

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

**Tender Document for " Supply and E&C Support services for VFD System for BPCL
Kochi and APCL Assam Projects (Ref. NKR0000235)**

TENDER REFERENCE DOC	NKR0000235
TENDER DOCUMENT AVAILABLE FROM	31.05.2018
LAST DATE AND TIME FOR SUBMISSION OF TENDER	22.06.2018 at 13.00Hrs IST
DATE AND TIME FOR TENDER OPENING	22.06.2018 at 13.30Hrs IST
SUBMISSION OF TENDER	Offer to be submitted in sealed cover/envelope (Refer Instruction to bidders for details)

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: NKR0000235
RFQ DATE: 31.05.2018
RFQ DUE DATE: 22.06.2018 at 13.00Hrs IST

(for all correspondence)
Purchase Executive : Nilmani Kumar
Phone :080- 26998663
Fax : 00918026989227
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SI No.	Material Code	Description	Qty	Unit	Delivery
1	VFD_COMM_SP	COMMISSIONING SPARES FOR VFD for - COMMISSIONING SPARES FOR VFD (PART OF CORRESPONDING MAIN PURCHASE SPECIFICATION) for Kochi project as per specification PS/445/2598	1	LOT	15.12.2018
2	PR0900005100	MANDATORY SPARES FOR VFD for Kochi project (PART OF CORRESPONDING MAIN PURCHASE SPECIFICATION) as per specification PS/445/2598	1	ST	15.12.2018
3	PR0900009144	VFD for 4600kW,6.6kV SCIM BPCL Kochi-RGC - 6.6kV VFD Panels with Diode/Active front end rectifier with integrated Dry Type Transformer, Air cooled and LCS. as per specification PS/445/2598	1	NO	15.12.2018
4	PR0900005100	MANDATORY SPARES FOR VFD for Kochi Project (PART OF CORRESPONDING MAIN PURCHASE SPECIFICATION) as per specification PS/445/2599	1	ST	15.12.2018
5	VFD_COMM_SP	COMMISSIONING SPARES FOR VFD for Kochi project COMMISSIONING SPARES FOR VFD (PART OF CORRESPONDING MAIN PURCHASE SPECIFICATION) as per specification PS/445/2599	1	LOT	15.12.2018
6	PR0900009136	VFD for 5640kW,6.6kV SCIM BPCL Kochi NGC as per specification PS/445/2599	1	NO	15.12.2018
7	PR0900009128	VFD FOR 1290KW SCIM- APCL, ASSAM as per specification PS/445/2597	1	NO	15.12.2018
8	PR0900009110	LOCAL CONTROL STATION FOR VFD for APCL Assam project as per specification PS/445/2597	1	NO	15.12.2018
9	PR0900009101	CABLE ACCESSORIES FOR VFD for APCL Assam project as per specification PS/445/2597	1	ST	15.12.2018
10	VFD_COMM_SP	COMMISSIONING SPARES FOR VFD for APCL Assam project COMMISSIONING SPARES FOR VFD (PART OF CORRESPONDING MAIN PURCHASE SPECIFICATION) as per specification PS/445/2597	1	LOT	15.12.2018
11	PR0900005100	MANDATORY SPARES FOR VFD for APCL Assam project (PART OF CORRESPONDING MAIN PURCHASE SPECIFICATION) as per specification PS/445/2597	1	ST	15.12.2018

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 period of 90 days from due date.

iv) The quotation must be enclosed in a sealed envelope superscribed with RFQ no. and due date. It should reach us on or before the due date by 13.00Hrs IST and will be opened at 13.30Hrs IST on the same day.

Pre-Qualification Criteria

Project: VFD for 1290kW Induction Motor
 Customer: Assam Petrochemicals Ltd., Assam
 Consultant: EIL, New Delhi
 VFD Specification: PS/445/2597

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 offered) of 1290 kW or above rating for feeding squirrel cage induction motor, which is in successful operation for a period of at least one (1) year as on 28-05-2018. 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.
3. Letter from user (end customer) for at least one year successful operation of the VFD system shall be furnished in support of pt.2 above. This letter shall also contain contact details of the customer.
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 EIL acceptance of the 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	

Pre-Qualification Criteria

Project: VFD for 5640kW Induction Motor

Customer: BPCL Kochi Refinery, Kerala

Consultant: EIL, New Delhi

VFD Specification: PS/445/2599

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 offered) of 3000 kW or above rating for feeding squirrel cage induction motor, which is in successful operation for a period of at least one (1) year as on 23-05-2018. 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.
3. Letter from user (end customer) for at least one year successful operation of the VFD system shall be furnished in support of pt.2 above. This letter shall also contain contact details of the customer.
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 EIL acceptance of the 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	

Pre-Qualification Criteria

Project: VFD for 4600kW Induction Motor

Customer: BPCL Kochi Refinery, Kerala

Consultant: EIL, New Delhi

VFD Specification: PS/445/2598

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 offered) of 3000 kW or above rating for feeding squirrel cage induction motor, which is in successful operation for a period of at least one (1) year as on 23-05-2018. 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.
3. Letter from user (end customer) for at least one year successful operation of the VFD system shall be furnished in support of pt.2 above. This letter shall also contain contact details of the customer.
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 EIL acceptance of the 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	



PURCHASE SPECIFICATION
GROUP: VFD ENGINEERING

P.S NO. : PS/445/2597

REV. NO: 00

CONTENT SHEET

PART-A : BHEL SPECIFICATION

- (A1) VFD PANEL AND TRANSFORMER SPECIFICATION
- (A2) SINGLE LINE DIAGRAM OF VFD SYSTEM-36610000967
- (A3) MOTOR DATASHEET- A672-001-16-50-DS-5003
- (A4) COMPRESSOR TORQUE CURVES- 4CM40000934, Rev0

PART-B : EIL SPECIFICATION

- (B1) EIL JOB SPECIFICATION: A672-001-16-50-SP-5009 Rev. 0
- (B2) EIL STANDARD SPECIFICATIONS: 6-51-0044 REV.4 FOR DRY TYPE TRANSFORMER
- (B3) EIL STANDARD SPECIFICATIONS: 6-51-0050 REV.2 FOR HV VARIABLE FREQUENCY DRIVE SYSTEM
- (B4) EIL SPECIFICATIONS FOR FLAME PROOF LOCAL OPERATING PANEL: 6-51-0006 REV.4
- (B5) VFD DATASHEET: A672-001-16-50-DS-5006,Rev. A
- (B6) DRY TYPE TRANSFORMER DATASHEET: A672-001-16-50-DS-5007, Rev. 0
- (B7) ITP FOR FLAME PROOF LOCAL CONTROL STATION: 6-81-1006 REV. 3
- (B8) ITP FOR DRY TYPE TRANSFORMER: 6-81-1044 REV.2
- (B9) ITP FOR HV VFD: 6-81-1050 REV.2
- (B10) VENDOR LIST
- (B11) EXPERIENCE RECORD SHEET – A672-001-16-50-DS-5009



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REVISION HISTORY SHEET

REV. NO.	DATE	NATURE OF CHANGE	REASONS	PREPARED BY	APPROVED BY
00	18-05-2018	FIRST ISSUE	-----		

REVISIONS 00

APPROVED BY *L. Subbalakshmi*
L SUBBALAKSHMI

PREPARED BY
K. Deo
KAMALINI DEY

ISSUED BY
VFD ENGG

DATE
18-05-2018

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**TECHNICAL SPECIFICATION OF IGBT/ IGCT/ SGCT BASED VFD FOR
1290kW SQUIRREL CAGE INDUCTION MOTOR FOR
NATURAL GAS COMPRESSOR****1. Project Details**

Sl. No.	Parameter	Specification
1	Project Location	ASSAM PETROCHEMICALS LTD., ASSAM INDIA
2	Project Title	500 TPD METHANOL AND 200 TPD FORMALIN PLANT
3	Customer	ASSAM PETROCHEMICALS LTD.
4	Consultant	ENGINEERS INDIA LIMITED (EIL)

2. Environment Specifications

Sl. No.	Parameter	Specification
1	Maximum Ambient Temperature	39.8°C
2	Minimum Ambient Temperature	1°C
3	Equipment Design Ambient Temperature (IS-9676)	40°C
4	Relative Humidity	88%
5	Altitude	Less than 1000m above mean sea level
6	Location of VFD Panels	Indoor, Ventilated Room with Air Conditioning.
7	Seismic Zone	As per IS-1893-Zone-III

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REVISIONS 00

APPROVED BY *L. Subbalakshmi*
L SUBBALAKSHMIPREPARED BY *K. S. De*
KAMALINI DEYISSUED BY
VFD ENGGDATE
18-05-2018



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3. Input and Transformer Data :

Sl. No.	Parameter	Specification
1	System Voltage / Frequency / Phase	6.6kV / 50Hz / 3
2	Voltage Variation	±10%
3	Frequency Variation	±3%
4	Combined Voltage and Frequency Variation	±10%
5	Fault Level	40kA/1 sec (Max 40kA and Min 10kA)
6	Transformer Type	Dry type integrated Transformer (In Vendor scope), Indoor
7	Rating	Transformer must be designed to carry 110% of calculated VFD rating. Transformer sizing calculation shall be provided along with offer.
8	Power Cables	Cable glands and termination suitable for 1RX3CX240 sq.mm. Al, XLPE cable to be provided by the vendor for Transformer HV side cable termination. The exact cable sizes will be intimated during drawing approval stage. Cables and termination kit in Customer scope.

4. Motor Data :

Sl. No.	Parameter	Specification		
1	Type	Squirrel Cage Induction Motor		
2	Scope	Manufactured by BHEL-Bhopal		
3	Rated Output	1290kW, 2979 RPM		
4	Rated Voltage and Current	6.6kV, 132A		
5	No load Current	During detailed engineering		
6	Pull Out Torque (% of FLT)	240%		
7	Fed from	Variable Frequency Drive (V/f Control)		
8	Duty Class	Continuous - S1		
9	Efficiency and Power Factor:	% of Load	Efficiency	Power Factor
		50	During detailed engineering	
		75	95%	0.88
		100	95.2%	0.90
10	Power Cables	Cable glands and termination suitable for 1RX3CX240 sq.mm. Al, XLPE cable to be provided by the vendor for VFD Output side cable termination. The exact cable sizes will be intimated during drawing approval stage. Cables in Customer scope.		



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5. Scope:

Sl. No.	Scope of Supply	Description
1	a) 1 No. Fully Assembled Unit of 6.6kV VFD Panels (IGBT/SGCT/IGCT), Air Cooled with integrated Dry type transformer. b) All interconnecting cables between the VFD and integrated Transformer. c) One number of Flame proof Local Control Station (LCS) mounted near motor. d) Power Cable glands (Flame proof) and hardware for VFD and Transformer, Cable glands (Flameproof) and lugs for LCS. e) Any special cable other than power and control cables from VFD to other equipment. f) Any special tools and tackles. g) Mandatory and Commissioning Spares.	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, EIL 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, motor cable selection etc. If any special arrangement is required in the input breaker, same shall be mentioned by the vendor in their offer. All necessary interlocks as required for safe and reliable operation of VFD system along with Input breaker, shall be provided in VFD system. The motor shall continuously run on VFD.

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6. VFD Specifications

Sl.	Parameter	Specification
1	Drive	Natural Gas Compressor
2	Input Voltage	From Integrated dry type Transformer
3	Power/Torque vs Speed	Torque $\propto$ Speed ² ; Power $\propto$ Speed ³
4	Single Line Diagram	See Attachment 3-661-00-00967
5	Output Voltage of VFD	0 to 6.6kV (V/f = Constant)
6	Output Current of VFD	132A at 40°C (Design Ambient)
7	Output Frequency	0 to 50Hz , Resolution: +/- 0.01% under transient conditions; +/- 0.5% under steady state conditions
8	Speed Regulation	+/- 0.5%
9	Speed Accuracy	+/- 1%
10	Over load Capacity	110% of rated current for one minute at rated voltage
11	Drive Control	Sensor less Vector Control
12	Braking Operation	Not Applicable
13	Output LC Sinusoidal Filter	Motor is designed for PWM operation. Distance between VFD and Motor is ~300 meters. Vendor to clarify and offer output Filter, if required. If O/P filter is required then the cables between VFD and filter will be in vendor scope. Cable glands, lugs and termination kit for the cables at both the end of the filter must be supplied by vendor.
14	VFD Panel Construction	a) Protection Class: IP31 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) Cooling: Air Cooled. Cooling system shall include well dimensioned panel with 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. Vendor to provide Low noise, redundant cooling fans for VFD panel. Suitable thermal switch for exit air temperature monitoring shall also be incorporated. d) Earth Bus – minimum 50*6 mm Copper shall be provided with provision for connection to plant earth grid.



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Sl.	Parameter	Specification
	VFD Panel Construction	e) Busbar Material – Electrolytic grade Copper, colour coded. Sleeving /shrouding for safety purposes shall be done. 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 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. The panel shall be spray painted with two coats of Epoxy Based final paint with Powder Coated Finish - shade RAL7032 (Pebble Gray), Paint Thickness: 60 Microns (minimum). h) Power and Control Wiring shall be done with Fire retardant cables as per EIL Specification. i) Double compression type Nickel plated brass flame proof 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. Gland Plates shall be minimum 3 mm thick Aluminium (steel not allowed). 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 equipment shall be used. k) All low voltage compartment and cabling shall be electrically and physically separated from the high voltage compartment. l) Lugs for all control cables shall be terminated in terminal block itself. This would avoid usage of different types of lugs at site during commissioning.



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Sl. No.	Parameter	Specification
15	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.
16	Storage Temperature	-40°C to +60 °C
17	Vibration	According to IEC68-2-6
18	Interference	According to IEC801 parts 2,3,4 Immunity: The panels shall be designed so as to have low Radio Frequency Interference (RFI) and Electromagnetic Interference (EMI).
19	VFD Efficiency	Shall be > 96%. Exact value to be specified by the Vendor.
20	Duty Cycle	Class I Duty Cycle as per IEC 146-1
21	VFD Requirements	a) Input Choke: Input chokes to be provided if necessary. b) Local/Remote: Selector switch shall be provided on VFD panel for operator to select type of operation: <u>Local</u> – Operation from VFD Panel for Speed Control from door mounted interface; <u>Remote</u> – Operation from DCS/LCS. 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 to be provided with 4NO + 4 NC contact for Emergency Stop. One normally open contact to be wired to Terminal Block for external Interlocking / Annunciation. e) Every Panel shall be provided with CFL 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. f) 240V, 1phase, 50Hz, 1000W (approximate, exact value 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.



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Sl. No.	Parameter	Specification
	VFD Requirements	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 & protection of VFD system shall be considered by the VFD vendor in their scope.

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22 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.
- 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.



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Sl. No.	Parameter	Specification
23	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 manual adjust the speed reference. In case the above operation is not possible through operator interface, vendor has to supply one laptop loaded with driver software alongwith a suitable communication cable for interface with VFD. c) The operator interface shall have LED indicators for drive fault, drive run 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. h) 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. i) The following Control signals must be provided: ➤ Local/Remote selection ➤ 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. j) All VFD operating parameter shall be stored in nonvolatile memory.



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Sl. No.	Parameter	Specification
23	Controls and Monitoring	k) 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) Output Frequency ii) Output Current iii) Motor Speed iv) Output Voltage v) DC Bus Voltage vi) Output Power (It shall be possible to display power output of the drive in kW) vii) Digital Input Status viii) Digital Output status ix) Analog Input Status x) Drive Thermal state xi) Motor energy meter xii) Hour run 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: i) Motor Running/ VFD ON ii) Motor Stopped/Tripped iii) AC Mains ON iv) Auxiliary Control Supply ON v) VFD Ready vi) VFD Fault vii) External Fault viii) Emergency Stop Activated ix) Motor Over speed x) Input Breaker Trip xi) Motor zero speed xii) Rectifier output 'ON'



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PURCHASE SPECIFICATION

GROUP: VFD ENGINEERING

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Sl. No.	Parameter	Specification
23	Controls and Monitoring	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. 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 & alarm 9) Communication and measurement system unhealthy
24	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 105% of the VFD's rated full load output current) c) Ground Fault Protection – 5-10A within 250ms maximum. 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/Fuse Failure g) Phase Sequence Protection h) Input Phase Loss/Single Phasing Preventer i) Over Speed/Over frequency of motor



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Sl. No.	Parameter	Specification
24	Protection	j) Heat sink over temperature/VFD Panel Temperature High Stall prevention (During acceleration, deceleration and constant speed operation) k) Loss of Cooling Fans l) External faults like Transformer Fault and alarm m) Incoming Line surge protection n) Under/Over voltage protection o) Inverter fault p) System earth fault protection q) The system shall be designed to deliver the motor input current and torque for the complete speed torque characteristics of the driven equipment, with input supply variation of +/-10% and frequency variation of +/-3% r) 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. s) The drive shall trip in case the speed exceeds 105% of the maximum operational speed or reduces to 95% of the minimum operational speed for more than 10 seconds. t) 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.



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Sl. No.	Parameter	Specification
25	Local Control Station (Flame proof) Features Gas Group IIC	a) The enclosure shall be made of cast light metal Alloy. b) Degree of protection is IP55. LCS shall be provided with integral canopy. The canopy shall be made of atleast 2mm galvanized sheet steel or FRP. The canopy shall be suitable for providing protection against rain from top and two sides. c) The LCS shall be provided with gaskets made of non-inflammable and self-extinguishing material. d) Paint shade is Light Yellow shade 355 of IS5. Paint shade will be confirmed during drawing approval stage. e) A warning inscription "Isolate power supply elsewhere before opening" shall be provided on the panel. The warning inscription shall be embossed on the enclosure or a separate warning plate fixed to the enclosure with screws. The warning plate shall be nickel plated brass or stainless steel. f) The LCS shall be provided with two earthing studs with lugs on the external surface of the enclosures suitable for termination of 8 SWG GI wire. g) The Emergency Stop push button shall be mushroom type with stay put feature and lockable in pressed position. h) All control switches shall be provided with a pistol grip handle. i) Meters shall be suitable for the appropriate input and shall be calibrated for the actual parameters. 4-20mA Signals for Display from VFD: i) Actual Current (0-150A) ii) Actual Speed (0-3000rpm) j) The sub-vendor of LCS shall be as per attached EIL approved sub-vendor list k) Nickel plated brass cable glands (Flame proof) and tinned Copper lugs for cable termination shall be provided by the vendor. l) Control supply to LCS shall be derived from the VFD.



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SI. No	Parameter	Specification
25	Local Control Station (Flame proof) Features Gas Group IIC	m) Push Buttons with 2NO + 2NC contacts 1. VFD Start 2. VFD Stop 3. Emergency Stop 4. Speed Increase 5. Speed Decrease n) Switch: 1. Local/Remote Selection o) Indications: 1. VFD Fault 2. VFD Ready to Start 3. VFD Running
26	Dry type Transformer	Dry type Transformer a) HV voltage: 6.6kV with Taps of $\pm 5\%$ 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 Protection: RTDs (2 nos) to be provided in each limb for winding temperature measurement. Temperature scanner to be provided for winding temperature of all limbs. Alarm and trip contacts required for annunciation for fault and tripping action. Construction: The dry type transformer shall be mounted in a panel which will be mounted along with the VFD panel. Connection: HV Incomer: Termination arrangement to be provided for 1RX3CX240 sqmm, Al, XLPE cable. Cable glands to be provided by the vendor. The exact number and size will be intimated during drawing approval stage. Cables in customer scope. LV Connection: Cable 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 despatch and the same shall be connected at site. Necessary connection and routing arrangements to be made at Vendor's works.



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Sl. No.	Parameter	Specification
27	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 $\pm 0.5\%$ 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.
28	Harmonic Limitations – Source	Shall be as per 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.
29	Harmonics at VFD Output / Motor Input	Shall be as per IEC 61800-4 Vendor to specify the maximum amount of voltage and current harmonics at the VFD Output / Motor Input terminals.
30	Switching frequency	To be specified by the vendor
31	Auxiliary Supply	a) 110V UPS feeder is provided by the Customer. Power supply for electronic modules has to be derived from the same. Feeder kVA Rating required is to be given by the Vendor. b) Auxiliary supply 415 V , 3 Ph, 4 wire, 50 Hz supply is provided by customer. Feeder power rating to be specified by vendor. c) Other supplies required by the VFD system to be generated internally within the VFD system.



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32. SPARES

Sl. No.	Parameter	Specification
A	Mandatory Spares and Commissioning Spares	Supplier should quote item wise price for the following spares. Unpriced List of Spares quoted for shall be provided in the Technical Offer.

