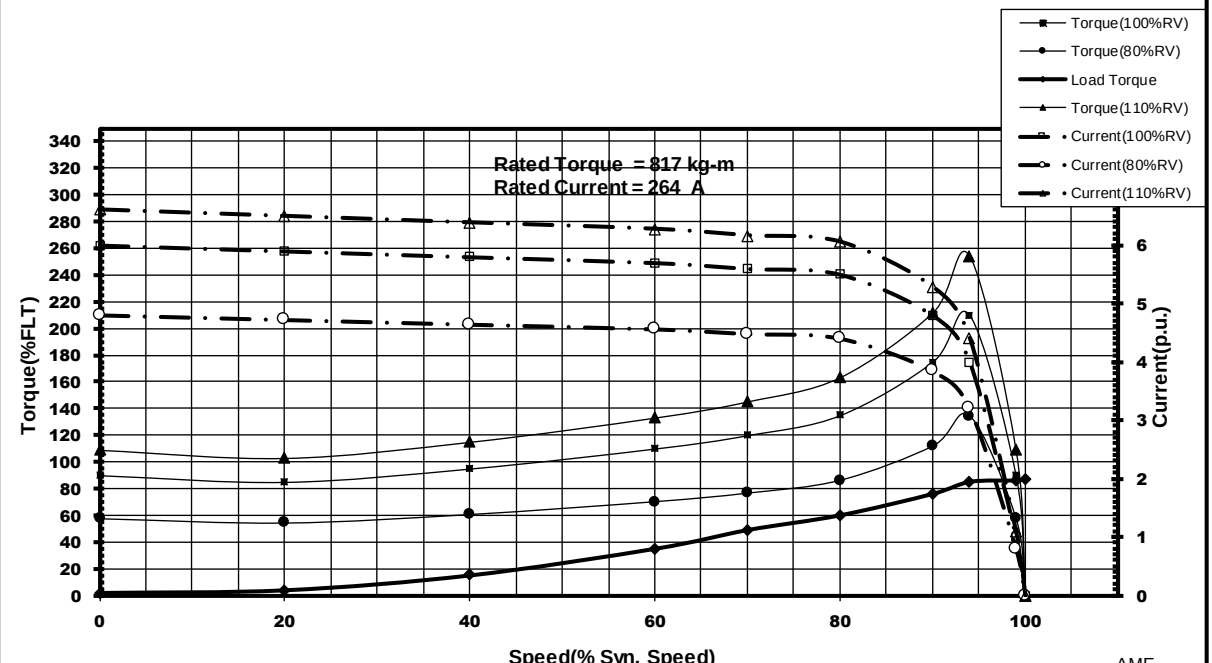


Curve No. 48154-71-04

AME DIVISION

Torque & Current Vs Speed Curves

Rating : 1250 KW, 3300 V, 4 P, TETV , Cage Rotor Asyn. Motor.
Frame : 1LA7716-4
W.O.No. : 48154P40171
Customer : M/S NTPC

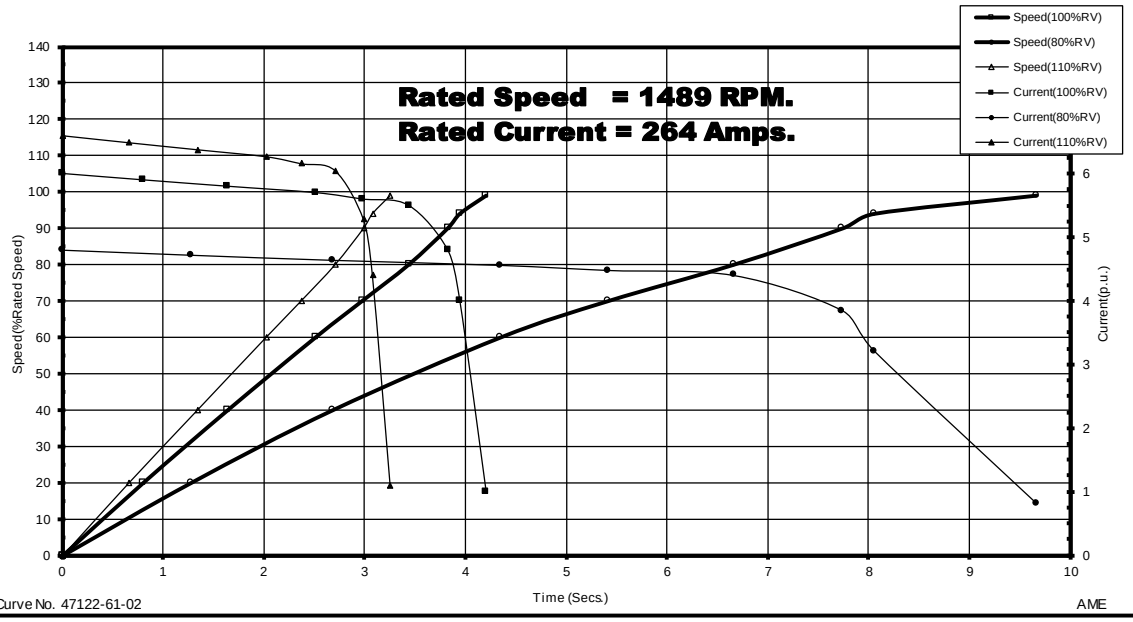


Curve No. 48154-71-01

AME

Speed & Current Vs Time Curves

Rating : 1250 KW, 3300 V, 4 P, TETV , Cage Rotor Asyn. Motor.
Frame : 1LA7716-4
W.O.No. : 48154P40171
Customer : M/S NTPC