Sl no	Items	<u>Mandatory Spares</u>	<u>Commissioning Spares</u> (shall also be supplied to customer along with mandatory spares)
1	Power cell consisting of IGBT /IGCT/SGCT OR Separate Converter and Inverter module consisting of IGBT /IGCT/SGCT	1 no. of each rating & type	1 no. of each rating & type
2	Electronic Cards	1 no. of each type	1 no. of each type
3	Power supply card and Power supply module	1 no. of each rating & type	1 no. of each rating & type
4	Power fuses	20% of each rating or 1 no. (min) of each rating, whichever is more .	20% of each rating or 1 no. (min) of each rating, whichever is more
5	Control fuses / MCB	10 no's of each rating and type	10% of each rating or 1 no. (min) of each rating, whichever is more
6	Contactors	10% of each type or 1 no. (min) of each type, whichever is more	-----
7	Indicating lamps along with covers	20% or 2 nos. of each color whichever is more	-----
8	Diode / Blocker diode	2 nos. of each rating & type	-----

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Sl. No.	Parameter	Specification
33	Testing and Quality Plan	a) Routine Tests shall be carried out on VFD panel and transformer as per relevant standards and attached EIL ITP. b) Type Test Certificates to be furnished and type tests to be conducted as per attached EIL ITP and relevant standards. c) During fabrication, the drive and Transformer shall be subject to inspection by EIL/Owner, or by an agency authorized by the owner to assess the progress of work, as well as to ascertain that only quality raw material is used. d) Combined test of job VFD with job Motor is not applicable.
34	Inspection, Training and Commissioning Support	a) Final Inspection: BHEL / Customer representative will be present at manufacturer's works for witnessing of final testing. This is to be incorporated in the Quality Plan. No charges shall be applicable for witnessing of final tests. b) Commissioning: Commissioning of VFD System at site shall be in the scope of Vendor. Final Acceptance shall be based on successful completion of the same. c) Any replacement of failed/damaged items during commissioning shall be exclusively at Vendor's cost. d) Vendor is advised to stock necessary spares and ensure easy availability to facilitate trouble free commissioning.
35	Software for Computer Interface	This 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.



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Sl. No.	Parameter	Specification
36	Maintenance	The procedure for maintenance of VFD panels and the schedule thereof shall be mentioned in the offer.
37	Confirmations/Deviations to Specification	Point-wise confirmation to this 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 35 of Specification shall be furnished in the format below.

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

7. Scope of Supply:

Sl.No.	Parameter	Qty
1.	a) Fully assembled unit of 6.6 KV VFD panel (IGBT/IGCT/SGCT) with integrated dry type transformer	1 no
	b) Flame proof Local control station	1 no
	c) Cable glands, and hardware for power cable termination in VFD and transformer. Cable glands and lugs for all cable terminations in LCS.	1 set
2.	Commissioning spares for VFD	1 set
3.	Mandatory spares for VFD	1 set
4.	Erection Supervision and Commissioning	1 lot



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8. Documentation

Sl. No.	Parameter	Specification
1	Attached Documents	a) Single Line Diagram : 3-661-00-00967 b) Motor Data Sheet : A672-001-16-50-DS-5003 c) Compressor Torque Curve : 4CM40000934,Rev0 d) EIL job Specification : A672-001-16-50-SP-5009 Rev. 0 e) EIL Standard Specifications:6-51-0044 Rev.4 for Dry Type Transformer f) EIL Standard Specifications:6-51-0050 Rev.2 for HV Variable Frequency Drive System g) EIL Specifications for Flame proof Local Operating panel : 6-51-0006 Rev.4 h) VFD Datasheet:A672-001-16-50-DS-5006, Rev. A i) Dry type Transformer Datasheet: A672-001-16-50-DS-5007, Rev. 0 j) ITP for Flame proof Local control station: 6-81-1006 Rev. 3 k) ITP for Dry type Transformer : 6-81-1044 Rev.2 l) ITP for HV VFD : 6-81-1050 Rev.2 m) EIL approved Vendor list
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. Confirmation / Clarification / Information / Deviation List as per Point 6.37 above. d) Confirmation / Clarification / Deviation List to EIL Specifications and other documents in (1) above e) Filled up Experience Record sheet as per EIL format for VFD and transformer. Doc. No. A672-001-16-50-DS-5009 f) Design calculation for sizing of transformer and VFD
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.



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Sl. No.	Parameter	Specification
3	Information / Confirmations required along with offer	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.
4	Technical (unpriced) and Commercial (priced) Bids – For Evaluation	Refer sheet no 18 of 20 for Unpriced and Priced bid for Sl.no. 7.1 to 7.4
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 rating equipment as per respective ITP. j) Filled up Data sheet for VFD and Transformer
6	Information Required along with Supply. Maintenance Manuals and Documentation	a) Erection, Commissioning and Maintenance Manuals along with Final Drawings and Documentation – 2 Copies b) 1 no. CD ROM consisting of the above. c) Test and Guarantee Certificates. d) Complete Bill of Material (item wise) for the equipment supplied.

19600-00-199-3

DRG. No.

2

3

4

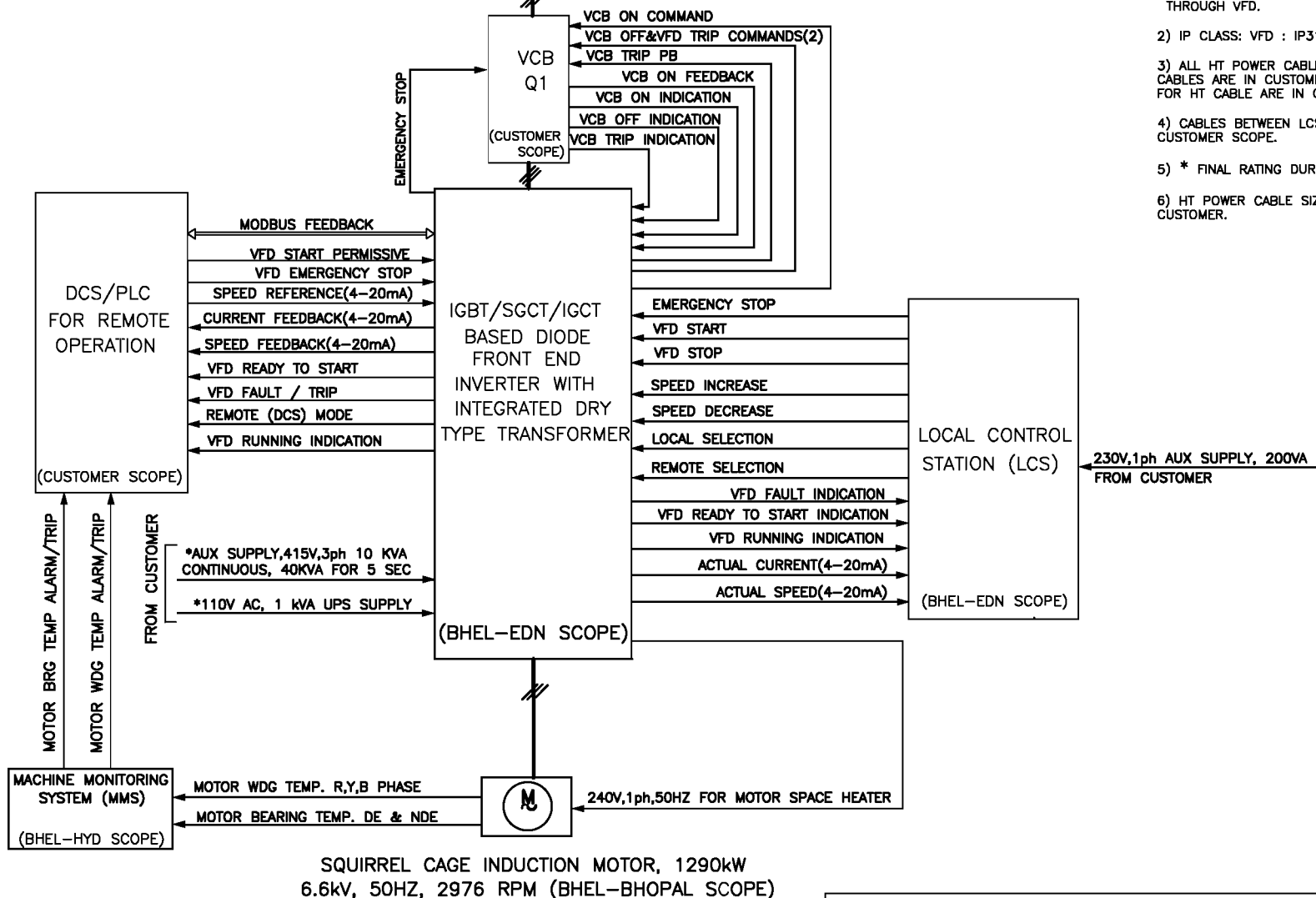
5

6

7

8

6.6kV, 50Hz, 3ph (CUSTOMER SCOPE)



- 1) 2 NUMBERS OF TRIP COILS TO BE PROVIDED TO ENSURE POSITIVE TRIPPING OF INPUT BREAKER (Q1) THROUGH VFD.
- 2) IP CLASS: VFD : IP31
- 3) ALL HT POWER CABLE, LT POWER CABLE, SCREENED CABLES ARE IN CUSTOMER SCOPE. TERMINATION KIT FOR HT CABLE ARE IN CUSTOMER SCOPE.
- 4) CABLES BETWEEN LCS AND VFD SHALL BE IN CUSTOMER SCOPE.
- 5) * FINAL RATING DURING DRAWING APPROVAL STAGE.
- 6) HT POWER CABLE SIZE TO BE INDICATED BY CUSTOMER.

MOTOR BRG TEMP ALARM/TRIP
MOTOR WDG TEMP ALARM/TRIP
FROM CUSTOMER

MACHINE MONITORING SYSTEM (MMS)
(BHEL-HYD SCOPE)

SQUIRREL CAGE INDUCTION MOTOR, 1290kW
6.6kV, 50HZ, 2976 RPM (BHEL-BHOPAL SCOPE)

PROJECT- INTEGRATED METHANOL & ACETIC ACID PROJECT
PLANT- METHANOL PLANT
CUSTOMER- ASSAM PETROCHEMICALS LTD. (APL)
CONSULTANT- ENGINEERS INDIA LIMITED

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

TITLE: SINGLE LINE DIAGRAM FOR VFD SYSTEM
1426-70-PR-VFD-1001

CARD CODE

No. OF SHEETS	01
SHEET No.	01
REV	00

M.O. No.

CE/1426

AS PER OPEN TOLERANCE
TO ED 0230499

DRG. No.

3-661-00-00967

BHEL W.O. 47134A418-11

Project	INTEGRATED METHANOL AND ACETIC ACID PROJECT			Client	ASSAM PETROCHEMICALS LIMITED
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Unit	METHANOL PLANT	Location	ASSAM, INDIA	Job No.	A672	Unit No.	001
-------------	----------------	-----------------	--------------	----------------	------	-----------------	-----

PURCHASER'S DATA

A. Site Conditions

1.	Maximum Ambient Temperature	39.8
2.	Minimum Ambient Temperature	1
3.	Design Ambient Temperature	40
4.	Relative Humidity	% 88
5.	Altitude	mm <1000
6.	Environment	Humid and Corrosive

B. Technical particulars

1.	Motor Tag no.:	By vendor
2.	Driven Equipment name:	Compressor
3.	Voltage:	kV 6.6 +/- 10 %
4.	Phase:	Three
5.	Frequency:	Hz 50 +/- 3 %
6.	Fault level:	kA 40
7.	Fault Duration:	sec. 1
8.	System Earthing:	Resistance Earthing
9.	Duty:	Continuous
10.	Method of starting:	V.S.D
11.	Cable size:	mm Client to arrange
12.	Cable type:	Al. cond. XLPE insulated
13.	Temperature rise:	80
14.	Cooling:	IC611
15.	Insulation class:	F
16.	Temperature rise Limited to insulation class	B
17.	Hazardous area classification:	Zone2
18.	Dust classification	NA
19.	Gas group:	IIC
20.	Dust Group	NA
21.	Type of explosion protection:	Ex'P'
22.	Prestart purging for Ex(n) motor	NA
23.	Type of ingress protection:	IP 55
24.	Reacceleration::	Refer EIL spec 6-51-0031
25.	Diff. protection CTs:	NA
26.	CT specs.:	NA
27.	Color shade:	632 as per IS 5
28.	Thermistors:	Not applicable
29.	RTD:	Required(note-2)
30.	BTD:	Required(note-2)
31.	RTD/BTD monitoring device:	Not Required
32.	Applicable specification:	EIL spec. 6-51-0031 /6-51-0050

DRIVEN EQUIPMENT MANUFACTURER's DATA

1.	Suggested motor rating:	kW 1290
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C	19-JAN-2016	ISSUED WITH MR	KODE LOKESH CHANDRA	RAMAN RAVISH KUMAR	JAIN V K
B	02-NOV-2015	ISSUED WITH MR	KODE LOKESH CHANDRA	RAMAN RAVISH KUMAR	JAIN V K
A	16-SEP-2015	ISSUED WITH MR	KODE LOKESH CHANDRA	RAMAN RAVISH KUMAR	JAIN V K
Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By

Project	INTEGRATED METHANOL AND ACETIC ACID PROJECT			Client	ASSAM PETROCHEMICALS LIMITED
Unit	METHANOL PLANT	Location	ASSAM, INDIA	Job No.	A672
				Unit No.	001
2.	Manufacturer:				
3.	Type of driver mounting:				Horizontal
4.	Driven equipment:				Compressor
5.	Shaft kW:	kW			382 kg mtr
6.	kW at maximum load:	kW			402 kg mtr
7.	Speed:	RPM			2979
8.	Rotation of eqpt. from coupling end:				CCW
9.	Coupling type:				Flexible
10.	Torque required starting	mkg			Depends on VFD
11.	Torque required Maximum	mkg			Depends on VFD
12.	GD2 of eqpt including flywheel	kgm			540 kg mtr2
	excluding flywheel:	kgm			
13.	Maximum thrust:	kg			NA
14.	Pulsation rate:				NA
15.	Starting condition:				VFD starting
MOTOR MANUFACTURER'S DATA					
1.	Rating:	kW			1290
2.	Manufacturer:				BHEL-Bhopal
3.	Frame designation:				1SD7452-2
4.	No. of poles:				2
5.	Full load speed:	RPM			2979
6.	Mounting:				Horizontal (B3)
7.	Full load torque (FLT):	mkg			422 kg mtr
8.	Starting torque:	% of FLT			77%
9.	Break down or pull out torque	% of FLT			240%
10.	Full load current (FLC):	A			132
11.	Starting current at 100%	% of FL			Depends on VFD
12.	Rotation viewed from coupling end:				Uni-directional (CW from DE)
13.	Starting time at 80%/100% voltage:	sec.			Depends on VFD
14.	Locked rotor withstand time (cold/hot) at,				
	80% voltage	sec.			25 sec / 18 sec
	100% voltage:	sec.			16 sec / 12 sec
15.	Time (Te) for Increased Safety Motor at 100% Voltage				Not applicable for Ex'p' motors
16.	Efficiency at 75%/100% Load:	%			95 / 95.2
17.	Power factor at 75%/100% Loa				0.88 / 0.9
18.	Heating/Cooling Time Const. (min.)	m m			30 / 105 minutes
19.	Space heater - voltage & power:				1000W , 240V , single phase
20.	Moment of inertia, GD2:	kgm			70 kg mtr2
21.	DE/NDE bearing type & no.:				Sleeve bearing dia 80mm for DE and NDE
22.	Type of lubrication:				Oil (FOLS not in BHEL scope)
23.	Type of main terminal box:				Elastimold type
24.	Type of neutral terminal b				Non PSTB type
25.	No. of Terminals				06
26.	Weight of motor:	kg			7500 kg

C	19-JAN-2016	ISSUED WITH MR	KODE LOKESH CHANDRA	RAMAN RAVISH KUMAR	JAIN V K
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A	16-SEP-2015	ISSUED WITH MR	KODE LOKESH CHANDRA	RAMAN RAVISH KUMAR	JAIN V K
Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By

Project INTEGRATED METHANOL AND ACETIC ACID PROJECT		Client ASSAM PETROCHEMICALS LIMITED	
Unit METHANOL PLANT	Location ASSAM, INDIA	Job No. A672	Unit No. 001
27. Thermistors, quantity	mo.	NA	
make: type:		NA	
28. RTD, quantity:	mo.	12 nos	
make: type:		Pt 100, 3W, simplex (BHEL approved)	
29. BTD, quantity	mo.	02 nos	
make: type:		Pt 100, 3W, duplex (BHEL approved)	
30. Shaft voltage:	v	Less than 250mV rms	
31. Critical speed, 1st/2nd st	RPM	Later	
32. Pressurization panel:		Yes	
make: type:		Make Expo , Type Pneumatic type	
33. Canopy:		NA	
34. Fan rotation Design		Uni-directional	

Eil Notes

- Recommended list of maintenance spares for two years operation shall include the following as minimum: (a) Bearing DE/NDE one set, (b) Terminal box coverwith screws, (c) Fan, (d) Terminal block
- Thermistors, RTDs and BTDs are applicable for motors as per EIL Specification 6-51-0031.
- Cable glands to be supplied with motors shall meet all requirements as pe IS/IEC-60079.
- For Approved makes of motors refer else where in the MR..
- Starting time calculations shall be based on operating conditions specified on Material Requisition eg. open valve ccondition/closed valve condition, at no load/full load, as applicable.

Note 1) Data given above are subject to tolerances as per IS

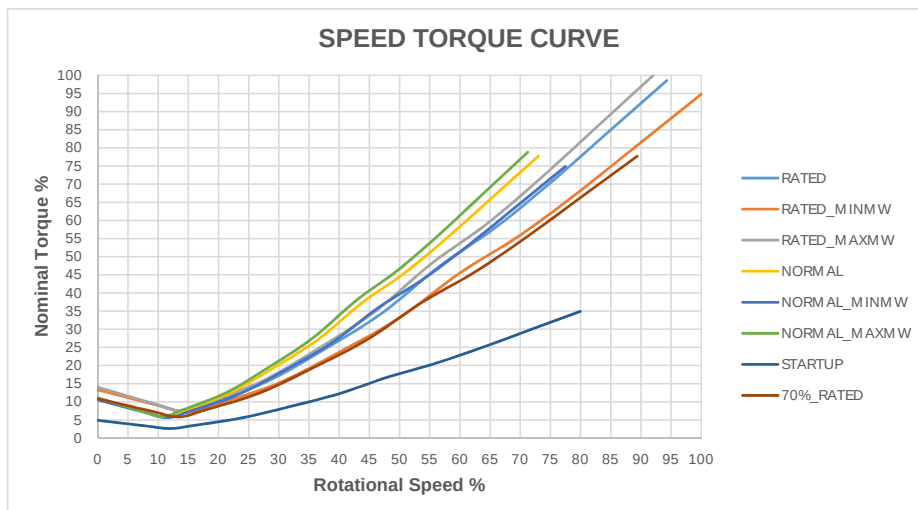
Note 2) Offered motor is suitable for current THD of VFD output limited to 2%

Note 3) NDE bearing shall be insulated

Note 4) Canopy, if required, shall not be in BHEL-Bhopal scope.

C	19-JAN-2016	ISSUED WITH MR	KODE LOKESH CHANDRA	RAMAN RAVISH KUMAR	JAIN V K
B	02-NOV-2015	ISSUED WITH MR	KODE LOKESH CHANDRA	RAMAN RAVISH KUMAR	JAIN V K
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Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By

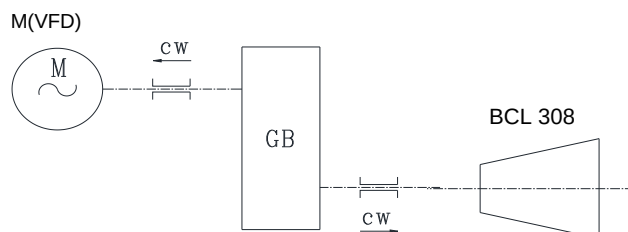
PROJECT : 500 TPD METHANOL AND 200 TPD FORMALIN PLANT PROJECT
SERVICE : NATURAL GAS COMPRESSOR
CUSTOMER : ASSAM PETROCHEMICALS LTD (APL)
CONSULTANT : EIL
No. OF UNITS : 1



The motor is provided with VFD in order to realize different operating conditions as specified by the customer. These are indicated by the curves as shown above.

Motor Rating	1290 kW
Nominal Power	1165 kW
Motor Speed at Full Load	2970 rpm
Nominal Torque at Full speed (Case: RATED_MINMW)	382 kgm
Max Torque (Case: RATED_MAXMW)	402 Kgm
Static Torque (max)	60.3 kgm
GD2 (Referred to Motor Speed)	540 kgm ²
Direction of Rotation seen from Coupling end (for Motor)	CW
Shaft end cylindrical diameter	120 mm #
No. of Keys on Shaft end	1
Speed Range % :	70 - 105%
Connection for Hub on Shaft Cylindrical fit of H6 / m5	
Compressor Power is referred to low speed shaft of step up Gear Box	

ARRANGEMENT OF MACHINES



(#) Considered for coupling sizing. Motor group to check adequacy and confirm.
Please refer enquiry specification for all other technical details to finalize the motor design

STEAM TURBINES AND COM PRESSORS				Date	Dept. code
				06-04-2018	420
Format No.	Prepared	Checked	Approved	Drawing No.	Rev
CA0-1-034-00	DILEEP	NEMA	YVRL	4CM 40000934	0



STARTING TORQUE CURVE FOR CENTRIFUGAL COM PRESSOR

Sheet 2 of 2

CASE DESCRIPTION

SL NO	DESCRIPTION	COMPR. POWER (KW)	COMPR. SPEED (RPM)
1	RATED	1142	12745
2	RATED_MINMW	1165	13518
3	RATED_MAXMW	1131	12441
4	NORMAL	697	9867
5	NORMAL_MINMW	713	10475
6	NORMAL_MAXMW	690	9631
7	START-UP	343	10808
8	70%_RATED	853	12079

STEAM TURBINES AND COM PRESSORS

Date

Dept. code

06.04.18

420

Format No.

Prepared

Checked

Approved

Drawing No.

CA0-1-034-00

DILEEP

NEMA

YVRL

4CM 40000934

JOB SPECIFICATION (ELECTRICAL) FOR NATURAL GAS COMPRESSOR

(PR No. – A672-001-KA-PR-5009-0002)

PROJECT : INTEGRATED METHANOL AND ACETIC ACID PROJECT

OWNER : M/s APL

JOB NO. : A672

0	10.04.2018	ISSUED WITH PR (M/s Bharat Heavy Electricals Ltd.)	PB	RKR	RSR
A	19.01.2016	ISSUED WITH MR	LCK	RKR	VKJ
Rev. No	Date	Purpose	Prepared by	Checked by	Approved by

1. GENERAL

- 1.1 The specification defines the basic requirements of the electrical works in vendor's scope for the Natural Gas Compressor for Integrated Methanol and Acetic acid Project, Assam of M/s APL. This job specification shall be read in conjunction with EIL standard specifications, data sheets and documents attached with the Purchase Requisition. In case of any conflict amongst various documents enclosed or referred with PR, the most stringent requirement shall govern and Owner/EIL decision in this regards shall be final.
- 1.2 The equipment shall conform to this specification, enclosed data sheets and standard specifications.

2. SCOPE

- 2.1 Vendor's scope shall include sizing, design, engineering, manufacturing, procurement, inspection, supply, testing at manufacturer's works, supervision of erection and commissioning, packing and delivery at site of electrical equipment including supply of all commissioning spares, 2 years O&M spares, mandatory spares, special tools & tackles as per the specifications and data sheets enclosed with the requisition. The major electrical equipments involved are:-
- Main Motor for Natural Gas Compressor (Ex-'de'/Ex-P type) as per enclosed data sheet.
 - Variable Frequency Drive (VFD) for main motor of Natural Gas Compressor along with associated dry type transformer at input side.
 - MV/ LV motors for auxiliaries of compressors.
 - Other misc. electrical consumers (Heaters etc., as required), trolley mounted equipment (if applicable) for the package covered under this PR.
 - Electrical facilities in Local Control Panel (LCP) for main motors/ auxiliary motors/ heaters for this package.
 - Local control station (LCS) for motors/ heaters located away from LCP within this package.
 - All interconnecting cabling between the equipments supplied by vendor within the package battery limits (within the field).
 - Earthing of electrical equipments within the skid and provision for bonding with main plant earth grid.
 - Any other electrical equipment not specifically mentioned above but required for normal operation of the compressor package.
- 2.2 Installation, testing & commissioning at site of the electrical items shall be done by others. Supervision of Installation, erection, testing and commissioning at site on per diem basis is included in vendor's scope as mentioned elsewhere. Supervision of testing and commissioning of VFD system shall be carried out by respective Original Equipment Manufacturer (OEM) i.e. VFD manufacturer.
- 2.3 Vendor shall supply cable glands and tinned copper lugs for equipment supplied by them. For outdoor equipment, double compression type Nickel plated brass FLP/weatherproof cable glands shall be supplied.

3. EXCLUSIONS

- Supply of 6.6kV circuit breaker feeders for VFD for main compressor motors
- Supply of 415V feeders for DOL starters for auxiliary motors (except trolley mounted motors) / Lube oil heater/ other misc electrical loads.
- Supply, laying and termination of all power (HV and MV), control, space heater & signal cables from field to Substation. However vendor to submit list of interconnecting cables required. Cables, as per clause 2.1 (g) are included in vendor's scope.
- Earthing grid outside package battery limit.

4. UTILIZATION VOLTAGE

Utilization voltage for motor, anti-condensation heaters based on their ratings shall be as listed below:

- | | | |
|--------------------------------------|---|----------------------------------|
| a.) Motors above 160 kW | : | 6.6kV $\pm$ 10% , 50 Hz $\pm$ 3% |
| b.) VFD for motors rated above 700kW | : | 6.6kV $\pm$ 10% , 50 Hz $\pm$ 3% |
| c.) Motors rated upto 160kW | : | 415V $\pm$ 10% , 50 Hz $\pm$ 3% |

d.) Anti-condensation heaters : 240V $\pm$ 10% , 50 Hz $\pm$ 3%

5. SPECIAL REQUIREMENTS

5.1 Motors shall fulfill the following requirements:-

- HV motors (>1100V) shall conform to EIL Specification 6-51-0031 and 6-51-0050 and motor data sheet no. A672-001-16-50-DS-5003.
- MV motors (415 V) shall conform to EIL Specification 6-51-0064 and motor data sheet no. A672-001-16-50-DS-5012.

5.2 The enclosure type / area classification / requirement for motors and their auxiliaries shall be as listed below:

S. No.	Tag No.	Enclosure Type	Area Classification
1.	001-KA-0411 (Natural Gas compressor)	Ex-de/Ex-p	Zone-2, IIC, Temp. Class T3
2.	AUXILIARIES FOR 001-KA-0411	Ex-n	Zone-2, IIC, Temp. Class T3
3.	LCS,LCP, etc	Ex-d	Zone-2, IIC, Temp. Class T3

5.3 All HV motors shall have minimum enclosure protection Ex -'de' / Ex-'p'and shall meet the requirements of IS/IEC 60079-1, 60079-2 & 60079-0 and all MV motors shall have a minimum enclosure protection Ex-n and shall meet the requirements of IS/IEC 60079-15 & 60079-0.

5.4 All motors having lube oil for bearing lubrication shall be provided with bearing isolator.

5.5 Vendor to provide trolley mounted flame proof motors and their flameproof starters (complete with all protection, controls and indication etc) suitable for use in Zone-2, Gas group IIC, Temp class T3, with 30 meters of armored copper conductor trailing cable.

Electrics for each portable trolley mounted motors, vendor shall supply following

- 415V, 63A TPN receptacles with plug (flameproof)
- Motor starter (flameproof)

Owner shall provide only 1 no. 415V TPN supply at the incoming of receptacles. Further power/control cable for trolley mounted motor shall be in vendor's scope.

5.6 The trolley mounted pumps shall be complete with integral starters; connection between motor & starter shall be through armored copper conductor cable and shall have motor protections, other hardware such as switch, fuse, contactor and BMR etc.

5.7 MV motors with starter and associated flexible cabling between FLP 415V, 63A TPN receptacle, motor starter and motor for trolley mounted pumps shall be provided.

5.8 Flameproof Equipments Ex d shall meet the requirements of latest revision of IS/IEC 60079-1.

5.9 For motors and heaters etc. controls shall be provided in the Local Control Panel (LCP)/ individual local control station (LCS), as applicable.

5.10 Following facilities shall be provided as a minimum on LCP/LCS:

- Start/Stop push buttons for all motors/heaters
- Ammeters for all motors rated above 5.5 kW.
- L-O-R (Local-Off-Remote) Selector switches as required.
- Speed raise/lower for VFD fed motor
- Motor running indication

5.11 For all other control and indication requirements refer elsewhere in PR.

5.12 The VFDs supplied with the package shall fulfill the following requirements

- The VFD system shall conform to EIL specification 6-51-0050 and VFD datasheet no. A672-001-16-50-DS-5006.

- b.) The machine shall always run on VFD. The V/F controlled system shall be complete in all respects including all connections between V/F panels and input/ output transformers.
 - c.) Input transformer and output transformer (if applicable) for VFD shall be panel mounted dry type suitable for indoor installation and comply with EIL standard specification 6-51-0044 attached.
 - d.) VFDs though shall be installed in Air-Conditioned area but it shall be suitable for operation in non-air-conditioned area also.
 - e.) Requirement of dedicated clean earth for VFD system (if any) and separate protective earthing conductor (if any) shall be suitably indicated by the vendor.
 - f.) For HV circuit breaker feeding the HV VFD, Owner shall provide two numbers shunt trip coils, operating at different control supplies.
 - g.) HV power cable (6.6kV, XLPE insulated, armoured, Overall PVC sheathed FRLS cable), MV power cable (415V, PVC insulated, armoured, Overall PVC sheathed FRLS cable) shall be supplied by owner.
 - h.) 240V, 1-Phase power supply to the motor space heater shall be derived from VFD. Necessary arrangement for these supplies shall be made available in VFD panels.
- 5.13 Lengths for various cables to be considered for design of the VFD for Natural Gas Compressor, as mentioned in the Data sheet no. A672-001-16-50-DS-5006 shall be as listed below :
- a.) Cable length between switchboard and VFD : 100m
 - b.) Cable length between VFD and Motor : 300m
 - c.) Cable length between VFD and DCS : 300m
- 5.14 Exact cable sizes of power and control cables shall be finalized during detailed engineering. Provisions, as required in Vendor's equipment for termination of the same, shall be made accordingly without any cost & time implications to Owner.
- 5.15 Cable glands to be supplied with the motor shall meet all the requirement of IS/IEC-60079-0. Cable glands shall be suitable for owner supplied cable conductor of following type
- a.) Cable size upto 16 mm² : Cu conductor
 - b.) Cable size greater than 16 mm² : Al Conductor
- 5.16 Vendor to note that, if there is any requirement of emergency electrical power for the auxiliary equipments supplied with the main motor/compressor, shall be informed by the vendor.
- 5.17 All the equipment indigenous and imported shall have a valid statutory approval of CCOE/PESO and copies of the same (CCOE/PESO) shall be furnished during detailed engineering stage which is mandatory as per local rules/regulations.

6. SPARES

- 6.1 Commissioning spares for all electrical equipments are included in Vendor's scope of supply.
- 6.2 Special Tools & Tackles are included in Vendor's scope of supply. Vendor to furnish list of tools & tackles required for Electrical system
- 6.3 Mandatory Electrical spares as per document No. A672-001-82-41-SL-5009 Annexure-1 are included in vendor's scope of supply.
- 6.4 Vendor shall submit a list with unit prices of recommended spares for two years of normal operation for all electrical equipment (i.e. motors, VFD, transformer, etc.).
- 6.5 Recommended list of maintenance spares for two years operation shall be as per Purchase Order (P.O.).

7. MAKES OF EQUIPMENT AND COMPONENTS

- 7.1 List of approved vendors for Electrical equipment/components is as mentioned in the master Vendor List, attached in the PR.
- 7.2 For HV Hazardous area motors, in the absence of approved Vendor list, Vendor shall select suitable motor vendor meeting the following requirements:-
 - a.) The vendor must be a regular manufacturer and supplier of HV hazardous area motors.
 - b.) The vendor must have designed, engineered, manufactured, tested and supplied at least two similar motors in terms of type of motor, voltage, kW rating etc. to any process industry, as being offered for this project.

- c.) The offered motors shall be manufactured and tested at the same works as for the reference equipment.
 - d.) At least one of the two systems must have completed 8000 hours of successful operation as on the date of bid opening.
 - e.) Vendor shall furnish the duly filled-in "Experience Record Format" (Doc NO. A672-001-16-50-DS-5009) to prove that the offered motors and VFD meet the above requirements.
- 8** Variation / Clarifications against the standard specification of HV motor 6-51-0031 and MV Motor 6-51-0064, shall be as per the MOU agreed with EIL by respective motor manufacturer. No further deviations to PR requirements shall be entertained.

शुष्क किस्म के डिस्ट्रीब्यूशन ट्रांसफार्मर के लिए विनिर्देश

SPECIFICATION FOR DRY TYPE DISTRIBUTION TRANSFORMERS

4	11.04.11	REVISED AND REISSUED AS STANDARD SPECIFICATION	MK	SA	UAP	DM
3	21.03.11	REVISED AND REISSUED AS STANDARD SPECIFICATION	NT	SA	UAP	DM
2	20.09.05	REVISED AND REISSUED	ND	AKT	AAN	VJN
1	08.11.01	REVISED AND REISSUED	NS	AAN	VPS	MRR
0	13.12.96	ISSUED AS STANDARD SPECIFICATION	NPG	VPS	SG	AS
Rev No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

Abbreviations:

BIS	:	Bureau of Indian Standards
BS	:	British Standards
CEA	:	Central Electricity Authority
CT	:	Current Transformer
GI	:	Galvanised Iron
HV	:	High Voltage
IEC	:	International Electrotechnical Commission
IEEE	:	Institute of Electrical and Electronics Engineers
IP	:	Ingress Protection
IS	:	Indian Standard
KVA	:	Kilo Volt Amperes
MV	:	Medium Voltage
NEMA	:	National Electrical Manufacturers Association
PVC	:	Poly Vinyl Chloride
SWG	:	Standard Wire Gauge
VDE	:	Verband Der Electro technik and information Stechnik

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Mr. MP Jain
Mr. BR Bhogal
Mr. Arun Kumar
Mr. KK Gera
Mr. Saeed Akhtar

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1.0 SCOPE

The intent of this specification is to define the requirements for design, manufacture, testing, packing and supply of cast resin / resin impregnated dry type distribution transformers.

2.0 CODES AND STANDARDS

2.1 The equipment shall comply with the requirements of the latest revision of the following standards issued by BIS (Bureau of Indian Standards) unless otherwise specified.

IS: 5	:	Colours for ready mixed paints and enamels
IS: 1271	:	Thermal evaluation and classification of electrical insulation
IS: 2705	:	Current transformers
IS: 10028	:	Code of practice for selection, installation and maintenance of transformers
IS: 11171	:	Dry type power transformers
IS/IEC: 60529	:	Degrees of Protection Provided by Enclosures (IP Code)

2.2 In case of imported equipment, standards of the country of origin shall be applicable, if these standards are equivalent to or stringent than the applicable Indian standards.

2.3 The equipment shall also conform to the provisions of the CEA Regulations and other statutory regulations currently in force in the country.

2.4 In case Indian standards are not available for any equipment, standards issued by IEC/ BS/ VDE/ IEEE/ NEMA or equivalent agency shall be applicable.

2.5 In case of any conflict between requirements specified in various applicable documents for the project, the most stringent one shall prevail. However owner's decision in this regard will be final and binding.

3.0 GENERAL REQUIREMENTS

3.1 The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.

3.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least 10 years from the date of supply.

3.3 Vendor shall give a notice of at least one year to the end user of equipment and EIL before phasing out the product/spares to enable the end user for placement of order for spares and services.

4.0 SITE CONDITIONS

Transformer shall be suitable for installation and satisfactory operation in tropical, humid and corrosive atmospheres. The transformer shall be designed to operate under site conditions as specified in data sheet. If not specifically mentioned therein, design ambient temperature of 40°C and altitude not exceeding 1000m above MSL shall be considered.

5.0 CONSTRUCTION

5.1 The transformers shall have core type construction. The core shall be assembled out of low-loss, nonageing; high permeability cold rolled grain oriented steel laminations.

- 5.2 The windings shall be of high-grade electrolytic copper. The insulation system for cast resin transformers shall comprise of windings cast under vacuum, free of voids in a homogenous uniform laminate of epoxy resin/ polyester resin. The totally assembled core and coil assembly, for resin impregnated transformers, shall be vacuum pressure impregnated to effectively make it impermeable to moisture, dirt, salt, air and other industrial contaminants.
- 5.3 The entire core assembly shall be covered with a resin-based lacquer for corrosion protection.
- 5.4 Lifting lugs shall be provided for core and winding assemblies.
- 5.5 The HV and MV windings shall have class 'F' or better insulation. The temperature rise of windings under continuous full load shall not exceed the maximum allowable temperature for the appropriate class of insulation as per IS 11171, above the design temperature specified in the data sheet.
- 5.6 The insulation material used shall be non-hygroscopic, non- inflammable and self-extinguishing if ignited by direct flame or arc. No toxic or harmful gases shall form during heating and /or burning. The insulation materials shall be sufficiently resistant to ageing.
- 5.7 The transformers shall be capable of withstanding the thermal and mechanical effects of a dead short circuit on any or all winding terminals with full voltage maintained on other windings as per IS. The transformers shall sustain a symmetrical short circuit on secondary terminals for 2 seconds without damage or impairment.
- 5.8 Each limb shall have two solid state winding temperature monitoring elements to initiate an alarm and trip for winding over temperature.
- 5.9 The transformers for Indoor & outdoor location shall have minimum degree of protection as IP 23 & IP 54 respectively. However the marshalling box, cable termination box, bus-duct termination chamber etc. shall have a degree of protection not less than IP-55.
- 5.10 All fasteners and bolts shall be galvanised.
- 5.11 The transformers shall be spray-painted or powder coated with epoxy paint. Colour shade of final paint shall be as specified in the data sheet.
- 6.0 **TERMINAL AND MARSHALLING BOX**
- 6.1 Windings shall be brought out on suitable nickel-plated copper terminals for cable termination. HV side termination shall be from the bottom. Suitable disconnection chambers shall be provided to permit the transformer to be removed without disconnecting the cable termination. The MV side termination shall be by bus-duct or cable as defined in datasheet / job specification.
- 6.2 The high voltage and medium voltage cable termination arrangement shall be complete with cable box and bolted type undrilled cable gland plates. Non-magnetic gland plate shall be provided for single core cables.
- 6.3 Primary cable box shall be able to withstand specified primary system fault level for 0.2 secs.
- 6.4 Terminal chamber for busduct termination shall have a gasketed cover plate, bolted to it. Separate inspection covers shall be provided to facilitate connection and inspection.

- 6.5** All protection, alarm and indication devices and neutral CTs shall be wired by means of PVC insulated cables upto the marshalling box. There shall be two gland plates, one for internal wiring to the marshalling box from various devices which shall be glanded and pre-wired, while the second gland plate shall be removable and undrilled for glanding outgoing cables.
- 6.6** One neutral terminal inside the cable box/ MV bus-duct connection chamber and a separate neutral terminal outside shall be provided for earthing of transformer winding neutral on the secondary side. The neutral terminal shall be complete with connector block assembly for easy termination of GI earth strip/cable.
- 6.7** The neutral CT shall be mounted as below:-
- CT for 51G shall be located in the earth path after bifurcation of neutral.
 - CT for 64 R can be located before bifurcation of neutral.

Supporting arrangement for GI strip/cable as applicable shall be provided for connection of neutral bushing to earth/NGR.

- 6.8** Two earthing terminals shall be provided on the transformer frame for transformer body earthing. Suitable lifting arrangement shall be provided in the transformer frame. The transformer shall be supported on flat rollers.

7.0 COOLING

Type of Cooling shall be in accordance with the datasheet.

8.0 TAPPINGS AND CONTROLS

Primary off-circuit tap changer shall be provided and shall have a range as specified in the data sheet. Under conditions of external short circuit, the tap changing device shall be capable of carrying the same current as the windings.

9.0 ACCESSORIES

- 9.1** Accessories as specified on data sheet shall be included in the scope of supply. All protective, alarm and indicating devices shall have minimum 1 no. potential free contact each for alarm and trip. All transformers must be provided with at least the following:

- Bi-directional flat rollers
- Rating and terminal marking plate
- Marshalling box
- Lifting hooks and jacking pads, towing holes
- Earthing terminals
- Neutral CT (as per data sheet)
- Off-circuit tap changer
- Temperature monitoring system (For rating 500KVA & above)

- 9.2** Temperature monitoring system shall be supplied with temperature sensors fitted in each limb. Temperature monitoring system shall initiate alarm and trip for winding over temperature. Alarm and trip temperatures shall be site settable. The monitoring system shall also have an indicating device.