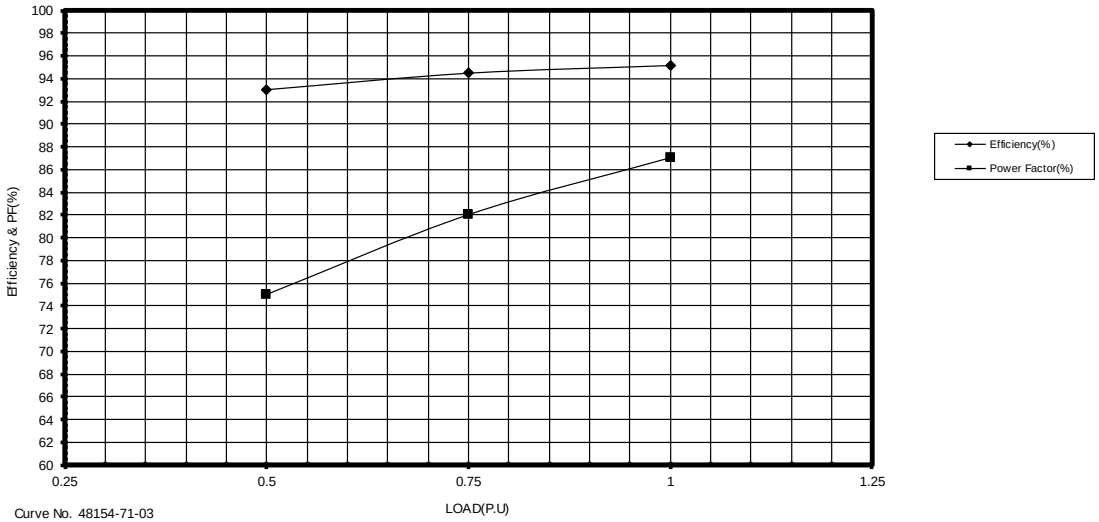


Curve No. 47122-61-02

AME

Efficiency, PF Vs Load Curves

Rating : 1250 KW, 3300 V, 4 P, TETV , Cage Rotor Asyn. Motor.
Frame : 1LA7716-4
W.O.No. : 48154P40171
Customer : M/S NTPC

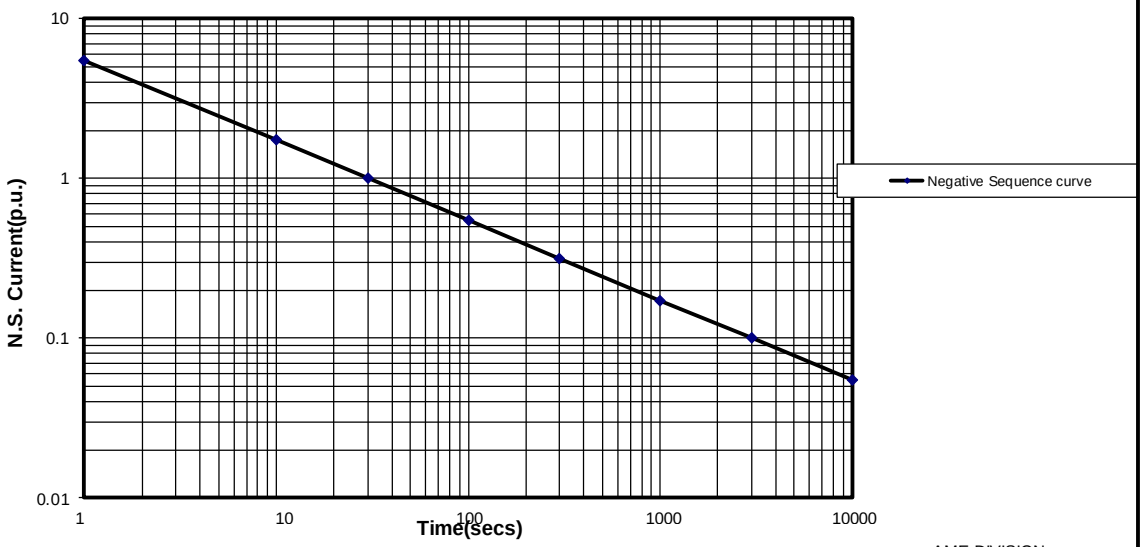


Curve No. 48154-71-03

AME DIVISION

NEGATIVE SEQUENCE CURVE

Rating : 1250 KW, 3300 V, 4 P, TETV , Cage Rotor Asyn. Motor.
Frame : 1LA7716-4
W.O.No. : 48154P40171
Customer : M/S NTPC

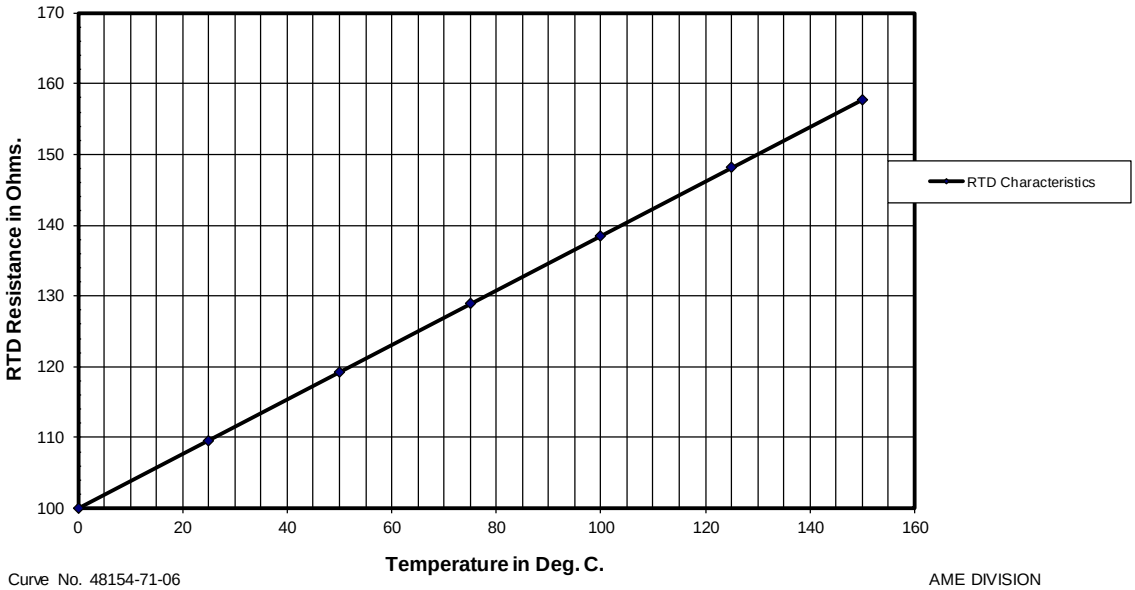


Curve No. 48154-71-05

AME DIVISION

RTD Characteristics(PT-100)

Rating : 1250 KW, 3300 V, 4 P, TETV , Cage Rotor Asyn. Motor.
Frame : 1LA7716-4
W.O.No. : 48154P40171
Customer : M/S NTPC



Curve No. 48154-71-06

AME DIVISION

VFD

1.00.00 **GENERAL**

The Design, manufacture, erection, testing and performance of items and services provided under this specification shall comply with the latest edition including all applicable official amendments and revisions as on date of award of the following standards. In case of conflict between this specification and code (IS Code, standards, etc.) referred herein, the former shall prevail. All work shall be carried out as per the following codes and standards.

2.00.00 **CODES AND STANDARDS**

HT breaker	IEC:60056
DC reactor	IEC 60289
Transformers	IS:2026, IEC: 60076 IEC 61378
Bushing	IS: 2099, IEC 60137
Adjustable Speed Electrical Power Drive Systems	IEC 61800
Semiconductor converters–General requirements	IEC 60146
IEEE Recommended practices and requirements for harmonic control in electrical power systems	IEEE 519
Degrees of protection provided by enclosures (IP Code)	IEC 60529
Electrostatic immunity test	IEC1000-4-2
Fast transient immunity test	IEC1000-4-4
Surge immunity test	IEC1000-4-5
High-voltage switchgear and controlgear; Pt.102: Alternating current disconnectors and earthing switches	IEC 62271-102
High-voltage switchgear and controlgear; Pt.200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 KV IS/IEC: 62271-200	
AC electricity meters	IS: 722
Metal oxide surge arrestor without gap for AC system	IEC: 60099-4
Terminal blocks for copper conductors	IEC: 60947-7-1
Dry transformer	IS: 11171
Motor	IEC 60034-18-41 &42, IEC60034 / NEMA 30 & 31,
Contactor/Switches/Fuses etc.	IEC:60947, IS: 13947
Harmonics & EM compatibility	IEEE:519/IEC: 61000
VFD	IEC: 60034/ IEC: 61800

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 Bidder shall clearly indicate

the standard(s) adopted, furnish a copy in English of the latest revision amendments and revision in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

3.00.00 **OPERATING CONDITIONS**

3.01.00 For the purpose of design of equipment/systems, an ambient temperature of 50 deg. Centigrade and also relative humidity of 95% at 40 deg. Celsius shall be considered.

3.02.00 All equipment shall be suitable for rated frequency of 50 Hz with a variation of +3% & -5%, and 10% combined variation of voltage and frequency unless specifically brought out in the specification.

3.03.00 The auxiliary AC voltage supply arrangement shall have 11/6.6/3.3kV and 415V systems (as applicable). It shall be designed to limit voltage variations as given below under worst operating condition:

1. 11kV/ 3.3 kV/ 6.6 KV : +/- 6%
2. 415V : +/- 10%

Note: The Voltage level mentioned above is the Nominal Voltage available at the input of the VFD System from the MCC/ Switchgear/transformer, based on the system requirement/Availability.