10.0 NOISE LEVEL

The average audible sound level for the transformers at a distance of 30 cm shall be as below:

KVA	AVERAGE SOUND LEVEL (DECIBEL)
0-50	50
51-150	55
151-300	58
301-500	60
501-700	62
701-1000	64
1001-1500	65
1501-2000	66
2001-3000	68
3001-4000	70
4001-5000	71

11.0 INSPECTION AND TESTING

EIL / owner's representatives shall be given free access to enter the plant and inspect the equipment at any time during fabrication. However, 4 weeks advance notice shall be given by vendor to witness the final tests. The final tests shall include the following:

11.1 Routine tests and special tests as listed below shall be carried out on all transformers:

- 11.1.1 Visual and Dimensional check
- 11.1.2 Bill of Material
- 11.1.3 Measurement of winding resistance
- 11.1.4 Measurement of voltage ratio and check of voltage vector relationship
- 11.1.5 Measurement of impedance voltage and load loss
- 11.1.6 Measurement of no- load loss and current
- 11.1.7 Induced over voltage withstand test
- 11.1.8 Separate-source voltage withstand test (HV Test)
- 11.1.9 Measurement of insulation resistance before and after HV test
- 11.1.10 Noise level check
- 11.1.11 Correctness of nameplate

11.2 Type tests and special tests as listed below shall be carried out on one transformer of each rating if called for in purchase documents:

- 11.2.1 Partial discharge test
- 11.2.2 Temperature rise test
- 11.2.3 Short circuit test
- 11.2.4 Lightning impulse test

12.0 PACKING AND DESPATCH

All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for the selected mode of transportation i.e. by ship/ rail or trailer. The equipment shall be wrapped in polythene sheets before being placed in the crates/ cases to prevent damage to the finish. Crates / cases shall have skid bottom for handling. Special notations such as 'Fragile', 'This side up', 'Centre of gravity', 'Weight', 'Owner's particulars', 'P.O. numbers' etc., shall be clearly marked on the package together with other tag numbers, P.O. number etc.

The equipment may be stored outdoors for long periods before erection. The packing shall be suitable for outdoor storage in areas with heavy rains/ high ambient temperature.

उच्च वोल्टेज वैरीएबल फ्रीक्वेन्सी
ड्राइव सिस्टम
के लिए विनिर्देश

SPECIFICATION
FOR
HV VARIABLE FREQUENCY
DRIVE SYSTEM

2	16.10.14	REVISED AND ISSUED AS STANDARD SPECIFICATION	MK/SA	HK	BRB	SC
1	24.04.09	REVISED AND ISSUED AS STANDARD SPECIFICATION	AM	SG	JMS	ND
0	25.03.03	ISSUED AS STANDARD SPECIFICATION	SSM	AAN	VPS	SKG
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

Abbreviations:

AC	:	Alternating Current
BIS	:	Bureau of Indian Standards
BS	:	British Standard
CEA	:	Central Electricity Authority
CFL	:	Compact Fluorescent Lamp
CIMFR	:	Central Institute of Mining and Fuel Research (formerly CMRI)
CRCA	:	Cold Rolled Cold Annealed
CW	:	Cooling Water
DC	:	Direct Current
DCS	:	Distributed Control System
DOL	:	Direct On Line
ECS	:	Electrical Control System
EM	:	Electromagnetic
HV	:	High Voltage
IEC	:	International Electrotechnical Commission
IEEE	:	Institute of Electrical and Electronics Engineers
IEGT	:	Injection Enhanced Gate Transistors
IGBT	:	Insulated Gate Bipolar Transistor
IGCT	:	Insulated Gate Commutated Transistor
I/O	:	Input/Output
IP	:	Ingress Protection
IS	:	Indian Standard
LED	:	Light Emitting Diode
mA	:	Milliampere
MCB	:	Miniature Circuit Breaker
MTBF	:	Mean Time Between Failure
MTTR	:	Mean Time to Repair
NEMA	:	National Electrical Manufacturer's Association
PLC	:	Programmable Logic Controller
PO	:	Purchase Order
PVC	:	Poly Vinyl Chloride
SGCT	:	Silicon Gate Commutated Transistor
THD	:	Total Harmonic Distortion
V_{BO}	:	Break Over Voltage
VDE	:	Verband Deutscher Electrotechniker
VFD	:	Variable Frequency Drive

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Mr. Parag Gupta
Mr. M.K.Sahu
Mr. A.K. Chaudhary (Inspection)
Ms. N.P. Guha (Projects)

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1.0 SCOPE

- 1.1** The scope of this specification is to define the minimum technical requirements for the design, manufacture, testing and supply of High Voltage, AC Variable Frequency Drive system. The VFD system shall be complete with Squirrel Cage Induction Motor/ Synchronous Motor as specified in data sheet, Converter, Converter input transformer (if required), drive output transformer (unless specifically agreed, drive output transformer shall not be provided), DC link reactor with associated auxiliaries, harmonic filters (if required) and field mounted local motor control panel.
- 1.2** The Vendor shall be responsible for engineering and functioning of the complete system, meeting the intent and requirement of this specification and data sheets. 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, motor cable selection and motor sizing/selection.
- 1.3** This specification applies to drive systems having converter input voltage above 1000 V AC and up to and including 11000V AC.

2.0 CODES AND STANDARDS

- 2.1** The equipment shall comply with the latest editions of the following standards unless specified otherwise:

IS:325	Three-phase Induction Motors
IS:3700	Essential Ratings and Characteristics of Semiconductor Devices
IS:3715	Letter symbols for semi-conducting devices
IS:4411	Code of designation of semi-conducting devices
IS:5001	Guide for preparation of drawings of semiconductor devices and Integrated Circuits
IS:5469	Code of practice for the use of semiconductor Junction Devices
IS:8789	Values of Performance characteristics for Three Phase induction motor
IS:12615	Energy Efficient Induction Motors Three Phase Squirrel Cage
IS:12729	Common specification for High-Voltage Switchgear and Controlgear standards
IS:14901	Semi-conductor devices- Discrete devices & Integrated Circuits
IS:15880	Three Phase Cage Induction motors when fed from IGBT Converters- Application Guide
IEC:60146-1-3	Semiconductor Convertors general requirements and line commutated convertors-Transformer & reactors
IEC:61800	Adjustable speed electrical power drive systems
IEEE:519	Recommended Practices and requirements for Harmonics Control in Electrical Power Systems

- 2.2** In case of imported equipment, the standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian standards.

- 2.3** The equipment shall also conform to the provisions of CEA Regulations and other statutory regulations currently in force in the country.

2.4 In case Indian standards are not available for any equipment, standards issued by IEC/ BS/ VDE/ IEEE/ NEMA or equivalent agency shall be applicable.

2.5 In case of any conflict between requirements specified in various applicable documents, the most stringent one shall prevail. However, owner's decision in this regard shall be final and binding.

3.0 SITE CONDITIONS

3.1 The drive system shall be designed to operate under specified site conditions as specified in the data sheets. If not specifically mentioned therein, a design ambient temperature of 40°C and an altitude not exceeding 1000 metres above mean sea level shall be considered.

3.2 The AC drive shall be installed indoors in a non-hazardous, air-conditioned or pressurized room, as specified in data sheet. Transformer installation (outdoor/ indoor) shall be as indicated in datasheet. Motor shall be installed outdoors in safe or hazardous area as specified in datasheet.

3.3 All the equipment shall be designed for continuous duty as per nameplate rating under the specified ambient conditions.

4.0 GENERAL REQUIREMENTS

4.1 The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.

4.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least 10 years from the date of supply.

4.3 Vendor shall give a notice of at least one year to the end user of equipment and EIL before phasing out the product/spares to enable the end user for placement of order for spares and services.

4.4 Vendor shall ensure proper co-ordination with the driven equipment supplier in selection / sizing of offered variable frequency drive system.

5.0 TECHNICAL REQUIREMENT

5.1 Performance Requirement

5.1.1 The system shall be energy efficient, designed as standard product and shall provide very high reliability, high power factor, low harmonic distortion and low vibration / wear / noise. It shall be easy to install in minimum time and expense and no special tools shall be required for routine maintenance.

5.1.2 The system shall be designed to deliver the motor input current and torque for the complete speed torque characteristics of the driven equipment, with input supply variation of $\pm 10\%$ and frequency variation of $\pm 3\%$. The system shall be suitable for the load characteristics and the operational duty of the driven equipment. It shall be capable of withstanding the thermal and dynamic stresses and the transient mechanical torque, resulting from short-circuit.

5.1.3 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 in the data sheet:

- a. Variable torque changing as a function of speed i.e. Speed squared
- b. Constant torque over a specific speed range
- c. Constant power over a specific speed range where the torque decreases when speed increases
- d. Any other as specified in data sheet

- 5.1.4 The drive controller shall be equipped with microprocessor based digital regulator with programmable functions. The power control regulator logic shall provide for an acceleration/deceleration current limit curve and shall be capable of field adjustments without shutting the system down. Linear acceleration and deceleration shall be separately programmable from 0.1 to 20 seconds.
- 5.1.5 The System shall be suitable for single quadrant operation and the speed variation shall be with range 10-100 % unless otherwise specified in data sheet with speed set accuracy of $\pm 1\%$ of rated maximum speed and steady state regulation of $\pm 0.5\%$ of rated speed.
- 5.1.6 The total harmonic distortion (THD) of the voltage and current at inverter output shall be as per IEC 61800 and same shall be considered in the design of the motor. The dv/dt limits & Vpeak shall also be as per IEC-61800-2.
- 5.1.7 Harmonics at the supply side of the drive system at primary of the main input transformer shall be restricted within the maximum allowable levels of current and voltage distortion as per recommendations in the latest edition of IEEE-519. The vendor shall perform design calculation for harmonic filter system considering VFD connected to the power system and including the supply of harmonic filters along with all accessories which shall be installed at owner's power system unless otherwise specified. These harmonic studies shall be conducted with maximum and minimum system fault level, cable capacitance, system equipment reactance etc. The studies shall highlight but not be limited to maximum load current, expected resonant frequencies, need of harmonic filters, sequence of switching of filters, voltage wave form, rating of equipments/ feeder for feeding filters from owner's switchgear etc.
- 5.1.8 Unless otherwise specified, the overload capacity of the controller shall be 150% of rated current of 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. If load demands exceed the current limit for more than 1 minute, the drive shall shutdown to prevent over heating of the motor and damage to the drive.
- 5.1.9 During operation, the system shall be capable of developing sufficient torque under all load conditions to respond to a 20% alteration in speed set point within a time limit upto 60 seconds.
- 5.1.10 The integrator action of the speed set point alteration shall be independently adjustable for both an upward and a downward alteration. The minimum time interval between set point adjustments by the distributed control system shall be considered as 10 seconds.
- 5.1.11 The drive shall trip in case the speed exceeds 105% of the maximum operational speed or reduces to 95% of the minimum operational speed for more than 10 seconds.
- 5.1.12 Maximum noise level from the drive at 1-meter distance, under rated load with all normal cooling fans operating shall not exceed 85 dBA.
- 5.1.13 Variable frequency drive shall be arranged so that it can be operated in an open circuit mode, disconnected from the motor for start up adjustments and troubleshooting/ maintenance.
- 5.1.14 Voltage at motor neutral shall be maintained at ground potential for the total operating condition.
- 5.2 Control Requirement**
- 5.2.1 The system shall operate on constant V/f supply with required voltage boost capability in low frequency mode of operation.
- 5.2.2 Short time voltage dips up to 20% of nominal voltage (e.g. in case of a large motor start up connected to the same bus as VFD) shall not cause the control system to stop functioning and shall not trip the drive system.

- 5.2.3 The system shall also be equipped with a momentary powerloss ride through feature which will restart the system in case of voltage dip over 20% or power interruptions for less than 2 seconds, with recovery of the voltage to its nominal value.. The drive shall have the facility to block this feature, if required by the operator. Upon restart, the converter shall be capable of synchronizing onto a rotating motor and develop full acceleration torque within 10 seconds.
- 5.2.4 The system shall be suitable for number of starts as per attached EIL specification for High Voltage Motors.
- 5.2.5 The power controller shall be controlled to always start the motor in the forward direction. Logic shall be provided to prevent the motor from being started in the reverse direction.
- 5.2.6 The drive motor shall be speed controlled corresponding to 4-20 mA or 0-10 V reference input signal. Unless otherwise specified, upon complete loss of the user's speed reference signal, the drive shall automatically run at constant speed as at 80-100% of the last speed reference available prior to the loss of signal.
- 5.2.7 It shall be possible to vary the speed of the drive in either manual or auto mode. Auto/Manual selection shall be from VFD panel unless otherwise specified.
- With the selector switch in "manual" mode, the operator shall be able to set the speed through key pad (mounted on front of the drive panel) or from speed increase/decrease push buttons (from the field). Motor operated potentiometer shall be provided as a speed set point device.
 - With the selector switch in "auto" mode, speed of the motor shall be controlled from a 4-20 mA signal, from owner's PLC/DCS (Process Control) system. Necessary equipment required for interfacing with PLC/DCS shall also be provided in the VFD panel.
 - Local/Remote selector switch shall be provided in local control station (in Field). With the selector switch in "Local" mode, the operator shall be able to start and set the speed through local control station (in Field). With the selector switch in "Remote" mode, speed of the motor shall be controlled either from VFD panel or from Owner's PLC/DCS as explained in a) and b) above. (For local control station, also refer Cl. 5.5.7 below).
- 5.2.8 The required provision for the interface with remote PLC/DCS located at control room shall be either through hardwired connection (with potential free contacts and transducers as described elsewhere in this specification) or through serial communication link as defined in the datasheet.
- 5.2.9 Drive system shall have provision for interface with upper level automation such as Substation monitoring system or electrical control system in case specified in the data sheet/job specification.
- 5.2.10 The closed loop control feed back for the drive system having out put transformer shall be tapped from the secondary side of the output transformer.

5.3 Panel Construction

- 5.3.1 The panel shall include suitable semi conducting power devices (Diodes/IGBT/IGCT/ IEGT/SGCT) modules with protective devices, reactors (if required) , filters (if required), control circuit, control accessories, indication and annunciation etc. The construction of the panel shall provide effective protection against electromagnetic emissions and shall meet the design requirement of relevant standards.
- 5.3.2 Upstream breaker 'ON/OFF/TRIP' indications and remote breaker closing and trip push buttons shall be provided on the front door.

- 5.3.3 Safety Interlock shall be provided so that power cabinet can't be opened unless the up stream breaker is disconnected, safety-grounding switch is closed and DC link capacitor is discharged. Power source breaker can only be closed once the earthing switch is open and panel door is closed with lock defeat facility.
- 5.3.4 The drive shall be suitably housed in sheet steel panels and shall be fabricated using cold rolled sheet steel. The sheet steel used for the panel shall be of minimum 1.6 mm CRCA. The panel shall be suitable for indoor installation, if not otherwise specified. The panel shall be free standing with degree of enclosure protection as IP-31. Maximum and minimum operating height shall be 1900 mm and 300 mm respectively.
- 5.3.5 Bolted un-drilled gland plate shall be provided at bottom. Clamp type terminals shall be used for connection of all wires up to 10 mm² and terminal for higher sizes shall be bolted type suitable for cable lugs. Minimum space for power cable termination shall be 600mm clear from bottom of the cable gland plate.
- 5.3.6 Bus bars shall be of electrolytic copper/aluminium, sleeved, color coded separately for AC and DC system. All the live parts shall be sleeved / shrouded to ensure complete safety to personnel intending to carry out routine inspection by opening the panel doors. All the equipment inside the panel and on the doors shall be provided with suitable nameplate.
- 5.3.7 All the switches, component and accessories which are essential for normal and emergency operation shall preferably be mounted on the door and shall be operable externally. All the analogue instruments, where provided, shall be switchboard type, back connected & of size 96x96mm. Scale shall have red mark indicating maximum permissible operating rating.
- 5.3.8 Each panel shall be provided with illuminating lamp/11 W CFL with switch and fuse. 5/15A, 240V power socket with switch and fuse shall be provided. Each panel shall have space heater with switch fuse and variable setting thermostat.
- 5.3.9 Copper earth bus of min. 30x6 sq.mm. upto short circuit withstand capacity of 31.5kA and 50x6 sq.mm. for a short circuit withstand capacity above 31.5kA shall be provided in the panel with provision for connection to owner's plant earth grid. All the non-metallic components/parts shall be connected to the main earth bus bar. Separate earth bus bar and stud for electronic control system if required shall be provided.
- 5.3.10 All panels shall be of same height so as to form a uniform line-up, to give good aesthetic appearance.
- 5.3.11 All the control wiring shall be enclosed in plastic/ metal channel. Each wire shall be identified at both ends by self-sticking wire marker tapes or PVC ferrules. Power and control wiring inside the panel shall be done with BIS approved, PVC insulated, fire retardant, low smoke, copper conductor wire 1.5mm² size wire shall normally be used provided the control fuse rating is 10 Amps or less and 2.5 mm² size for control fuse rating above 16 A for electrical circuits and 0.5mm² for electronic circuits. All wires shall be ferruled and terminals shall be properly numbered, minimum 20% spare terminals shall be provided.
- 5.3.12 All electronic modules and components shall be accessible from front of panel only. Modular assemblies for both the system control electronic equipments and power electronic equipments shall be used.
- 5.3.13 Low voltage compartment and cabling shall be electrically and physically separated from the high voltage compartment.
- 5.3.14 DC link capacitor and pre-charging & discharging circuit shall be preferably mounted in the rear of the panel.
- 5.3.15 Suitable eyebolts/ lifting clamps/ strap & cradle arrangement shall be provided for lifting of the panel/shipping section. The bolts, when removed shall not leave any opening in the panel.
- 5.3.16 Acrylic type transparent insulating material shall be used for covering live components.

5.3.17 Drive keypad, operator control panel required for control, monitoring and measurements shall be supplied and installed outside the panel on the front door. It shall be accessible for operation without opening the front door and shall be non-removable type.

5.3.18 All equipment shall be complete with cable glands, lugs etc. and cable glands shall be single or double compression type for indoor and outdoor equipment respectively. Cable glands shall also be suitable for the hazardous area application if specified in data sheet.

5.4 Cooling

5.4.1 The drive panel shall be naturally cooled or water cooled type as per manufacturer's standards. However, it is preferred to have natural air cooled system. If unavoidable, forced type-cooling system shall be provided. Cooling system shall include well-dimensioned panel, adequate cooling airflow path, modular cooling fan and if necessary, panel cooling fan or water-cooling system shall be considered. Vendor shall ensure that the panel dimensions and flow paths have been designed for continuous running at the specified ambient without overheating. For fan cooled drives, redundant ventilating fans (N+1) shall be provided. In case redundant cooling fan is not possible to be mounted in the panel, same shall be supplied loose.

5.4.2 For water-cooled drives, entire cooling system including but not limited to heat exchanger, flow and pressure meters and pumps shall be in vendor's scope. The system shall be provided with closed circuit water cooling system, requiring only make up water required for topping up. The cooling water pumps, in case provided, shall have 100% redundancy. Water quality/characteristics shall be as defined in the data sheet and selected cooling water system components/material shall be suitable for the same. Adequate safety measures shall be incorporated in water cooled drives such that no leakage is there which results in malfunctioning of electronic devices. Proper segregation between water cooling system and other equipment shall be provided. It is preferred that cooling cabinet panel shall be separated from the main panels.

5.4.3 Necessary starters shall be provided within the VFD panels for the Ventilation fans, Cooling Water circulation pumps, any other auxiliary motor etc. The system provided shall be interfaced with drive starting and shutdown so that safety interlocks such as start permit from cooling system to drive and trip signal from cooling system to drive in case of cooling system failure etc., are incorporated in the overall sequence logic.

5.4.4 MCB for motor space heater, auxiliary power supply if required for local panel, drive panel space heater etc. shall be included and mounted in easy accessible location.

5.5 Equipment/ Component Specification

5.5.1 Motor

The motor shall be designed, constructed and tested in accordance with the latest revision of EIL's Specification /data sheet for High Voltage Induction / Synchronous Motor, in addition to the following requirements:

- The motor shall be suitable for operation with a solid-state power supply consisting of an adjustable frequency inverter for speed control.
- The motor shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive.
- The motor shall be designed to operate continuously at any speed over the range (10-100%) of rated speed unless otherwise specified in data sheet.
- The permitted voltage variation should take into account the steady state voltage drop across the AC drive and all other system components upstream of the motor.