The voltage level for the VFD output to be fed to motor shall be as follows:-

1. Upto 400 kW : 415V/690V, Low Voltage, Three Phase AC
2. Above 400kW and upto 700 KW : 690V, Low Voltage, Three Phase AC
3. Above 700KW : Medium Voltage

From here onwards in the specifications all the VFD Systems consisting of either 415 V or 690 V may be termed as LV VFD while the higher rated VFD System shall be termed as MV VFD. If nothing is mentioned than the Clause is applicable for both the LV and the MV VFD until deliberated otherwise.

4.00.00 **SYSTEM DESCRIPTION**

Type of drive	3-Phase Diode / Thyristor / Multi Stage IGBT / IGCT / SGCT/ IEGT
Type of Cooling of VFD	Naturally air cooled/forced air cooled/Liquid cooled
Converter Type	Full wave diode rectifier/active front end type
Inverter Type	Thyristor/IGBT/IGCT/SGCT/IEGT

5.00.00	**GENERAL REQUIREMENTS**
5.01.00	**Medium Voltage VFD**: The Variable frequency drive (VFD) system shall be of a modern proven design for similar applications in power plants/industry. The system shall be either Current Source Inverter (CSI) or Voltage Source Inverter (VSI) type with minimum eighteen (18) pulse design.
5.02.00	**415 V/690 V LV VFD:** The Variable frequency drive (VFD) system shall be of a modern proven design for similar applications in power plants/industry. The system shall be either Current Source Inverter (CSI) or Voltage Source Inverter (VSI) type with minimum Twelve (12) pulse design. For drives less than 100 KW Six (6) pulse can be offered meeting all other requirements.
5.03.00	The system shall be fully digital, PLC/Microprocessor based, energy efficient, and shall provide very high reliability, high power factor, low harmonic distortion and low vibration and wear and noise. It shall be easy to install in minimum time and expense and no special tools shall be required for routine maintenance.
5.04.00	The offered equipment shall be with state of art technology and proven field track record. No prototype equipment shall be offered.
5.05.00	The VFD manufacturer shall ensure the proper coordination of their VFD with the Driven Motor and the supply system. All the Motors which are to be driven by VFDs will be of Inverter duty type. Also these motors shall comply the requirements stipulated in IEC: 60034-18-41 and IEC: 60034-18-42 as applicable. The VFD operation shall have no inherent detrimental impact on the Motors/ cables & supply system.
6.00.00	**TECHNICAL AND OPERATIONAL REQUIREMENTS**
6.01.00	The system shall be designed to deliver the motor input current and torque for the complete speed torque characteristics of the driven equipment, with worst input supply voltage and frequency variation. The system shall be suitable for the load characteristics and the operational duty of the driven equipment.
6.02.00	The overload capacity of the controller shall be 150% of the rated current of the motor for one minute for constant torque applications and 110% of rated current for one minute for variable torque applications at rated voltage. If the motor load exceeds the limit, the drive shall automatically reduce the frequency and voltage to the motor to guard against overload.
6.03.00	The drive system shall be designed to operate in one or more of the following operating modes as to suit characteristics of the driven equipment or specified by the load: a. Variable torque changing as a function of speed. b. Constant torque over a specific speed range. c. Constant power over a specific speed range.

	d. Any other as specified in data-sheet
6.04.00	VFDs shall comply with the latest edition of IEEE 519 & IEC 61000 for both individual as well as total harmonic voltage and current distortion limits. The Voltage and Current limits shall be applicable at the Point of Common Coupling (PCC), which shall be the MCC/ Switchgear/ from which the VFD system is fed.
6.05.00	The above compliance shall be verified by the field measurements of harmonics at the PCC with and without VFDs operation.
6.06.00	VFD shall be capable of withstanding the thermal and dynamic stresses and the transient mechanical torque, resulting from short circuit. Any damage resulting from such a short circuit or internal fault shall be limited to the component concerned.
6.07.00	The system shall be suitable to maintain speed variation within range 10-110% or as per the requirement of driven equipment with speed set accuracy of +1% of rated maximum speed and steady state regulation of +0.5% of rated speed as per system requirement.
6.08.00	The VFD System shall maintain a power factor of 0.95 (minimum) (for LV VFD system) and 0.9 (minimum) (for MV VFD system) in the entire operating range.
6.09.00	Maximum allowable audible noise from the VFD system will be 85 dB (A) at a distance of one meter under rated loaded with all cooling fan operating conditions.
6.10.00	All the circuit components shall be suitably protected against over voltages, surges, lightning etc.
6.11.00	The panels shall be designed to provide easy access to hardware, to facilitate replacement of cards in case of any failure.
6.12.00	All the VFDs for particular application shall be of same design so as to ensure 100 % interchangeability of components.
6.13.00	For each programmed warning and fault protection function, the VFD shall display a message in complete English words or Standard English abbreviations. At least 30 time tagged fault messages shall be stored in the drive's fault history.
6.14.00	The VFD cubicles shall be placed in air conditioned environment. However if VFDs of less than 100 kW are designed to operate in non-air condition environment the same shall also be acceptable.
6.15.00	The 3-Phase Thyristor/IGCT/SGCT/ multistage IGBT/IEGT based VFD system shall have minimum number of components to ensure very high reliability. The input side converter shall have 3-Phase Diode/Thyristor bridge configuration modular type and inverter shall be of 3-Phase Thyristor/IGCT/SGCT/multi stage IGBT/IEGT type, using Pulse Width Modulation or better technique for generating near sine wave output to motor.
6.16.00	Fiber optic cable connection shall be provided preferably to ensure high network reliability.

7.00.00	**VFD COMPATIBILITY WITH THE MOTOR**
7.01.00	MV VFD output current waveform, as measured at the motor, shall be inherently sinusoidal at nominal loads, with a total harmonic current and voltage distortion within acceptable/standard limits. VFD with transformers on output side are not acceptable.
7.02.00	The system design shall not have any inherent output harmonic resonance in the operating speed range.
7.03.00	VFD shall provide stable operation of motor from high-voltage dv/dt stress, regardless of cable length to motor. The vendor shall clearly state the limitations in the motor cable distance in his proposal. However, due to system requirements & constraints if the cable length becomes critical, filters/ chokes etc. shall be provided by the VFD manufacturers as an integral part of the VFD to mitigate the reflected wave effect of harmonics.
8.00.00	**BYPASS ARRANGEMENT (OPTIONAL, IF SPECIFIED)**
8.01.00	The VFD System shall have an optional feature to run the motor under bypass arrangement for operation of Motor with VFD bypassed. During starting (under rated conditions) the motor will be switched on in VFD Mode to limit the starting current and after gaining speed, the load would be switched over to bypass mode.
8.02.00	Comprehensive motor protection scheme for protection and control for operation VFD during bypass mode shall be finalized during detailed engineering.
9.00.00	**STANDBY VFD ARRANGEMENT (OPTIONAL, IF SPECIFIED)**
9.01.00	A Common standby arrangement with auto/manual switchover shall be provided in case of failure of any VFD in a group of drives. Complete protection, interlocks & control required shall be provided in the changeover module.
10.00.00	**EFFICIENCY**
10.01.00	Efficiency (Drive only) shall be minimum 98% for both MV VFD and LV VFD. Overall efficiency shall be minimum 96.5% for LV VFD and minimum 94 % for MV VFD at rated load and speed. Overall Efficiency evaluation shall include input transformer, harmonic filters and power factor correction (if applicable), VFD converters, cooling fans and output filter, as applicable in the system. Auxiliary controls, such as internal VFD control boards, cooling fans/pumps.
10.02.00	In absence of valid test report, a factory test shall be performed at the VFD manufacturer's facility verifying the efficiencies. Manufactures who are supplying Drive and transformer from different locations, efficiency test will be conducted separately for Drive and transformer.
11.00.00	**COOLING SYSTEM**

11.01.00	The VFD shall be designed to operate indoor under temperature range of 0 deg C to 50 deg C and relative humidity of 95 %(at 40 deg C).	
11.02.00	VFD manufacturer to primarily offer Air cooled Design. However in case of large ratings, liquid cooled drives may be accepted subject to employer's approval. In case of liquid cooled system, there shall be no necessity of continuous water supply system (Closed Loop System).	
11.03.00	In case of Air cooled design, the VFD Cooling system shall be such that it puts minimum heat load inside the room and preferably throw the hot air outside the room with ventilation ducts. The Cooling system shall be designed in such a way that the Air Conditioning & Ventilation Air requirements are kept to minimum. The VFD Manufacturer shall furnish the data regarding heat load, air flow requirements during the detailed engineering.	
11.04.00	Air cooled VFDs shall be provided with cooling fans mounted integral to the VFD/ enclosure. The VFD shall include air-flow pressure switches and temperature detectors to monitor proper operation of the air cooling system. If the fan fails, the system must generate the alarm/trip for the fan failure.	
12.00.00	**TRANSFORMER:**	
12.01.00	Type: Outdoor Mineral oil filled ONAN type or Indoor natural air-cooled Dry type, Three phase unit, rectifier/converter duty type transformer.	
12.02.00	All other components, technical parameters shall be as per applicable IEC/IS.	
12.03.00	Enclosure for Dry Type Transformer (as applicable) Enclosure shall be of a tested quality sheet steel of minimum thickness 2 mm & shall also accommodate cable terminations. The housing door shall be interlocked such that it should be possible to open the door only when transformer is off. The enclosure shall be provided with lifting lugs and other hardware for floor mounting.	
12.04.00	Core	Shall be High grade non-ageing cold rolled grain oriented silicon steel Laminations.
12.05.00	Winding conductor	Shall be electrolytic grade copper. Windings shall be of class F insulation.
12.06.00	Winding temperature Indicator (WTI)	Shall be Platinum resistance type temperature detector in each limb.
12.07.00	Thermistors	Shall be embedded in each limb with alarm and trip contacts for remote annunciation.
12.08.00	Temperature rise:	Winding temperature rise shall be as per applicable IEC.