- e. Motors required to be transferred to DOL by-pass mode shall be rated for specified variations in system line voltage and frequency. Starting current of motor in DOL bypass mode shall be limited to value specified in motor specifications, unless otherwise specified in datasheets.
- f. The motor shall be constructed to withstand torque pulsations resulting from harmonics generated by the solid-state power supply.
- g. The motor insulation shall be designed to accept the applied voltage waveform, within the V_{peak} and dv/dt limits as per IEC-61800-4 and necessary co-ordination between the VFD manufacturer & motor manufacturer w.r.t. incorporation of VFD output parameter in the design of motor shall be carried out.
- h. The drive manufacturer shall be solely responsible for proper selection of the motor for the given load application and the output characteristics of the drive.
- i. Motors shall be provided with Resistance Temperature Detectors (RTDs).

5.5.2 Converter Transformer/ Output transformer (if specifically agreed by Purchaser)

- a. The converter transformer shall be dry type or oil filled type as specified in the data sheet. In case of the dry type transformer, it shall be mounted in the drive system panel unless specified otherwise in the datasheet. Offered transformer shall be as per enclosed EIL Specifications/data sheet.
- b. The impedances of converter input transformers with more than one secondary windings for 12/18/24/36 pulse systems shall be selected to ensure equal load/current sharing between the secondary windings, the converters and the motor windings under all operational conditions including starting and restarting.
- c. Drive out put transformer considered only for the purpose of meeting standard rated motor voltage i.e. 3300, 6600V, 11000V shall not be provided unless otherwise agreed between purchaser and the manufacturer.

5.5.3 Power Converter

- a. The static power converter shall consist of a line side power converter for operation as a rectifier and a load side power converter for operation as a fully controlled inverter. Power converter shall be fast switching, most efficient and low loss type.
- b. Adequate short circuit and over voltage protection shall be provided for the converter and inverter system.
- c. All power converter devices shall include protective devices, snubber networks and dv/dt networks as required.
- d. 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 entire speed range.
- e. All power diodes shall be of silicon type with minimum V_{BO} rating as 2.5 times the rated operating voltage.
- f. 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 due to harmonic currents generated by the inverter operation.
- g. 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.
- h. 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.

- i. Offered system shall also take into account the distance between Drive panel and motor and system shall include all material and accessories to make system suitable for a distance of 350m unless otherwise specified in the data sheet.

5.5.4 DC Link Reactor

- a. Smoothing reactors for the DC link shall be designed to sufficiently decouple the rectifier and inverter portion of the converter and to limit fault currents in this circuit.
- b. Unless otherwise specified, the reactor shall be air-cooled or fan cooled type located within the panel.
- c. Reactor shall be suitable for operation with the non-sinusoidal current wave shapes and DC components under all operational conditions of the system without exceeding its temperature limits.

5.5.5 Output Filter

VFD output current waveform should be inherently sinusoidal at all speeds, with harmonic limits as specified in this specification. Output filter shall be provided, if required. Output filter capacitors shall be provided with discharge circuits to ensure that all residual stored charge is reduced to less than 50 V DC within 300 seconds after a loss of AC voltage. All capacitor shall be maintenance-free and self-healing type.

The VFD system shall inherently protect motor from high voltage dv/dt stress, independent of cable length to motor. Output filter shall be an integral part of the VFD system and included within the VFD enclosure.

5.5.6 Bypass Feature

- a. Bypass feature along with motor protection relay and output side isolator/breaker shall be provided by purchaser unless otherwise specified in the datasheet. All necessary interlocks as required for safe and reliable operation of VFD system along with bypass feeder and output side isolator/breaker provided by Purchaser shall be provided in VFD system.
- b. Bypass starter shall be in separate compartment and switching scheme shall be such that in case of drive mal-operation, the motor could be taken on bypass control manually, while the drive could be attended independently. Suitable interlock shall be provided such that bypass mode and VFD mode shall not operate simultaneously.

5.5.7 Local Motor Control Station

- a. The local motor control station, to be installed in the field near the motor shall conform to the attached EIL specifications. Components and accessories that are required in the local motor control station may be mounted on the local field mounted panel envisaged for the driven equipment.
- b. Meters in the local control station shall be suitable for 4-20mA transducer outputs and shall be calibrated for the actual motor current. Further, for drives with bypass facility, the meters shall be capable of reading bypass mode full load and starting currents as well as the VFD mode drive current.

5.6 Protection, Control, Metering, Indication and Annunciation

- 5.6.1 The system vendor shall provide all the necessary system control, protection, alarm and metering equipment for the entire drive system and its auxiliary equipment.
- 5.6.2 Automatic sequence control shall include start-up of cooling system, auxiliary system of the motor, interlock checking, automatic start and run-up of drive, planned and emergency shutdown. The same shall be processed through microprocessor-based system.

5.6.3 Operator Control Panel

- a. Each drive shall be equipped with a front mounted operator control console consisting of a backlit alphanumeric display and a keypad with keys for parameterization and adjusting parameter which shall not be limited to Start/Stop, Local/Remote, Auto/Manual, Increase/Decrease, menu navigation and protection and measurement parameter selection, etc.
- b. All parameter names, fault messages, warnings and other information shall be displayed in complete English words or standard English abbreviations to allow the user to understand the display without the use of a manual or cross-reference table. This shall also be used for the modification of all electrical values, configuration parameters, drive menu parameters, application and activity function access, faults, local control, adjustment storage, self test and diagnostics. Keypad shall be operable with password for changing the protection setting, safety interlock etc. However, the parameters such as measurements, setting, mode of drive etc. shall be allowed to be viewed without any password.
- c. Operator console shall have facility/ port to connect external hardware such as Laptop etc. Console shall have facility to upload and download all parameter settings from one drive to another identical drive for start-up and operation.
- d. Drive system control shall also have facility to receive tripping signal from upstream breaker for tripping and also provision for closing upstream breaker after all required process parameters are achieved.
- e. User-friendly software for operation and fault diagnostic shall be loaded in the drive system panel before commissioning.

5.6.4 Protective Features

The system shall incorporate adequate protective features, properly coordinated for the drive control and for the motor but not limited to the following:

- i. Incoming line surge protection
- ii. Under / Over voltage protection
- iii. Phase loss protection.
- iv. Programmable over current protection and under load protection.
- v. Inverter Fault.
- vi. Over frequency/Over speed of motor
- vii. Ventilation loss (In case same is not provided, drive shall generate an over temperature fault alarm and suitable sensors, as required for same, shall be provided).
- viii. Over temperature of equipment.
- ix. Specific motor protection, including motor winding, bearing temperatures, over-current, overload, negative phase sequence and earth fault protections etc.
- x. System earth fault protection.
- xi. Excitation system protection for synchronous motor
- xii. Over and under frequency, rotor earth fault (if applicable), field failure protection for synchronous motor
- xiii. Additional protection, if any for the drive system

5.6.5 Control

The following controls shall be provided as a part of the Operator Control Panel or through separate switches.

- i. Start/Stop
- ii. Speed control (Raise/Lower)
- iii. Forward/Reverse (if specified)
- iv. Auto/Manual /Test mode
- v. Local/Remote
- vi. Emergency stop
- vii. Start/Stop for bypass starter (where specified)
- viii. Trip-Remote Breaker
- ix. Excitation control system for synchronous motors
- x. Sequential switching of filters

5.6.6 Indications

Vendor shall provide indications as required for normal operation and for ease of maintenance, which shall not be limited to the following indications.

- i. Motor running
- ii. Motor stopped
- iii. VFD System Fault
- iv. System ready to start
- v. AC mains ON
- vi. Motor over speed
- vii. Rectifier output 'ON'
- viii. Motor zero speed
- ix. Remote breaker trip
- x. Excitation system healthy for synchronous motors

Above indications may be provided as a part of the operator control panel, i.e. door mounted keypad or through hardwired LEDs. LEDs provided for indication shall be cluster type with adequate brightness and minimum 2 Nos LEDs chips per light. LEDs shall be connected in parallel and each LED chip having diameter not less than 3mm.

Potential free contacts for items i to iv shall be wired separately for remote indications in DCS system.

5.6.7 Metering

Digital display of the following parameters shall be as a part of the Operator Control Panel, selectable by the operator.

- i. Output voltage
- ii. Output current-VFD mode/ Bypass mode
- iii. Output frequency
- iv. Drive thermal state
- v. Motor speed

- vi. Motor energy meter
- vii. Hour Run
- viii. Voltage and current meter for excitation system of synchronous motor
- ix. KVAR, power factor meter for synchronous motors
- x. Necessary transducer shall be provided with 4-20mA output for indicating motor speed and motor current in DCS unless otherwise specified for other parameters.

5.6.8 Audio-visual Annunciations

- a. The system shall incorporate audio-visual annunciations for protection, for various fault conditions, for the Drive motor, Supply cables, DC Reactor and the Converter, out put transformer etc.
- b. Alarms shall also be included for the failure of various auxiliaries together with identification of the failing unit, loss of cooling system, various protection devices provided for converter transformer etc.
- c. Audio-visual window annunciations shall be provided on the front of the panel. All annunciations as required for normal and satisfactorily operation of the drive system shall be included as per vendor standards. These annunciations can be part of operator console panel or separately mounted type.
- d. Vendor shall include audio-visual alarm as required for normal operation and maintenance of the system but not be limited to the following.
 - i. Rectifier fuse failure/Drive fault
 - ii. Main AC failure
 - iii. Inverter fuse failure/Drive fault
 - iv. Inverter overload
 - v. Inverter high temperature/Drive fault
 - vi. Cooling system failure
 - vii. Motor failed to start/Drive fault
 - viii. Transformer failure
 - ix. Excitation system failure for synchronous motor
 - x. Battery monitoring healthiness
 - xi. Communication and measurement system unhealthy
 - xii. Motor temperature high
 - xiii. Harmonic filters monitoring

All drive internal faults will be annunciated as drive fault.

Common potential free contacts shall be provided for above annunciations and these shall be wired up to terminal block for owner's use for remote alarm and monitoring.

5.7 Fault Diagnostic

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, shutdown of the system, shall be available for a period of minimum 4 days (96 hours) after a shutdown, even though no supply would be available to the system. The system may be totally de-energized for maintenance or otherwise. It shall be possible to retrieve the record of events prior to tripping of the system or de-energisation. Auxiliary supply to the system components or to the electronics (firmware) for the diagnostics / display shall be taken care by the manufacturer for this purpose.

5.8 External Power supply for auxiliary and Control Circuit

Auxiliary power supply for devices external to VFD module, space heater supply for Motor, VFD panel space heater, auxiliary power supply for transformers, cubicle 11W CFL lamps, indicating lamps, digital meters (Ammeter, Speedometer) etc. shall operate on 240 volts single phase AC supply provided by purchaser.

All control circuit shall operate at maximum voltage of 240V AC or 220V DC unless otherwise specified in the datasheet.

Vendor shall include supply of all control transformers, protective devices, associated accessories etc. and any other control supply voltage required for the system shall be derived by the vendor from the power supply made available by purchaser.

5.9 Reliability Features

The expected lifetime of the drive system shall be min. 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.

5.10 Maintenance features

The controller design shall incorporate the following maintenance features:

- Modular construction
- All components shall be easily accessible.
- Standard diagnostics to aid maintenance personnel. These shall include LED or alphanumeric displays, test or measurement points.

5.11 Painting

5.11.1 After preparation of the under surface, the panel shall be spray painted with two coats of epoxy based final paint or shall be powder coated. The colour shade of final paint shall be as RAL 7032, unless specified otherwise. Panel finish shall be free from imperfections like pinholes, orange peels, runoff paint, etc.

5.11.2 All unpainted steel parts shall be zinc passivated, cadmium plated or suitably treated to prevent rust and corrosion. If these parts are moving elements, then these shall be greased.

6.0 INSPECTION, TESTING AND ACCEPTANCE

6.1 During fabrication, the drive shall be subject to inspection by EIL / Owner, or by an agency authorized by the Owner, to assess the progress of work, as well as to ascertain that only quality raw material is used. The manufacturer shall furnish all necessary information concerning the supply to EIL / Owner's inspectors.

6.2 All tests shall be carried out at the manufacturer's works under his care and expense. The tests shall be witnessed by an inspector of EIL/ Owner or of an agency authorized by the owner. Prior notice of minimum 4 weeks shall be given to the inspector for witnessing the tests.

6.3 All Routine & Type Tests shall be conducted as per the ITP for HV variable frequency drive 6-81-1050 as per IEC 61800-2. However, combined test for VFD and motor at vendor's works shall be carried out if specified in the datasheet.

6.4 Additional tests on switchgears and transformers shall be carried out based on the requirement defined in the EIL's specification of respective equipment.

6.5 String Test with driven equipment

If a string test with driven equipment is specified in the data sheet of the driven equipment, it shall be carried out with the job equipment.

7.0 CERTIFICATION

The motors and associated Variable frequency drive system equipment shall have test certificates issued by recognized independent test house (CIMFR/ BASEEFA/ LCIE/UL/FM or equivalent). All indigenous motors shall conform to Indian Standards and shall be certified by Indian testing agencies. All motors (indigenous and imported) shall also have valid statutory approvals as applicable for the specified hazardous location. All indigenous flameproof motors shall have valid BIS license and marking as required by statutory authorities.

Also the motor nameplate shall clearly indicate that the motor is suitable for operation with variable frequency drive along with VFD make and model number.

8.0 PACKING AND DESPATCH

All the equipment shall be divided in to several shipping sections for protection and ease of handling during transportation. The equipment shall be properly packed for selected mode of transportation i.e. ship/rail or trailer. The equipment shall be wrapped in polyethylene sheets before being placed in wooden crates/cases to prevent damage to the finish. Crates/cases shall have skid bottoms for handling. Special notations such as 'Fragile', 'This side up', 'Weight', 'Owner's particulars', 'PO nos.' etc., shall be clearly marked on the package together with other details as per purchaser for scrutiny.

The equipment may be stored outdoors for long periods before installation. The packing shall be completely suitable for outdoor storage, in areas with heavy rains/high ambient temperature.

अग्निरोधक नियंत्रण स्टेशन के लिए विनिर्देश

SPECIFICATION FOR FLAMEPROOF CONTROL STATIONS

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Approved by						

Abbreviations:

AC	:	Alternating Current
BIS	:	Bureau of Indian Standards
BS	:	British Standards
CEA	:	Central Electricity Authority
CCE	:	Chief Controller of Explosives
CIMFR	:	Central Institute of Mines and Fuel Research (formerly CMRI)
CPRI	:	Central Power Research Institute
CT	:	Current Transformer
DGFASLI	:	Directorate General of Factory Advice Service and Labour Institutes
DGMS	:	Directorate General of Mines Safety
ERTL	:	Electronics Regional Test Laboratory
FM	:	Factory Mutual Research Corporation
FRP	:	Fibre Reinforced Plastic
GI	:	Galvanised Iron
IEC	:	International Electro-technical Commission
IEEE	:	Institute of Electrical and Electronics Engineers
IP	:	Ingress Protection
IS	:	Indian Standards
LCIE	:	Laboratoire Central des Industries Electriques
LED	:	Light Emitting Diodes
NEMA	:	National Electrical Manufacturers Association
PESO	:	Petroleum and Explosives Safety Organisation
PVC	:	Poly Vinyl Chloride
SWG	:	Standard Wire Gauge
VDE	:	Verband Der Electrotechnik, Elecktronik und Information Stechnik
UL	:	Underwriters Laboratory

Electrical Standards Committee

Convenor: Mr. UA Patro

Members: Mr. AK Tickoo
Mr. MP Jain
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Mr. KK Gera
Mr. Saeed Akhtar

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1.0 SCOPE

This specification covers the requirements of design, manufacture, testing, packing and supply of flameproof control stations and accessories suitable for installation in locations handling flammable liquids and gases.

2.0 CODES AND STANDARDS

2.1 The equipment shall comply with the requirements of latest revision of the following standards issued by BIS:

IS-5	: Colours for ready mixed paints and enamels.
IS-1248	: Direct acting indicating analogue measuring instruments and their accessories.
IS-2148	: Flameproof enclosures for electrical apparatus.
IS-6381	: Electrical apparatus for explosive gas atmospheres – Increased safety “e”.
IS / IEC 60079-0	: Electrical apparatus for explosive gas atmospheres (General Requirements).
IS / IEC 60079-1	: Electrical apparatus for explosive gas atmospheres (Equipment Protection by Flameproof Enclosures “d”).
IS / IEC 60079-7	: Electrical apparatus for explosive gas atmospheres (Equipment Protection by Increased Safety “e”).
IS / IEC 60529	: Degree of protection provided by enclosures (IP Code).
IS / IEC 60947	: LV switchgear and control gear.

2.2 In case of imported equipment, standards followed in the country of origin shall be applicable, if these standards are equivalent or more stringent than the applicable Indian Standards.

2.3 The equipment shall also confirm to the provisions of CEA Regulations and other statutory regulations currently in force in the country.

2.4 In case Indian standards are not available for any equipment, standards issued by IEC/ BS/ VDE/ IEEE/ NEMA or equivalent agency shall be applicable.

2.5 In case of any conflict between requirements specified in various applicable documents for the project, the most stringent one shall prevail. However, Owner's decision in this regard will be final and binding.

3.0 GENERAL REQUIREMENTS

3.1 The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.

3.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least 10 years from the date of supply.

4.0 SITE CONDITIONS

The equipment shall be suitable for installation and satisfactory operation in classified hazardous locations in tropical, humid and corrosive atmosphere as prevalent in refineries, petrochemical and fertilizer plants. Unless otherwise specified, a design ambient temperature of 40° C and an altitude not exceeding 1000 m above mean sea level shall be considered.

5.0 CERTIFICATION

The equipment shall have test certificates issued by recognised independent test house (CIMFR/ CPRI/ ERTL/ Baseefa/ LCIE/ UL/ FM or equivalent). All indigenous equipment shall conform to Indian standards and shall be certified by Indian testing agencies. All equipment (indigenous & imported) shall also have valid statutory approvals as applicable for the specified location. All indigenous flameproof equipment shall have valid BIS license and marking as required by statutory authorities.

6.0 TECHNICAL REQUIREMENTS

6.1 Construction

- 6.1.1 The enclosures of the control stations shall be made of cast light metal alloy.
- 6.1.2 The control stations shall be suitable for use in outdoor open locations and shall have IP-55 degree of protection. They shall preferably be provided with integral canopy. However, where the enclosure has been certified without integral canopy, a separate canopy can be accepted. The separate canopy shall be made of at least 14 SWG (2mm) galvanised sheet steel or FRP. The canopy shall be suitable for providing protection against rain from top and two sides.
- 6.1.3 The control stations shall be provided with gaskets made of non-inflammable and self-extinguishing material.
- 6.1.4 All metal surfaces shall undergo manufacturer's standard cleaning/ painting cycle. After preparation of under surface, the equipment shall be painted with two coats of epoxy based final paint with colour shade as below:

- Flame proof (Gas group IIA/ IIB) : Dark admiralty grey shade 632 of IS-5/
RAL 7035
- Flame proof (Gas group IIC) : Light yellow shade 355 of IS-5

All unpainted steel parts shall be suitably treated to prevent rust formation. If these parts are moving elements then they shall be greased.

- 6.1.5 A warning inscription "Isolate power supply elsewhere before opening" shall be provided on each enclosure. The warning inscription shall be embossed on the enclosure or a separate warning plate with above inscription shall be fixed to the enclosure with screws. The warning plate shall be of nickel plated brass or stainless steel.
- 6.1.6 All accessories like nuts, bolts, washers etc. shall be made of stainless steel SS-304.
- 6.1.7 The control stations shall be provided with two earthing studs with lugs on the external surface of the enclosures suitable for termination of 8 SWG GI wire.
- 6.1.8 The control station shall be provided with bottom cable entries. Required number of flameproof double compression nickel plated brass cable glands and flameproof nickel plated brass sealing plugs shall be provided.
- 6.1.9 The control stations shall have external fixing lugs for mounting on wall or column. The holes provided on these lugs shall be of oblong type.
- 6.1.10 A nameplate indicating Tag Number shall be provided on each control station. Separate nameplate shall also be provided to indicate the details of testing agency (CIMFR or equivalent), test certificate no. with date, statutory approval no. with date and agency (PESO/ CCE/ DGFASLI/ DGMS), BIS license number and date, applicable gas group etc. The nameplates shall be engraved type and permanently fixed on the equipment. In case the standard details given above are embossed on the enclosures, the same need not be repeated on the name plate.