13.00.00	**POWER CONVERTER:**
13.01.00	The static power converter shall consist of a line side converter for operation as a rectifier and a load side power converter for operation as a fully controller inverter. Power converter shall be fast switching, most efficient and low loss type.
13.02.00	The converter shall be coordinated with the transformers. The converter shall be able to withstand a three phase short circuit current until interrupted by normal breaker operation.
13.03.00	Adequate short circuit and over voltage protection shall be provided for the converter and inverter system.
13.04.00	All power converter devices shall include protective devices, snubber networks and dv/dt networks as required.
13.05.00	The current rating of the converter's semi-conductor components shall not be less than 120% of the nominal current flowing through the elements at full load of the VFD through the whole speed range. If the parallel connection of semiconductor is applied, the above current rating shall not be less than 140% of the above values.
13.06.00	All power diodes shall be of silicon type with minimum VBO rating at 2.5 times the rated operating voltage.
13.07.00	The power converter circuit shall be designed so that motor can be powered at its full nameplate rating continuously without exceeding its rated temperature rise nor reducing its service factor due to harmonic currents generated by the inverter operation. The conversion devices and associated heat sinks shall be assembled such that individual devices can be replaced without requiring the use of any special precautions / tools.
13.08.00	The cooling system of the electronic components, if provided, shall be monitored and necessary alarms shall be provided to prevent any consequential damage to the power control devices.
14.00.00	**OUTPUT FILTER (AS APPLICABLE):**
14.01.00	Output/ dv/dt filter shall be provided, if required. It shall be an integral part of the VFD system and included within the VFD enclosure. It shall inherently protect motor from high voltage dv/dt stress.
15.00.00	**DC LINK CAPACITOR (AS APPLICABLE):**
15.01.00	Capacitor shall be of self-healing film or electrolytic type having high life time. The capacitor shall be an integral part of VFD system. DC link Capacitors shall have discharge resistors which shall be capable of reducing the residual charges to zero just after the capacitor is disconnected from the supply source. The capacitor shall be suitable for high ripple currents.
16.00.00	AC/**DC Reactor (As applicable)**

	1) Type: Dry type, air cored, self cooled, indoor type. Suitable for withstanding earth fault continuously. 2) Insulation: Thermal Class 155(F), temperature rise is limited to thermal class 130 (B). 3) Noise level shall not exceed value specified in NEMA TR-1.
17.00.00	**VFD PANEL REQUIREMENTS**
17.01.00	Enclosure frames and load bearing members shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness 2.0 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness 1.6 mm. Doors and covers shall also be of cold rolled sheet steel of thickness 1.6 mm. Stiffeners shall be provided wherever necessary. The gland plate thickness shall be 3.0 mm for hot / cold-rolled sheet steel and 4.0 mm for non-magnetic material. In case dry type transformer is provided inside VFD panels, the enclosure and in its frame thickness shall be same as indicated in this para.
17.02.00	The cable entry shall be from the bottom of the panel and a removable bolted un-drilled gland plate.
17.03.00	All Panels shall be of dust-proof and vermin-proof construction and shall be provided with a degree of protection of IP: 3X or better for MV VFD and IP: 4X or better for LV VFD as per IS/IEC 60947
17.04.00	Enclosures must be designed to avoid harmonic and inductive heating effects and to shield any outside equipment from interference, enclosing and shielding the complete to eliminate any radio frequency interference. The construction of the panel shall provide effective protection against electromagnetic emissions.
17.05.00	Each panel shall be provided with illuminating lamp, space heater with switch fuse and variable setting thermostat.
17.06.00	Proper ventilation using air filters and fans/pumps shall be provided in the panels to ensure that maximum temperature inside the cubicle is within permissible limits for reliable and continuous operation of the system.
18.00.00	**PAINTING**
	Paint shade shall be as follows a) VFD transformer reactor enclosure : RAL 5012 (Blue), legend in black letter b) Motors : RAL 5012 (Blue) c) VFD Panels : Front and rear panels in Grey (RAL9002). End panel sides in blue (RAL 5012)
19.00.00	**HT SWITCHGEAR**
19.01.00	The technical requirements of HT switchgear shall be as per chapter of HT switchgear in Part-B of Technical specifications.
20.00.00	**MOTORS**

20.01.00	VFD shall be used to drive three (3) phase squirrel cage inverter duty Induction motor with VPI insulation (Resin poor) suitable for VFD application. These motors shall be provided with insulated bearing on at least one side.
20.02.00	Motors shall also meet the requirements mentioned in subsection for motors and relevant IS/IEC.
20.03.00	Motor shall be suitable for operation with a solid state power supply consisting of an adjustable frequency inverter for speed control & shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive.
20.04.00	Motor insulation shall be designed to accept the applied voltage waveform, within the Vpeak and dv/dt limits as per IEC-61800.
20.05.00	Drive manufacturer shall coordinate with the motor manufacturer for proper selection of the motor for the given load application and the output characteristics of the drive.
20.06.00	Other requirements of motor shall be as stipulated in technical chapter of Motors in Part-B of technical specifications.
21.00.00 .	**LT & HT CABLES**
21.01.00	Contractor's scope shall also include LT and HT cables suitable for VFD system and Motors.
22.00.00	**CONTROL AND PERFORMANCE REQUIREMENTS**
22.01.00	The VFD to provide an automatic current limiting feature to control motor currents during startup and provide a "soft start" torque profile for the motor load combination. Current and torque limit adjustments shall be provided to limit the maximum VFD output current and the maximum torque produced by the motor.
22.02.00	It shall be possible to vary the speed of the drive and control it in either Local or Remote mode. Local / Remote selection shall be done from VFD panel unless otherwise specified.
22.03.00	Provision shall be kept for exchange of information between different VFD control system parameters thru PLC/DDCMIS. Man machine interface for (MV) VFD shall have one flat TFT monitor with keyboard (password protected) in the VFD room and a color laser printer for system alarm and monitoring located in control room. Parameter Monitoring: -Input and output voltage of Drive - Input and output current of Drive - Motor speed - Input and output power frequency of Drive - Torque -Input and Output power of Drive system (covering transformer if applicable) - Output kWhr of Drive - Transformer (if applicable) temperature for alarm & trip. - Ambient temperature

	- Run/stop and local/remote status displayed
22.04.00	Drive shall be equipped with a front mounted operator console panel consisting of a backlit alphanumeric display and a keypad with keys for parameterization and adjusting parameter. Control panel shall be operable with password for changing the protection setting, safety interlock etc.
22.05.00	Operator console/Main Control Card shall have facility / port to connect external hardware such as Lap-Top etc. Console shall have facility for upload and download of all parameter settings from one drive to another drive for start up and operation.
22.06.00	User-friendly licensed software for operation and fault diagnostic shall be loaded in the drive system panel before commissioning.
23.00.00	**PROTECTION FEATURES**
23.01.00	The system offered shall incorporate adequate protection features as per IEC 61800-4: 2002 Table-8, properly coordinated for the drive control and for motor including following: i) Converter transformer: short circuit, over current, earth fault & winding temperature high protection. ii) Incoming and outgoing line surge protection. iii) Under / over voltage protection iv) Phase loss, phase reversal, overload, negative phase sequence, locked rotor protection. v) Instantaneous Over current & Earth fault protection vi) Converter/Inverter module failure indication. vii) Over frequency/speed protection. viii) Ventilation failure indication & alarm. ix) Over temperature of VFD x) Bearing temperature protection. xi) System earth fault protection. xii) Speed reference loss protection.
23.02.00	Under VFD Bypass Mode (if applicable) all the electrical protections related to the Motor shall remain applicable.
24.00.00	**CONTROL FEATURES**
24.01.00	Following controls shall be provided as a part of the Operator Control Panel or through separate switches on the front panel door.

	i) Start / stop (in local/remote mode)
	ii) Speed control (Raise / lower)
	iii) Acknowledge/Accept/ Test Push Button for annunciation
	iv) Auto / Manual / Test Mode select
	v) Emergency stop
	vi) Trip-Remote Breaker
25.00.00	**DIAGNOSTIC FEATURES**
25.01.00	The VFD shall include a microprocessor/PLC based digital diagnostic system which monitors its own control functions and displays faults and operating conditions.
25.02.00	Fault diagnostic shall be built into the system to supervise the operation and failure of the system. The information regarding failure of any of the system including shut down of the system shall be available. It shall be possible to retrieve the record of events prior to tripping of the system or de-energization. Auxiliary supply to the system components or to the electronics (firmware) for the diagnostics / display shall be taken care of by the manufacturer for this purpose.
26.00.00	**SERVICEABILITY / MAINTAINABILITY**
26.01.00	Power Component Accessibility: All power components in the converter sections shall be designed for rack-out accessibility for ease of maintenance and to minimize repair downtime.
26.02.00	Marking / Labeling: Sleeve type wire marker tags or other acceptable means of permanent identification shall be applied to power and control wiring. Individual labels shall be provided for all major components of the VFD system.
27.00.00	**STORAGE AND PRESERVATION**
27.01.00	The Contractor shall be responsible for the storage and preservation of all the equipments to be supplied under the VFD System, till the time of successful installation and commissioning. The equipment should be suitable for storage for long periods before installation. Contractor should take adequate measures to ensure that no damage happens to the VFD System due to storage and preservation.
28.00.00	**TESTS**
28.01.00	**ROUTINE TESTS**
	All acceptance and routine tests as envisaged in QA section shall be carried out. Charges for these shall be deemed to be included in the equipment price.
28.02.00	**TYPE TESTS**
28.02.01	The Contractor shall carry out the type tests as listed in this specification on the