6.2 Component Specification

- 6.2.1 Push buttons for START and STOP shall be of GREEN and RED colour respectively. Each push button shall have one NO and one NC contact. The STOP push button shall be mushroom type with stay put feature and lockable in pressed position.
- 6.2.2 All control switches shall be provided with a pistol grip handle. Circuit breaker control switch, wherever specified, shall have three positions (START - NEUTRAL - STOP) with spring return to neutral from START position and stay put in STOP position. All control/ selector switches shall have minimum two poles for each position. Each position of switch shall be indelibly marked on the control station.
- 6.2.3 All ammeters shall be of moving iron type having an accuracy class of 3 and suitable for 1 Ampere CT secondary. Minimum size of ammeter shall either be 72mm x 72 mm or 65 mm diameter. 80% of the scale length shall cover 100% of the CT primary current uniformly and the balance 20% of the scale shall cover 100-800% of the CT primary. A red mark corresponding to the full load current of the motor shall be provided on the ammeter dial. The ammeter front glass shall be toughened.
- 6.2.4 Indicating lamp(s) wherever provided shall be clustered LED type (with minimum 3 numbers LEDs, preferably connected in parallel), mounted inside an enclosure of minimum diameter of 15mm.

6.3 Terminals & Wiring

- 6.3.1 The control stations shall be provided with sufficient number of terminals. More than 2 wires per terminal shall not be permitted. If required, additional terminal with shorting link may be used. Each terminal for external cable connection shall be suitable for termination of 2.5 mm² solid copper conductor. Tinned copper lugs shall be provided for cable termination.
- 6.3.2 All internal wiring shall employ 2.5 mm², 660V grade, PVC insulated copper conductor wires.
- 6.3.3 For flameproof equipments, terminal box can be provided in 'Exe' execution.

7.0 INSPECTION, TESTING AND ACCEPTANCE

- 7.1 During fabrication, the equipment shall be subjected to inspection by EIL/ Owner or by an agency authorized by the Owner, if specified/ agreed in Inspection Test Plan. Manufacturer shall furnish all necessary information concerning the supply to EIL/ Owner's inspector. All routine/acceptance tests shall be carried out at manufacturer's works under his care & expense.
- 7.2 Type test certificates from CIMFR or equivalent test house, applicable PESO/ CCE/ DGFASLI/ DGMS approval certificates, BIS license and original drawings referred in type test certificates shall be shown to the inspection agency on demand during inspection. The certificates and BIS license must be valid at the time of despatch.
- 7.3 Test certificates of bought out components shall be shown to the inspection agency on demand during inspection.
- 7.4 All equipments shall be subjected to various routine / acceptance tests as per standards but not limited to the following:
- 7.4.1 General visual inspection
- 7.4.2 Dimensional inspection
- 7.4.3 Verification of mechanical and electrical operations
- 7.4.4 Dielectric tests
- 7.4.5 Over pressure test
- 7.4.6 Any other routine and acceptance test as per applicable standards.

8.0 PACKING AND DESPATCH

All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for the selected mode of transportation, i.e. by ship/ rail or trailer, and shall be wrapped in polythene sheets before being placed in crates/ cases to prevent damage to finish. The crates/ cases shall have skid bottom for handling. Special notations such as 'Fragile', 'This side up', 'Center of gravity', 'Weight', 'Owner's particulars', 'PO no.' etc., shall be clearly marked on the packages together with other details as per purchase order.

The equipment may be stored outdoors for long periods before installation. The packing shall be completely suitable for outdoor storage, in areas with heavy rains/ high ambient temperature.

DATA SHEET – HV VARIABLE FREQUENCY DRIVE
Part-I (Data to be filled in by purchaser)

1. Applicable standards : EIL spec. 6-51-0050
2. Rated output capacity (KW) : *
3. Rated Output voltage : *
4. Cable length between VFD and Motor : Approx. 300m
5. Motor Details
 - a) Drive system : Single
 - b) Motor tag no. :
 - c) Type of motor : Squirrel cage induction motor
 - d) KW rating : *
 - e) Starting condition : Soft start
 - f) Frequency range : *
 - g) Voltage range : *
 - h) Full load current : *
 - i) Full load PF
 - pf at lowest KW : *
 - pf at Highest KW : *
 - j) Starting current : *
 - k) Load torque details : *(As per Cl . 5.1.3 of 6-51-0050)
6. **SITE CONDITIONS:**
 - a) Ambient temperature : Max. 39.8°C / Min.1° C
 - b) Design temperature : 40° C
 - c) Altitude : Less than 1000M
 - d) Installation : Indoor
 - e) Location : Substation VFD room
7. **INPUT POWER SUPPLY SYSTEM CONDITIONS**
 - a) No. of phases : 3
 - b) AC input voltage : 6.6kV
 - c) Voltage fluctuation : $\pm 10\%$
 - d) Rated frequency : 50 Hz
 - e) Frequency fluctuation : $\pm 3\%$
 - f) System fault level : Max 40kA & Min 10kA
8. **SYSTEM REQUIREMENTS**
 - a) Speed range required : As per process requirement
 - b) Adjustment of speed : Auto (from DCS) & Manual (from LCS – As per process requirement)
 - c) Speed Reference by measurement of the stator voltage frequency through voltage transformer : *
 - d) Reference Signal : 4 - 20 mA (from DCS).
 - e) By pass Breaker : Not Required
 - f) Acceleration time : *
 - Deceleration time : *

B	15.01.2016	ISSUED WITH MR	LCK	RKR	VKJ
A	11.09.2015	ISSUED WITH MR	LCK	RKR	VKJ
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- | | | | |
|----|--|---|----------------------------------|
| i) | Fault diagnostic | : | Required |
| j) | Braking | : | |
| k) | Regeneration | : | |
| l) | Cable length between swbd and I/P trafo. | : | as applicable |
| n) | Cable length between I/Ptrafoand VFD | : | as applicable |
| o) | Separate PE Conductor b/n VFD & Motor | : | Not Envisaged, Vendor to confirm |
| p) | Communication facility with data concentrator on open protocol | : | |

*** - Data to be provided by vendor/equipment supplier**

PART-II (to be filled in by vendor and submitted with bid)

1. Make :
2. Model No. :
3. Rating :
4. Applicable code/standards :
5. Speed range :
6. Speed reference :
7. Input power supply ratings
 - a) Voltage : ± %
 - b) Frequency : ± %
8. Overload capability
 - a) 125% : minutes
 - b) 150% : secs.
 - c) Inrush current 250% I_n for : secs.
9. Overall efficiency at
 - a) 100% load :
 - b) 75% load :
 - c) 50% load :
 - d) 25% load :
10. Overall power factor at
 - a) 100% load :
 - b) 75% load :
 - c) 50% load :
 - d) 25% load :
11. AC Output
 - a) Output voltage range :
 - b) Voltage accuracy :
 - c) Frequency range :
 - d) Frequency accuracy :
12. Transient voltage
 - a) fluctuation ratio :
 - b) Its recovery time :
13. Transient Torque
 - 13.1 Max. Transient air gap torque/duration :
 - 13.2 Max. Transient torque/duration :

Same shall be furnished at the coupling of VFDs, accounting for the motor and the driven equipment in the case of a two and a three phase short-circuit at the motor terminal.
14. Wave form distortion factor (% harmonics) in output/
Input waveform :
(Number of harmonics and magnitude of each harmonic generated shall be furnished).
15. Output short circuit capability and duration :
16. Deration of motor at
 - a) Maximum speed :
 - b) Minimum speed :
17. **Rectifier/Inverter**
 - a) Make :
 - b) Type/Model No. :
 - c) Diodes/GTOs configuration :
 - d) Total No. of Diodes/GTOs :

- | | | | |
|-----|--|---|--------------------------|
| e) | Cooling system | : | |
| | - Type | : | |
| | - Redundancy in cooling Units | : | |
| f) | Type of feedback for speed control | : | |
| 18. | DC Reactor | | |
| a) | Make | : | |
| b) | Type | : | |
| c) | Rating | : | |
| d) | Inductance of the reactor | : | |
| e) | Air Core/Iron Core | : | |
| 19. | Output Filter | | |
| a) | Make | : | |
| b) | Type / Model No. | : | |
| c) | Rating | : | |
| d) | Rated Voltage | : | |
| 20. | Output Power Isolating Device | | |
| a) | Make | : | |
| b) | Type | : | |
| c) | Model No. | : | |
| d) | Cont. Current Rating | : | |
| e) | Short Circuit Rating | : | |
| f) | Rated Voltage | : | |
| g) | Applicable Standard | : | |
| h) | Panel details | : | |
| | - Overall Length | : | |
| | - Height | : | |
| | - Depth | : | |
| | - Degree of protection | : | |
| 21. | Main Transformer | | |
| a) | Make | : | |
| b) | Type of Transformer | : | Dry Type (Panel mounted) |
| c) | KVA Rating | : | |
| d) | Voltage ratio | : | |
| e) | Vector group | : | |
| f) | Impedance | : | |
| g) | Overall dimension
(LxBxH) | : | |
| 22. | VFD PANEL DETAILS | | |
| a) | Overall Length | : | |
| b) | Height | : | |
| c) | Depth | : | |
| d) | Weight of cubicle | : | |
| | (Dimensional details of all panels shall be furnished) | | |
| e) | Degree of protection for enclosure. | : | |
| f) | Paint shade | : | |
| g) | Heat output of Panel | : | |
| h) | Type of cooling | : | |
| 23. | Auxiliary Power Requirement: | | |
| a) | KW | : | |
| b) | Voltage | : | |

- | | | | |
|-----|--|---|-----|
| 24. | LCS/LCP required as per spec | : | Yes |
| 25. | Requirement of earthing cable between motor& drive | : | |
| 26. | Address of Manufacturing Location | : | |
| 27. | Address of Shop Testing Location | : | |
| 28. | Since when the proposed type of semiconducting power devices are being used in the offered drive model | : | |
| 29. | List of equipments / Components to be sourced from India | : | |

 ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)		DRY TYPE TRANSFORMER DATA SHEET		Document No. A672-001-16-50-DS-5007 Rev. No. 0 Page 1 of 4																															
Project INTEGRATED METHANOL AND ACETIC ACID PROJECT			Client ASSAM PETROCHEMICALS LIMITED																																
Unit METHANOL PLANT		Location ASSAM, INDIA		Job No. A672 Unit No. 001																															
PURCHASER'S DATA																																			
A. Site Conditions																																			
1.	Maximum Ambient Temperature	°C	39.8																																
2.	Minimum Ambient Temperature	°C	1																																
3.	Design Ambient Temperature	°C	40																																
4.	Relative Humidity	%	88																																
5.	Altitude Above MSL	m	<1000																																
6.	Environment		Humid and Corrosive																																
B. Technical particulars																																			
1.	Tag no.		By vendor																																
2.	Duty		Continuous																																
3.	Service		VFD																																
4.	No. of windings		By vendor																																
5.	Type of cooling		ANAN																																
6.	Rated MVA		By vendor																																
7.	Rated voltage																																		
	HV winding	kV	6.6																																
	LV winding	kV	By vendor																																
8.	System earthing																																		
	HV side		Resistance Earthed																																
	LV side		Solidly Earthed																																
9.	Rated frequency	Hz	50 +/- 3 %																																
10.	No. of phases		Three																																
11.	Fault level on HV side	kA	40 KA for 1 sec																																
12.	Connection																																		
	HV side		By vendor																																
	LV side		By vendor																																
13.	Vector group		By vendor																																
14.	Impedance at max. MVA	%	By vendor																																
15.	Insulation class		H																																
16.	Insulation level																																		
	P.f withstand																																		
	HV winding	kV	20																																
	LV winding	kV	By vendor																																
	Impulse withstand																																		
	HV winding	kVp	60																																
	LV winding	kVp	By vendor																																
17.	Winding insulation type		Uniform																																
18.	Creepage distance																																		
	Prim. winding																																		
	total																																		
	protected																																		
	LV winding																																		
	total																																		
	protected																																		
19.	Tab changer																																		
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 16.6%; height: 20px;"></td> <td style="width: 16.6%;"></td> <td style="width: 16.6%;"></td> <td style="width: 16.6%;"></td> <td style="width: 16.6%;"></td> <td style="width: 16.6%;"></td> </tr> <tr> <td style="height: 20px;"></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td style="height: 20px;"></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td style="text-align: center;">0</td> <td style="text-align: center;">10-APR-2018</td> <td style="text-align: center;">ISSUED WITH PR</td> <td style="text-align: center;">BISWAS PRITAM</td> <td style="text-align: center;">RAMAN RAVISH KUMAR</td> <td style="text-align: center;">RATHAUR RASHMI SINGH (MS)</td> </tr> <tr> <td style="text-align: center;">Rev. No.</td> <td style="text-align: center;">Date</td> <td style="text-align: center;">Purpose</td> <td style="text-align: center;">Prepared By</td> <td style="text-align: center;">Reviewed By</td> <td style="text-align: center;">Approved By</td> </tr> </table>																								0	10-APR-2018	ISSUED WITH PR	BISWAS PRITAM	RAMAN RAVISH KUMAR	RATHAUR RASHMI SINGH (MS)	Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By
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Project INTEGRATED METHANOL AND ACETIC ACID PROJECT **Client** ASSAM PETROCHEMICALS LIMITED

Unit METHANOL PLANT **Location** ASSAM, INDIA **Job No.** A672 **Unit No.** 001

	Location		Primary Winding
	Type		Offcircuit
	Range	%	± 5
	No. of steps		5
20.	Normal load	%	By vendor
21.	Max efficiency at 0.8 p.f		
22.	Load at which max eff. occurs	% MVA	
23.	Power flow		Unidirectional
24.	Terminal location		
	HV side		Larger side
	LV w.r.t HV	°	180
25.	Terminal connection		
	HV side		Cable box
	LV side		Cable Box
26.	Cable Size/Type		
	HV side		Later
	LV side		Later
27.	Neutral CT specification		
	51G		Not Required
	64R		Not Required
	Vk	A	
	Im at Vk/2	mA	
	RCT	ohm	
28.	Installation		Indoor(Panel mounted)
29.	Painting & colour		Epoxy & shade 632 of IS 5 / RAL 7031
30.	AC Auxiliary voltage	V	415 +/- 10 % TPN
31.	DC Auxiliary voltage	V	220 +/- 10 % %
32.	Bidirectional roller type		Flat
33.	φ distance of flat rollers	mm	NA
34.	Applicable specifications		EIL std. 6-51-0044
35.	Loss Capitalization		Not Applicable
a.	Rate for copper loss Rs./kW		Not Applicable
b.	Rate for iron loss Rs./kW		Not Applicable
36.	Accessories requirement		Yes
	Two temp. sensing devices in each limb		Yes
	Marshalling box(IP-55)		Yes
	Temp. sensing relay		Yes
	Channels, towing lugs :		Yes
	Rollers		Yes
	Neutral bushing outside terminal box		
	with connector assembly		
	Indicating platinum resistance type		Yes
	thermometer with contacts		

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Project INTEGRATED METHANOL AND ACETIC ACID PROJECT Client ASSAM PETROCHEMICALS LIMITED

Unit METHANOL PLANT Location ASSAM, INDIA Job No. A672 Unit No. 001

	Busduct flange on LV	Not Required
	Lugs and cable glands	Required
37.	Tests requirements	
	Impulse test	Test Certificate Req'd.
	Heat run test	Test Certificate Req'd.
38.	Partial discharge test	
	(cast resin)	Test Certificate Req'd.
	Short circuit test	Test Certificate Req'd.
	Acoustic sound	Test Certificate Req'd.

MANUFACTURER'S DATA

1.	Make	
2.	Rated power at ambient temperature of	
	25 °C	
	30 °C	
	35 °C	
	40 °C	
	45 °C	
	50 °C	
3.	Insulation type	
B. Performance		
1.	No load loss at	
	100% voltage kW	
	110% voltage kW	
2.	Full load copper loss at 75 °C	kW
3.	No load current at	
	100% voltage A	
	100% voltage A	
4.	Efficiency at full load at 75 °C	
	at 0.8 p.f. %	
	at 1.0 p.f. %	
5.	Eff. at half load at 75 °C	
	at 0.8 p.f. %	
	at 1.0 p.f. %	
6.	Load at which max eff. occurs	MVA
7.	Regulation at 75 °C	
	at 0.8 p.f. %	
	at 1.0 p.f. %	
8.	Maximum efficiency	%
C. Mechanical data		
1.	Core & winding weight	kgs.
2.	Total weight	kgs.
3.	Wheel gauge	
4.	Overall dimensions	
	Length	mm
	Breadth	mm
	Height	mm

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Project INTEGRATED METHANOL AND ACETIC ACID PROJECT

Client ASSAM PETROCHEMICALS LIMITED

Unit METHANOL PLANT

Location ASSAM, INDIA

Job No. A672

Unit No. 001

Eil Notes

- 1 All unfilled data shall be filled in by contractor/ vendor.
- 2 Losses shall be inclusive of positive tolerance and shall be at nominal tap.
- 3 Valid test reports in lieu of test to be provided
- 4 For VFD input transformer- HV winding shall be suitable for 6.6kV $\pm$ 10%
- 5 For VFD output transformer- HV winding shall be as appicable

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अग्निरोधक नियंत्रण स्टेशनों के लिए निरीक्षण एवं परीक्षण योजना

INSPECTION AND TEST PLAN FOR FLAMEPROOF CONTROL STATIONS

2.	21.11.2013	Revised and Reissued	MJ	RS	SCG	SC
2	29.06.2012	Revised and Reissued	AB	HVJ	AKC	DM
1	28.09.2007	Revised and Re-issued	AKG	PPM	MVKK	VC
0	30.04.2002	Issued for implementation	RG	AKC	AKB	GRR
Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
						Approved by

INSPECTION AND TEST PLAN FOR FLAMEPROOF CONTROL STATIONS

STANDARD SPECIFICATION NO.

6-81-1006 Rev. 3

Page 2 of 5

Abbreviations

AS	:	Alloy Steel	MPT/MT	:	Magnetic Particle Testing
BASEEFA	:	British Approval Service for Electrical Equipment in Flammable Atmospheres	MRT	:	Mechanical Run Test
BIS	:	Bureau of Indian Standard	MTC	:	Material Test Certificate
CCE or CCOE	:	Chief Controller of Explosives	MOC	:	Material of Construction
CEIL	:	Certification Engineers International Limited	NPSH	:	Net Positive Suction Head
CIMFR	:	Central Institute of Mining & Fuel Research	NDT	:	Non Destructive Testing
CE	:	Carbon Equivalent	NEMA	:	National Electrical Manufacturers Association
DFT	:	Dry Film Thickness	PO	:	Purchase Order
DT	:	Destructive Testing	PESO	:	Petroleum Explosive Safety Organization
DPT	:	Dye Penetrate Testing	PQR	:	Procedure Qualification Record
ERTL	:	Electronics Regional Test Laboratory	PR	:	Purchase Requisition
FCRI	:	Fluid Control Research Institute	PMI	:	Positive Material Identification
FM	:	Factory Mutual	PVC	:	Poly Vinyl Chloride
FLP	:	Flame Proof	QC	:	Quality Control
HT	:	Heat Treatment	RT	:	Radiography Testing
HIC	:	Hydrogen Induced Cracking	TC	:	Test Certificate
ITP	:	Inspection and Test Plan	TPI or TPIA	:	Third Party Inspection Agency
IP	:	Ingress Protection	UT	:	Ultrasonic Testing
IC	:	Inspection Certification	UL	:	Under writer Laboratories
IGC	:	Inter Granular Corrosion	VDR	:	Vendor Data Requirement
IEC	:	International Electro technical Commission	WPS	:	Welding Procedure Specification
JEC	:	Japanese Electro technical Committee	WPQ	:	Welders Performance Qualification
			XLPE	:	Cross Linked Poly Ethylene

Inspection Standards Committee

Convenor : Mr. S.C. Gupta

Members:

Mr. R.K. Singh	Mr. Rajeev Kumar	Mr. Himangshu Pal
Mr. Neeraj Mathur	Mr. T Kamalakannan	Mr. Deepak Gupta (Project)
Mr. Mayank Jain		

INSPECTION AND TEST PLAN
FOR
FLAMEPROOF CONTROL STATIONS

STANDARD SPECIFICATION NO.

6-81-1006 Rev. 3

Page 3 of 5

1.0 SCOPE

This Inspection and Test Plan covers the minimum testing requirements of Flameproof Control Stations.

2.0 REFERENCE DOCUMENTS

PO/PR/ Standards referred there in/Job specifications/Approved documents.

3.0 INSPECTION AND TEST REQUIREMENTS

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
1.0	Procedures	--	--	--	--	--	--
2.0	Material Inspection						
2.1	Incoming material like castings, glass, meters, Fasteners etc	Visual, Dimensional, Operational checks, Review of Manufacturer's Certificates etc. as applicable	100%	TC's/ Inspection & Test records / Lab Test Records	H	H	R
3.0	In process Inspection						
3.1	Flameproof enclosure without components	Routine Pressure test	100% by Supplier	Supplier's Test Records	-	H	R

INSPECTION AND TEST PLAN
FOR
FLAMEPROOF CONTROL STATIONS

STANDARD SPECIFICATION NO.