	equipment to be supplied under this contract. The bidder shall indicate the charges for each of these type tests separately in the relevant schedule and the same shall be considered for the evaluation of the bids. The type tests charges shall be paid only for the test(s) actually conducted successfully under this contract and upon certification by the employer's engineer.
28.02.02	The type tests shall be carried out in presence of the employer's representative, for which minimum 15 days' notice shall be given by the Contractor. The Contractor shall obtain the employer's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set–up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.
28.02.03	In case the Contractor has conducted such specified type test(s) within last ten years as on the date of bid opening, he may submit during detailed engineering the type test reports to the Employer for waival of conductance of such test(s). These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. The Employer reserves the right to waive conducting of any or all the specified type test(s) under this contract. In case type tests are waived, the type test charges shall not be payable to the Contractor.
28.02.04	Further the Contractor shall only submit the reports of the type tests as listed in "LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED" and carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. However if the Contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the Contractor shall conduct all such tests under this contract at no additional cost to the Employer either at third party lab or in presence of client/Employers representative and submit the reports for approval.
28.03.00	**LIST OF TYPE TESTS TO BE CONDUCTED** The following type tests shall be conducted under this contract for MV VFD i) Overall efficiency determination of VFD system including transformer/ Harmonic filters etc at motor full load ii) Temperature rise test iii) Noise level iv) Harmonics of No load current.(Input/Output)
28.04.00	**LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED** The following type test reports shall be submitted for VFD Panels' **1) VFD panels (For LV VFD)** i. Rated Current/ Output

ii. Temperature rise test

iii. Noise level test

iv. Power Loss Determination Test

v. Power factor measurement.

vi. Degree of Protection Test

vii. EMC Test

viii. The Fast transient SWC tests as per ANSI / IEEE C37.901-2002 / IEC 60255-22-04-2008 / IEC 61800

2) VFD panels (For MV VFD)

i. Rated Current/ Output

ii. Current Sharing

iii. Voltage Division

iv. Power Loss Determination Test

v. Power factor measurement.

vi. Degree of Protection Test

vii. The Fast transient SWC tests as per ANSI / IEEE C37.901-2002 / IEC 60255-22-04-2008 / IEC 61800

3) AC/DC Reactor

i. Lightning impulse test(If applicable)

ii. Heat run test

iii. Short time current test(If applicable)

iv. Noise level test

4) Transformers (In case of non integrated type)

i. As per requirements mentioned in subsection for Transformer chapter in technical specifications.

SUB-SECTION-V-QE14

VFD MODULE

DRY TYPE TRANSFORMER

Attributes / Characteristics / Items/Components Sub Systems	Visual & Dimensional check	Mechanical properties	Electrical strength	Thermal Properties	Chemical Properties	NDT / DP / MPI	Voltage Ratio, Vector Group & Polarity	Make / Type / Rating / Model /TC / General Physical Inspection	WPS & PQR	Routine Test as per relevant standard	Measurement of capacitance & tan delta between winding	Routine Test
Enclosure door, H.V. & L.V. Cable Box / Flange Throat	Y	Y						Y				
Copper Conductor	Y	Y	Y		Y							
Insulating Material	Y			Y	Y							
CRGO Lamination & Built Core	Y											
Bushing /Insulator (IS:2544 / 5621)	Y							Y		Y		
Gasket	Y							Y		Y		
Off-Circuit Tap Changer	Y							Y				
Core Coil Assembly	Y						Y					
Marshalling Box	Y									Y		
WTI, Thermister, Terminal Connector	Y							Y				
Welding									Y			
Complete Transformer (IS:11171 / IEC 60076)	Y										Y	Y

Notes: 1) This is an indicative List of test/checks. The manufacturer is to furnish a detailed Quality Plan indicating his practice and procedure along with relevant supporting documents during QP finalization for all item.

2) All major Bought out Items will be subject to NTPC approval.

VFD PANEL

Attributes Characteristics / Item Components Sub System Assembly	Electrical Properties	Mechanical Properties	Chemical Properties	Dimensions / Finish	Type/ Rating/Functional check	HV/IR	Routine test as per relevant std.	Constructional Features	IS:6005 ,Seven tank process	Paint finish/ shade/thickness	Mountings / BOM/ Make, Completeness	Interlock Functional & Operation Testing / Simulation check	Degree of Protection Test	Final testing as per Relevant IS/IEC
Sheet Steel (IS-513)		Y	Y	Y										
Aluminum / Copper Bus-bar(IS-5082/IS-613/IS-1987)	Y	Y	Y	Y										
Support Insulator (BS-2782/IEC-660/IS-10912)	Y	Y	Y	Y										
Control / Selector Switch(IS-6875)					Y	Y	Y							
Contactor/ MCB(IS-13947)					Y	Y	Y							
O/L Protection relays(IS-3231)					Y		Y							
C.T /V.T/ Indicating Meter(IS-2705/3156/1248)					Y	Y	Y							
Fuse/ Fuse carrier(IS-13703)					Y	Y	Y							
Terminals/lugs/pvc wires(IS-13947//IS-694)	Y			Y	Y	Y	Y							
Timers(IS-3231)					Y	Y	Y							
Push Button/ Lamp/ (IS-6875)					Y	Y	Y							
Control Transformer (IS-12021)					Y	Y	Y							
Mimic, Annunciater					Y		Y							
GASKET(IS-11149)		Y	Y	Y	Y		Y							
Fabrication								Y						
Pretreatment & Painting									Y	Y				
VFD panel										Y	Y	Y	Y	Y

NOTE:

1. This is an indicative list of Test/ Checks. The manufacturer to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. All major Bought Out Items will be subject to NTPC approval.