6-81-1006 Rev. 3

Page 4 of 5

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
4.0	Final Inspection						
4.1	Flameproof Control Station (Acceptance tests)	- Visual/Dimensional/BOM Checks - Plan Gap/Path/Clearances - Electrical/Functional Checks - High voltage test - IR test before and after High voltage	100% by Supplier 10% by EIL/TPIA	Test Records / Inspection Witness Record	-	H	H
4.2	Submission of Certificates & Documents	- Certificate of Statutory testing agency for suitability of area classification - Certificate of Statutory approval authority like CCoE/ PESO as applicable. - Valid BIS License as applicable - Degree of protection certificate as applicable	Samples	Certificates from test agencies	-	H	R
5.0	Painting						
5.1	Painting and Packing	- Visual - Suitable protection to prevent entry of foreign material. - Proper packing to prevent any damage during transportation and storage.	100%	Packing list / Supplier's Records	-	H	-
6.0	Documentation and IC						

**INSPECTION AND TEST PLAN
FOR
FLAMEPROOF CONTROL STATIONS**

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
6.1	Documentation and IC	- Review of Internal Test Reports & MTC - IC Issuance	100%	Supplier's Test Records / Inspection Certificate	-	H	H

Legends: H- Hold (Do not proceed without approval), Random 10% , R-Review, RW-Random witness, W- Witness (Give due notice, work may proceed after scheduled date).

NOTES :-

- This document describes the generic test requirements. Any additional test or inspection scope if specified in contract documents shall also be applicable. (Unless otherwise agreed upon).
- Acceptance Norms for all the activities shall be as per PO/PR/ Standards referred there in/ Job specifications /Approved documents

INSPECTION AND TEST PLAN
FOR
DRY TYPE DISTRIBUTION TRANSFORMER

STANDARD SPECIFICATION NO.

6-81-1044 Rev. 2

Page 1 of 5

शुष्क किस्म के डिस्ट्रीब्यूशन ट्रांसफॉर्मर
के लिए निरीक्षण एवं परीक्षण योजना

INSPECTION AND TEST PLAN
FOR
DRY TYPE DISTRIBUTION TRANSFORMER

2	30.01.2014	Revised and Re-issued	MJ	RS	SCG	SC
1	29.06.2012	Revised and Re-issued	RKP	HVJ	AKC	DM
0	08.12.2008	Issued for implementation	RB	SKD	SKP	VC
Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
						Approved by

INSPECTION AND TEST PLAN FOR DRY TYPE DISTRIBUTION TRANSFORMER

STANDARD SPECIFICATION NO.

6-81-1044 Rev. 2

Page 2 of 5

Abbreviations

AS	:	Alloy Steel	MPT/MT	:	Magnetic Particle Testing
BASEEFA	:	British Approval Service for Electrical Equipment in Flammable Atmospheres	MRT	:	Mechanical Run Test
BIS	:	Bureau of Indian Standards	MTC	:	Material Test Certificate
CCE or CCOE	:	Chief Controller of Explosives	MOC	:	Material of Construction
CEIL	:	Certification Engineers International Limited	NPSH	:	Net Positive Suction Head
CIMFR	:	Central Institute of Mining & Fuel Research	NDT	:	Non Destructive Testing
CE	:	Carbon Equivalent	NEMA	:	National Electrical Manufacturers Association
DFT	:	Dry Film Thickness	PO	:	Purchase Order
DT	:	Destructive Testing	PESO	:	Petroleum Explosive Safety Organization
DPT	:	Dye Penetrate Testing	PQR	:	Procedure Qualification Record
ERTL	:	Electronics Regional Test Laboratory	PR	:	Purchase Requisition
FCRI	:	Fluid Control Research Institute	PMI	:	Positive Material Identification
FM	:	Factory Mutual	PVC	:	Poly Vinyl Chloride
FLP	:	Flame Proof	QC	:	Quality Control
HIC	:	Hydrogen Induced Cracking	RT	:	Radiography Testing
ITP	:	Inspection and Test Plan	TC	:	Test Certificate
IP	:	Ingress Protection	TPI or TPIA	:	Third Party Inspection Agency
IC	:	Inspection Certification	UT	:	Ultrasonic Testing
IGC	:	Inter Granular Corrosion	UL	:	Under writer Laboratories
IEC	:	International Electro technical Commission	VDR	:	Vendor Data Requirement
JEC	:	Japanese Electro technical Committee	WPS	:	Welding Procedure Specification
LPT	:	Liquid Penetrate Testing	WPQ	:	Welders Performance Qualification
			XLPE	:	Cross Linked Poly Ethylene

Inspection Standards Committee

Convenor : Mr. S C Gupta

Members:

Mr. R.K. Singh	Mr. Rajeev Kumar	Mr. Himangshu Pal
Mr. Neeraj Mathur	Mr. T Kamalakannan	Mr. Deepak Gupta (Project)
Mr. Mayank Jain		

INSPECTION AND TEST PLAN FOR DRY TYPE DISTRIBUTION TRANSFORMER

STANDARD SPECIFICATION NO.

6-81-1044 Rev. 2

Page 3 of 5

1.0 SCOPE

This Inspection and Test Plan covers the minimum testing & inspection requirements of Dry Type Distribution Transformer.

2.0 REFERENCE DOCUMENTS

PO/PR & Standards referred there in /Job specifications / Approved documents.

3.0 INSPECTION AND TEST REQUIREMENTS

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
1.0	Procedures	--	--	--	--	--	--
2.0	Material Inspection						
2.1	Incoming Raw Material like Marshalling box, cables, fasteners and bolts, copper flexible, insulators, gauges, CTs, OLTC(if Applicable) etc	- Material Identification - Operational checks - Physical and Dimensional tests (as applicable)	100%	Sub-Supplier's TC / Supplier Test Records/ Third party lab	H	H	R (For major items only)
3.0	Inprocess Inspection						
3.1	Transformer assembly	Visual, Dimensions, Bill of materials.	100%	Supplier's Test Records	-	H	-

INSPECTION AND TEST PLAN
FOR
DRY TYPE DISTRIBUTION TRANSFORMER

STANDARD SPECIFICATION NO.

6-81-1044 Rev. 2

Page 4 of 5

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
4.0	Final Inspection						
4.1	Transformer (Routine Tests)	- Physical and Dimensional check. - Verification of Bill of Material. - Measurement of winding resistance - Measurement of voltage ratio and check of voltage vector relationship - Measurement of impedance voltage, short-circuit impedance and load loss. - Measurement of no-load loss and current - Induced over voltage withstand test - Separate –source voltage withstand test (HV Test) - Measurement of Insulation Resistance before and after HV test. - Noise level check. - Tests on OLTC(if applicable).	100%	Inspection test records	-	H	H
4.2	Transformer (Special Tests)	Temperature Rise Test	1 No. of Sample/Rating	Inspection test records	-	H	H
4.3	Transformer (Type Tests)	- Impulse withstand test. - Short circuit test. - Partial Discharge test - Degree of Protection of Enclosure.	1 No. of Sample/Rating	Inspection test records	-	H	R
5.0	Painting						
5.1	Painting of Transformers	Pre treatment, primer and final paint, shade, thickness	100%	Test records	-	H	--

**INSPECTION AND TEST PLAN
FOR
DRY TYPE DISTRIBUTION TRANSFORMER**

STANDARD SPECIFICATION NO.

6-81-1044 Rev. 2

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
6.0	Documentation and IC						
6.1	Documentation and IC	- Review of Internal Test Reports. - IC issuance	100%	Supplier's Test Records / Inspection Certificate (IC)	-	H	H
6.2	Final Document submission	Compilation of Inspection reports ,drawings, etc as per VDR / PR	100%	Final data folder /Completeness certificate	-	H	H

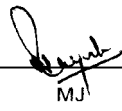
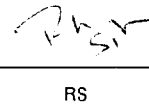
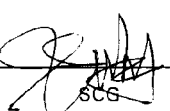
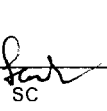
Legends: H- Hold (Do not proceed without approval, R-Review, RW-Random witness (As specified or 10 % - Samples must include min 1 No of each type), W- Witness (Give due notice, work may proceed after scheduled date).

NOTES :-

- This document describes the generic test requirements. Any additional test or inspection scope if specified in contract documents shall also be applicable. (Unless otherwise agreed upon).
- Acceptance Norms for all the activities shall be as per PO/PR/ Standards referred there in/ Job specifications /Approved documents

उच्च वोल्टेज वैरीएबल फ्रीक्वेन्सी ड्राइव सिस्टम के लिए निरीक्षण एवं परीक्षण योजना

INSPECTION AND TEST PLAN FOR HV VARIABLE FREQUENCY DRIVE SYSTEM

2	30.01.2014	Revised and Reissued	 MJ	 RS	 SCS	 SC
1	29.06.2012	Revised and Reissued	AB	RJD	AKC	DM
0	08.12.2008	Issued for implementation	RB	SKD	SKP	VC

Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
						Approved by

INSPECTION AND TEST PLAN FOR HV VARIABLE FREQUENCY DRIVE SYSTEM

STANDARD SPECIFICATION NO.

6-81-1050 Rev. 2

Page 2 of 6

Abbreviations

AS	:	Alloy Steel	MPT/MT	:	Magnetic Particle Testing
BASEEFA	:	British Approval Service for Electrical Equipment in Flammable Atmospheres	MRT	:	Mechanical Run Test
BIS	:	Bureau of Indian Standard	MTC	:	Material Test Certificate
CCE or CCOE	:	Chief Controller of Explosives	MOC	:	Material of Construction
CEIL	:	Certification Engineers International Limited	NPSH	:	Net Positive Suction Head
CIMFR	:	Central Institute of Mining & Fuel Research	NDT	:	Non Destructive Testing
CE	:	Carbon Equivalent	NEMA	:	National Electrical Manufacturers Association
DFT	:	Dry Film Thickness	PD	:	Partial Discharge
DT	:	Destructive Testing	PO	:	Purchase Order
DPT	:	Dye Penetrate Testing	PESO	:	Petroleum Explosive Safety Organization
ERTL	:	Electronics Regional Test Laboratory	PQR	:	Procedure Qualification Record
FCRI	:	Fluid Control Research Institute	PR	:	Purchase Requisition
FM	:	Factory Mutual	PMI	:	Positive Material Identification
FLP	:	Flame Proof	PVC	:	Poly Vinyl Chloride
HT	:	Heat Treatment	QC	:	Quality Control
HIC	:	Hydrogen Induced Cracking	TC	:	Test Certificate
ITP	:	Inspection and Test Plan	TPI or TPIA	:	Third Party Inspection Agency
IP	:	Ingress Protection	UT	:	Ultrasonic Testing
IC	:	Inspection Certification	UL	:	Under writer Laboratories
IGC	:	Inter Granular Corrosion	VDR	:	Vendor Data Requirement
IEC	:	International Electro technical Commission	WPS	:	Welding Procedure Specification
JEC	:	Japanese Electro technical Committee	WPQ	:	Welders Performance Qualification
LPT	:	Liquid Penetrate Testing	XLPE	:	Cross Linked Poly Ethylene

Inspection Standards Committee

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Mr. R.K. Singh	Mr. Rajeev Kumar	Mr. Himangshu Pal
Mr. Neeraj Mathur	Mr. T Kamalakannan	Mr. Deepak Gupta (Project)
Mr. Mayank Jain		

INSPECTION AND TEST PLAN FOR HV VARIABLE FREQUENCY DRIVE SYSTEM

STANDARD SPECIFICATION NO.

6-81-1050 Rev. 2

Page 3 of 6

1.0 SCOPE

This Inspection and Test Plan covers the minimum testing requirements of HV Variable Frequency Drive System (VFD).

2.0 REFERENCE DOCUMENTS

PO/PR/ Standards referred there in/Job specifications/Approved documents.

3.0 INSPECTION AND TEST REQUIREMENTS

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
1.0	Procedures	--	--	--	--	--	--
2.0	Material Inspection						
2.1	Incoming Material like fabricated panels, Power semiconductors, IGBT/SCRs, relays, meters, CT/PT, transducers transformer unit, rectifier unit, filter etc.	- Material Identification - Operational checks	100%	Material Test Certificates / Test Lab Certificates	H	H	R
3.0	In process Inspection						
3.1	VFD Assembly	Visual ,Dimensional, Bill of Materials	100%	Supplier's records	-	H	R
4.0	Final Inspection						

INSPECTION AND TEST PLAN
FOR
HV VARIABLE FREQUENCY DRIVE SYSTEM

STANDARD SPECIFICATION NO.

6-81-1050 Rev. 2

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
4.1	Final Inspection ** (Acceptance tests)	• Visual and Dimensional • Check calibration status of all testing equipment. • Bill of Material. • Simulation check of control signals • Check of Speed/rpm at different frequency at constant Torque/ Voltage/ Power Mode, as applicable • Memory function check of fault diagnostics • Insulation Test • Light Load and Functional test • Load characteristics • Load duty test • Check Auxiliary Devices • Check the properties of the control equipment • Check the Protective Devices • Check control and functional requirements • High voltage test • Leakage and pressure test for cooling system where provided • Automatic restart/re-acceleration. • Noise Level Measurement	100%	Supplier's Records	-	H	H
4.2	Final Inspection (Type Tests)	• Load current versus speed at different frequency at constant torque/ Voltage/Power Mode as applicable. • Efficiency • Temperature rise • Voltage division	One sample from each type/rating	Supplier's records	-	H	H

INSPECTION AND TEST PLAN FOR HV VARIABLE FREQUENCY DRIVE SYSTEM

STANDARD SPECIFICATION NO.

6-81-1050 Rev. 2

Page 5 of 6

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
		- Line side current distortion content - Power factor - Dynamic performance test - Current limit and current loop test - Speed loop test capability to ride through voltage dips upto 20 % - Test capability to restart the system and resynchronize converter onto running motor after a voltage interruption. - Noise Level Measurement. - Harmonic measurement at output of VFD for Volatge and Current Integral Test is to be carried out along with job motor, as per PR/ EIL Standard Specification.					
4.3	Submission of certificates /documents	- Degree of protection certificate as per latest IS/IEC. - Type test certificates from recognized independent test house such as ERTL, CIMFR,BASEEFA,FM/UL, PTB, ATEX etc for rated current test, power loss determination, temperature rise, EM Immunity and EM Emission	Sample/Prototype	Statutory Approval Certificates / Type Test Certificates	-	H	R
5.0	Painting						
5.1	Painting and Packing	- Visual - Protection against damage during transportation.	100%	Packing list / Supplier's Records	-	H	-

**INSPECTION AND TEST PLAN
FOR
HV VARIABLE FREQUENCY DRIVE SYSTEM**

STANDARD SPECIFICATION NO.

6-81-1050 Rev. 2

Page 6 of 6

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
6.0	Documentation and IC						
6.1	Documentation and IC	- Review of Internal Test Reports and MTCs. - IC issuance	100%	Supplier's Test Records / Inspection Certificate (IC)	-	H	H
6.2	Final Document submission	Compilation of Inspection reports ,drawings, etc as per VDR / PR	100%	Final data folder /Completeness certificate	-	H	H

** All the load tests/ Functional Checks are to be carried out either with the job motor or with Shop Motor

Legends: H- Hold (Do not proceed without approval, R-Review, RW-Random witness (As specified or 10 % - Samples must include min 1 No of each type), W- Witness (Give due notice, work may proceed after scheduled date).

NOTES :-

1. This document describes the generic test requirements. Any additional test or inspection scope if specified in contract documents shall also be applicable. (Unless otherwise agreed upon).
2. Acceptance Norms for all the activities shall be as per PO/PR/ Standards referred there in/ Job specifications /Approved documents

Approved Vendor List for Equipment/Materials

Control Stations (Flameproof)	Baliga Lighting Equipments (P) Limited, FCG Flameproof control gears P. Ltd, FCG Power Industries Pvt. Ltd., Flameproof Equipments Pvt. Ltd., Flexpro Electricals Pvt. Ltd., Petroleum Safety Products Ind. PVT. LTD., Kaysons Techno Equipment P LTD., Sudhir Switchgears PVT LTD.
Junction Box (Flameproof)	Baliga Lighting Equipments (P) Limited, FCG Flameproof control gears P. Ltd, FCG Power Industries Pvt. Ltd., Flameproof Equipments Pvt. Ltd., Flexpro Electricals Pvt. Ltd., Petroleum Safety Products Ind. PVT. LTD., Kaysons Techno Equipment P LTD., Sudhir Switchgears PVT LTD.,
Motors (Imported)	Asea Brown Boveri Limited (ABB Ltd.), NIDEC ASI SPA, CEMP SRL, General Electric Canada, Hitachi Ltd., Jeumont SA/ Framatone ANP, Loher GMBH, LLOYD Dynamowerke GMBH&CO. KG, Siemens AG, Toshiba Corporation, WEG Equipamentos Eletricos S.A., Wegeuro- Industria Electrica S.A.
Motors (Induction) MV (Zone-2 Type –e and n)	ABB Limited, Bharat Bijlee Ltd., Crompton Greaves Ltd., Kirloskar Electric Co. Ltd, Laxmi Hydraulics Pvt. Ltd., Marathon Electric Motor Ltd.
Cable glands (Hazardous Area)	Baliga Lighting Equipments (P) Limited, Comet Brass Products, Comet Industries, FCG Flameproof Control Gears P. Ltd., FCG Power Industries Pvt. Ltd., Flameproof Equipments Pvt. Ltd., Flexpro Electricals Pvt. Ltd., Standard Metal Industries, Kaysons Techno Equipment P LTD., Sudhir Switchgears PVT LTD.
A.C. VARIABLE SPEED DRIVE	ABB Ltd., Asea Brown Boveri Ltd (ABB Ltd), Baldoe Electric Company, GE Energy power conservation france Sas, Danfoss Industries Pvt Ltd, Eurotherm Del India limited, Hitachi Ltd, KARL E BRINKMANN GMBH, Larsen & Toubro Ltd – Mahape, Meidensha Corp, Rockwell Automation India Pvt Ltd, Siemens Ltd (Nashik), Schneider Electric India.Pvt Ltd, Siemens AG, Toshiba Corporation, Vacon Oyj, Vacon Controls and Drives.
Transformer- Distribution (Dry Type)	BHEL Jhansi, Kirloskar Electric Co Ltd, Megawin Switchgear P Ltd, Voltamp Transformers Ltd.

A	19.01.16	Issued with MR	LCK	RKR	VKJ
Rev. No	Date	Purpose	Prepared by	Checked by	Approved by

EXPERIENCE RECORD - For Hazardous Area Induction Motor & VFD System

Motor Tag No. :
Offered motor ratings :
Motor Supplier :

Sr. No.	Parameter	Information on Offered Model	Information on Operating Installation		
			1	2	3
	Ex – 'de'/'p' HV Induction Motor				
1	Motor Frame Designation, Voltage rating & kW				
2	Place of manufacturing				
3	Applicable Code				
4	BKW / PF / Terminal Voltage				
5	Insulation Class / Full Load Temp Rise Limited To Class				
6	Enclosure weather protection Class				
7	Type of Cooling (Air Cooled/Water Cooled)				
8	Type of starting – VFD/ DOL				
9	Type of running – VFD/ Bypass/ Other				
10	Output transformer provided – Yes/ No				
11	Starting current				
12a	Hazardous area protection class				
12b	Hazardous area Certification details (attach relevant documents from country of origin)				
13	Frequency / full load speed				

ENGINEERS INDIA LIMITED NEW DELHI	Project: Integrated Methanol and Acetic Acid Project Client: M/s APL	EXPERIENCE RECORD	DOCUMENT NO.	Date	Rev
			A672-001-16-50-DS-5009	11.09.2015	A

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Sr. No.	Parameter	Information on Offered Model	Information on Operating Installation		
			1	2	3
14	Type of bearing (DE and NDE)				
15	Service / Details of driven equipment				
	<u>Input Transformer for VFD</u>				
1	Make				
2	Integral/Separate				
3	Rating				
4	Transformer Type (Dry/Oil Filled)				
5	Voltage ratio				
6	Impedance				
7	Vector Group				
8	Dimensions (LXBXH)				
	<u>VARIABLE FREQUENCY DRIVE</u>				
1	Make				
2	Model				
3	Technology (LCI/VSI)				
4	Bypass Mode provided (Yes/No)				
5	VFD Output Voltage				
6	Input Supply Voltage				
7	Type of Cooling (Air cooled/water cooled)				
8	Any special requirement of upstream breakers (two trip				

ENGINEERS INDIA LIMITED NEW DELHI	Project: Integrated Methanol and Acetic Acid Project Client: M/s APL	EXPERIENCE RECORD	DOCUMENT NO.	Date	Rev
			A672-001-16-50-DS-5009	11.09.2015	A

Sheet 2 of 3



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Sr. No.	Parameter	Information on Offered Model	Information on Operating Installation		
			1	2	3
	coils etc)				
9	Encoder (required/not required)				
10	Special earthing cable				
11	Heat Load				
12	Dimensions (LXWXH)				
	<u>Other Details</u>				
1	Combined testing of input transformer, VFD and motor done at which place (motor works/vendor works)				
2	Date of supply & commissioning				
3	No. of operating hours completed as on date of bid opening				
4	Purchaser/Owner- Name Contact number				
5	Location of Machine (complete address) TELEPHONE /FAX / E MAIL NOS. CONTACT PERSON				

ENGINEERS INDIA LIMITED NEW DELHI	Project: Integrated Methanol and Acetic Acid Project Client: M/s APL	EXPERIENCE RECORD	DOCUMENT NO.	Date	Rev
			A672-001-16-50-DS-5009	11.09.2015	A

Sheet 3 of 3





A4 – 12

PURCHASE SPECIFICATION

GROUP: COE/VFD

P.S NO. : PS/445/2599

REV. NO: 00

PAGE 00 OF 20

REVISION HISTORY SHEET

REV. NO.	DATE	NATURE OF CHANGE	REASONS	PREPARED BY	APPROVED BY
00	03-05-2018	FIRST ISSUE	-----		

REVISION 00

APPROVED BY
Amaranath Pramanick

PREPARED BY
M M Bharat Kumar

ISSUED BY
VFD ENGG.

DATE
03-05-2018

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TECHNICAL SPECIFICATION OF VFD FOR 5640kW, 6.6kV SQUIRREL CAGE INDUCTION MOTOR AND LOP FOR NET GAS COMPRESSOR

MATERIAL CODE: PR0900009136

1. Project Details

Sl. No.	Parameter	Specification
1	Project Location	BPCL Kochi Refinery, Kerala, India
2	Project Title	BS IV MS Block project at BPCL, Kochi
3	Customer	BPCL Kochi Refinery
4	Consultant	Engineers India Ltd.

2. Environment Specifications

Sl. No.	Parameter	Specification
1	Maximum Ambient Temperature	46°C
2	Minimum Ambient Temperature	1.1°C
3	Equipment Design Temperature (IS-9676)	45°C
4	Relative Humidity	86%
5	Altitude	Less than 1000m above mean sea level
6	Location of VFD Panels	Indoor, Ventilated Room with Air Conditioning.
7	Seismic Zone	As per IS-1893-Zone-V

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3. Input and Transformer Data

Sl. No.	Parameter	Specification
1	System Voltage / Frequency / Phase	6.6kV / 50Hz / 3ph
2	Voltage Variation	±10%
3	Frequency Variation	±5%
4	Combined Voltage and Frequency Variation	±10%
5	Fault Level	40kA/1 sec
6	Transformer Type	Dry type integrated Transformer (In Vendor scope)
7	Rating	Transformer must be designed to carry 110% of calculated VFD rating. Transformer sizing calculation shall be provided along with the offer.
8	Power Cables	Cable glands, Lugs and termination kit suitable for Power cable to be provided by the vendor for Transformer HV side cable termination. The exact no. and size will be intimated during drawing approval stage. Cables in Customer scope.

4. Motor Data

Sl. No.	Parameter	Specification									
1	Type	Squirrel Cage Induction Motor									
2	Scope	Manufactured by BHEL-Bhopal									
3	Rated Output	5640kW, 1495RPM									
4	Rated Voltage and Current	6.6kV, 555A									
5	No load Current	During detailed Engineering									
6	Pull Out Torque (% of FLT)	190%									
7	Fed from	Variable Frequency Drive (V/f Control)									
8	Duty Class	Continuous - S1									
9	Efficiency and Power Factor:	<table><tr><th>% of Load</th><th>Efficiency</th><th>Power Factor</th></tr><tr><td>75</td><td>95.6%</td><td>0.86</td></tr><tr><td>100</td><td>95.8%</td><td>0.88</td></tr></table>	% of Load	Efficiency	Power Factor	75	95.6%	0.86	100	95.8%	0.88
% of Load	Efficiency	Power Factor									
75	95.6%	0.86									
100	95.8%	0.88									
10	Power Cables	Cable glands, Lugs and termination kit suitable Power cable to be provided by the vendor for VFD Output side cable termination. The exact no and size will be intimated during drawing approval stage. Cables in Customer scope.									



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5. Scope:

Sl. No.	Scope of Supply	Description
1	a) 1 Nos. Fully Assembled Unit of 6.6kV VFD Panels with Diode/Active Front End Rectifier, Air Cooled with integrated Dry type transformer b) 1 No of Local Operating Panel mounted near motor(as per EIL approved Vendor list) c) All interconnecting cables along with Cable glands,lugs and termination kit between the VFD and integrated Transformer d) Any special cable other than power and control cables from VFD to other equipment. e) Special tools and Tackles/instruments, if required, the same to be supplied along with main equipment. f) Lifting trolley required for lifting the power modules.	The vendor shall be responsible for engineering and functioning of the complete VFD system, meeting the intent and requirement of this specification, EIL specification and datasheet. This shall include but not be limited to Converter sizing, inverter sizing, transformer sizing, transformer impedance selection, vector group, input and output harmonic filter design and sizing, output dv/dt filter sizing, motor cable selection etc. All necessary interlocks as required for safe and reliable operation of VFD system along with Input breaker shall be provided in VFD system. All other control and protections not included in owner's scope but required for vendors supplied system for synchronization shall be in vendor's scope. VFD to take care 110% Overload for 1 min.



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6. VFD Specifications

Sl. No.	Parameter	Specification
1	Drive	Net Gas Compressor
2	Input Voltage	From Integrated dry type Transformer
3	Power/Torque vs Speed	Torque $\propto$ Speed ² ; Constant Torque over specified speed range; constant power over specified speed range
4	Single Line Diagram	See Attachment 1434-70-PR-VFD-1001
5	Output Voltage of VFD	0 to 6.6kV (V/f = Constant)
6	Output Current of VFD	555A at 45 °C (Design Ambient)
7	Output Frequency	0 to 50Hz , Resolution: +/- 0.01% under transient conditions; +/- 0.5% under steady state conditions
8	Speed Regulation	+/- 0.5%
9	Speed Accuracy	+/- 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 is ~450 meters. Vendor to clarify and offer output Filter, if required. If Output Filter required then the cables between VFD and Filter will be in Vendor scope. Cable glands, Lugs and Termination kit for the cables at both the ends must be supplied by Vendor.
13	VFD Panel Construction	a) Protection Class: IP42 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) Cooling: Air Cooled. Cooling system shall include well dimensioned panel, adequate cooling air flow path and module cooling fan. Vendor shall ensure that the panel dimensions and flow paths have been designed for continuous running at the specified ambient without overheating. Low noise, redundant cooling (loose spare fan is not acceptable) fans at the top of the cubicle are required for air cooling. Suitable thermal switch for exit air temperature monitoring shall also be incorporated.

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Sl. No.	Parameter	Specification
13	VFD Panel Construction	d) Busbar Material – Electrolytic grade Copper, colour coded. Sleeving/shrouding for safety purposes shall be done. e) Earth Bus – minimum 50*6 mm Copper. f) Door Interlock: The VFD shall have a door interlock for safety. This shall include an electromechanical interlock system that functions in conjunction with the safety grounding switch and electrical interlocks from the main circuit breaker (external). This interlock system should ensure that none of the power cabinets can be opened until the main source of power is disconnected, the safety grounding switch is closed and the DC link capacitors are discharged. Additionally the same interlock system should ensure that power cannot be initialized to the drive unless the doors are closed and the safety grounding switch has been opened. 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 RAL7032 Paint Thickness: 60 Microns (minimum). Exact paint shade will be confirmed during drawing approval stage. h) Power and Control Wiring shall be done with FRLS cables as per EIL Specification. i) Double compression type Nickel plated brass flame proof 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. Gland Plates shall be minimum 6 mm thick Aluminium (steel not allowed). j) Termination kit, Lugs for the VFD Transformer Input and VFD Output power cables shall be supplied. k) 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. l) All low voltage compartment and cabling shall be electrically and physically separated from the high voltage compartment.



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Sl. No.	Parameter	Specification
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 Temperature	-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 Frequency Interference (RFI) and Electromagnetic Interference (EMI).
18	VFD Efficiency	Shall be > 96%. Exact value to be specified by the Vendor.
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 mode of operation: Local – Operation from VFD Panel for Speed Control on door mounted interface; Remote – Operation from DCS/LCS. 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) Door Mounted Local Start/Stop Push Button to be provided d) Door Mounted Lockable Push-Button to be provided with 4NO + 4 NC contact for Emergency Stop. One normally open contact to be wired to Terminal Block for external Interlocking / Annunciation e) Every Panel shall be provided with CFL/ LED 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. f) 240V, 1phase, 50Hz, 1000W (approximate, exact value 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.



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Sl. No.	Parameter	Specification
20	VFD Requirements	g) 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.
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) Eight (8) 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. 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.



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Sl. No.	Parameter	Specification
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. 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. h) 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. i) The following Control signals must be provided: 1) Local/Remote 2) Emergency stop 3) 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. j) All VFD operating parameter shall be stored in nonvolatile memory. k) The drive shall have built in monitoring of following parameters as minimum on its digital operator interface and these parameter shall also



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Sl. No.	Parameter	Specification
22	Controls and Monitoring	be displayed at Plant DCS through Modbus link: i) Output Frequency ii) Output Current iii) Motor Speed iv) Output Voltage v) DC Bus Voltage vi) Hour run vii) 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) Motor energy meter 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: i) Motor Running ii) Motor Stopped/Tripped iii) AC Mains ON iv) Auxiliary Control Supply ON v) VFD Ready vi) VFD Healthy vii) VFD ON viii) VFD Fault ix) External Fault x) DC Link charged and Ready to Operate xi) Emergency Stop Activated xii) Motor Overspeed xiii) Input Breaker Trip xiv) Motor zero speed xv) Rectifier output 'ON' 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.



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Sl. No.	Parameter	Specification
22	Controls and Monitoring	Included in the scope and the interface protocol (i.e. Modbus only) shall be provided. 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) Motor temperature high 9) Transformer failure 10) 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 105% of the VFD's rated full load output current) c) Ground Fault Protection – 5-10A within 250ms maximum. 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/Fuse Failure 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 l) External faults like Motor Temperature Fault (including motor winding temperature fault/ alarm) and Transformer Fault



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Sl. No.	Parameter	Specification
23	Protection	m) Incoming Line surge protection n) Under/Over voltage protection o) Inverter fault p) System earth fault protection q) The system shall be designed to deliver the motor input current and torque for the complete speed torque characteristics of the driven equipment, with input supply variation of +/-10% and frequency variation of +/-5% r) 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. s) The drive shall trip in case the speed exceeds 105% of the maximum operational speed or reduces to 95% of the minimum operational speed for more than 10 seconds. t) Upon complete loss of the user's speed reference signal, the drive shall automatically run at constant speed as at 80-100% of the last speed reference available prior to the loss of signal. 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.
24	Local Control Station (Flame proof) Features	a) The enclosure shall be made of cast light metal alloy. b) Degree of protection is IP55. LOP shall be provided with integral canopy. The canopy shall be made of at least 2mm galvanized sheet steel or FRP. The canopy shall be suitable for providing protection against rain from top and two sides. c) The LOP shall be provided with gaskets made of non-inflammable and self-extinguishing material. d) Paint shade is Light Yellow shade 355 of IS5.



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Sl. No.	Parameter	Specification
24	Local Control Station (Flame proof) Features	Paint shade will be confirmed during drawing approval stage. e) A warning inscription “Isolate power supply elsewhere before opening” shall be provided on the panel. The warning inscription shall be embossed on the enclosure or a separate warning plate fixed to the enclosure with screws. The warning plate shall be nickel plated brass or stainless steel. f) The LOP shall be provided with two earthing studs with lugs on the external surface of the enclosures suitable for termination of 8 SWG GI wire. g) The Emergency Stop push button shall be mushroom type with stay put feature and lockable in pressed position and 4NO+4NC Auxiliary contacts. h) All control switches shall be provided with a pistol grip handle. i) Meters shall be suitable for the appropriate input and shall be calibrated for the actual parameters. Further, for Bypass operation, the meters shall be capable of reading bypass full load and starting currents, as well as the drive current. 1) 4-20mA Signals for Display from VFD: (i) Actual Current (0-500A) (ii) Actual Speed(0-1500rpm) j) The sub-vendor of LOP shall be as per attached EIL approved sub-vendor list. k) Cable glands (shall be Flameproof & double compression type) and lugs, Termination kit for cable termination shall be provided by the vendor. l) Push Buttons with 2NO + 2NC contacts 1. Start 2. Stop 3. Emergency Stop(4NO+4NC) 4. Speed Increase 5. Speed Decrease m) Switch: 1. Local/Remote Selection



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Sl.No	Parameter	Specification
24	Local Control Station (Flame proof) Features	n) Indications: 1. VFD Fault 2. VFD Ready to Start 3. VFD Running o) The Pushbutton, Switches, Lamps which are on the Local Operating Panel shall be flameproof certified.
25	Dry type Transformer	Dry type Transformer: Copper only a) HV voltage: 6.6kV with Taps of $\pm 5\%$ 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: H Protection: RTDs (2 nos) to be provided in each limb for winding temperature measurement. Temperature scanner to be provided for winding temperature of all limbs. Alarm and trip contacts required for annunciation for fault and tripping action. Construction: The dry type transformer shall be mounted in a panel which will be mounted along with the VFD panel Connection: HV Incomer: Termination arrangement to be provided for Al, XLPE cable. Termination kit and cable glands, Lugs to be provided by the vendor. The exact number and size will be intimated during drawing approval stage. Cables in customer scope. LV Connection: Cable 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 despatch and the same shall be connected at site. Necessary connection and routing arrangements to be made at Vendor's works.



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Sl. No.	Parameter	Specification
26	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 $\pm 0.5\%$ 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.
27	Harmonic Limitations – Source	Shall be as per 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.
28	Harmonics at VFD Output / Motor Input	Shall be as per IEC 61800-4 Vendor to specify the maximum amount of voltage and current harmonics at the VFD Output / Motor Input terminals.
29	Switching frequency	To be specified by the vendor
30	Auxiliary Supply	a) 110V DC feeder is provided by the Customer. kVA Rating is to be given by the Vendor. Power supply for electronic modules has to be derived from the UPS supply. b) Auxiliary Supply – 415V, 3 ϕ , 50Hz is provided by Customer. Feeder Power rating (short time & continuous) to be specified by the Vendor. c) 230V AC feeder is provided by the Customer. kVA Rating is to be given by the Vendor. Power supply for motor space heater, cubicle heater & CFL Lamps has to be derived from this supply. d) Other supplies required by the VFD system to be generated internally within the VFD system.



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31. SPARES

Sl. No.	Parameter	Specification
A	Mandatory Spares and Commissioning Spares	Supplier should quote item wise price for the following spares. Unpriced List of Spares quoted for shall be provided in the Technical Offer. Vendor shall supply commissioning spares along with main equipment. Any spares consumed over and above the commissioning spares supplied along with main equipment, shall be replaced by vendor at the time of commissioning without any time/cost to BHEL/Customer. Any unused commissioning spare shall be retained by customer.

Sl no	Items	Mandatory Spares	Commissioning Spares
1	Power cell consisting of Transistors / IGBT /IGCT or Separate Converter and Inverter module consisting of IGBT/IGCT/SGCT	1 no. of each rating & type	1 no. of each rating & type
2	Set of Control Cards: Cards of each and every type used in the system must be supplied as spare	1 no. of each type	1 no. of each type
3	Power supply card	1 no. of each rating & type	1 no. of each rating & type
4	Power fuses	20% of each rating or 1 no. (Min) of each rating, whichever is more.	20% of each rating or 1 no. (min) of each rating, whichever is more
5	Control fuses / MCB	10 Nos. of each rating & type	10% of each rating & type
6	Indicating lamps	20% OR 1 no. (min.), whichever is more of each type and rating	N/A
7	Indicating Lamp Covers	2 nos of each type	N/A
8	Contactors	10% OR 1 no. (min.), whichever is more of each type and rating	N/A
9	Blocker Diodes	2 nos of each rating and type	N/A
10	Local Operating Panel Push Buttons	20% OR 2 no. (min.), whichever is more of each type and rating	N/A
11	Local Operating Panel Indicating Lamps	20% OR 2 no. (min.), whichever is more of each type and rating	N/A
12	Local Operating Panel Switches	20% or 2 no(min) whichever is more of each type and rating	N/A
13	Power Supply Module	N/A	1 No of each type and rating



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Sl. No.	Parameter	Specification
32	Testing and Quality Plan	a) Routine Tests shall be carried out on all Panels as per relevant standards. b) Type Test Certificates for similar equipment (90% or more of the job VFD) of the supplied by the Vendor shall be submitted during detailed engineering. If Type test certificates are not available as per attached ITP tests must be done on the supplied equipment with out cost and time implication on BHEL c) Test Protocol and Quality Plan shall be submitted along with the Technical Offer. These documents shall explicitly list out all final tests done as below: 1) Fully assembled VFD Panel at VFD Vendor's works including Temperature Rise Test, Motor Run Test and testing of VFD with test bed motor. 2) Temperature Rise Test and Routine Tests on the Transformer at the Transformer vendor's works. d) During fabrication, the drive and Transformer shall be subject to inspection by BHEL/Owner, or by an agency authorized by the BHEL/Owner to assess the progress of work, as well as to ascertain that only quality raw material is used.
33	Inspection, Training and Commissioning Support	a) Final Inspection: BHEL / Customer representative will be present at manufacturer's works for witnessing of final testing. This is to be incorporated in the Quality Plan. No charges shall be applicable for witnessing of final tests. Boarding and Lodging on BHEL/Customer account. b) Training: Training for 5 (FIVE) persons from BHEL / Customer for a period of 3 days at manufacturer's works and 2 days of Training at site for 5(Five) site engineers. Boarding and Lodging on BHEL/Customer account. c) Commissioning: Commissioning of VFD System at BPCL Kochi Refinery 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.
34	Software for Computer Interface	This software must be loaded in a laptop and supplied with Laptop. This software should be an easy to use commissioning tool for drives and full version of this software 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.



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Sl. No.	Parameter	Specification
35	Maintenance	The procedure for maintenance of VFD panels and the schedule thereof shall be mentioned in the offer.
36	Confirmations/Deviations to Specification	Point-wise confirmation to this 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 35 of this Specification, EIL specification and ITP shall be furnished in the format below. This is mandatory. Deviations furnished below ONLY will be considered by BHEL. Deviations mentioned elsewhere will not be allowed. BHEL have the right to not accept the deviations mentioned by Vendor.

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



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7. Documentation

Sl. No.	Parameter	Specification
1	Attached Documents	a) EIL VFD specifications 6-51-0050 rev02 b) Compressor Torque Curve : C1721012/ST c) Motor Data Sheet : BP-AME-48005-11-001 d) Single Line Diagram : 1434-70-PR-VFD-1001 e) Sub Vendor list for Local Operating Panel f) Dry Type Transformer specs 6-51-0044 rev05 g) Local Control Panel specs 6-51-0006 rev04 h) Experience record B034-000-16-50-DS-1009 i) Inspection and test plan 6-81-1050 rev02 & 6-81-1044 REV02 j) datasheet VFD B034-000-16-50-DS-0561 revB k) Job specs VFD B034-0MR-16-50-SP-5210 revB
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. d) Confirmation / Clarification / Information / Deviation List as per Point 36 above. e) Confirmation / Clarification / Deviation List to EIL Specifications and other documents in (1) above f) Sizing Calculation for Transformer and VFD. g) Filledup Experience record sheet A702-014-16-50-DS-5165
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 during detailed Engineering. 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.



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Sl. No.	Parameter	Specification
4	Technical (unpriced) and Commercial (priced) Bids – For Evaluation	a) VFD System b) Commissioning Charges (on lumpsum basis) c) Commissioning Spares with itemwise prices. d) Mandatory Spares with itemwise prices
5	Information required for Customer / Consultant Approval (within 2 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, 230V AC 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 rating equipment 1) Short circuit test and Impulse withstand for transformer 2) Degree of protection and EM immunity and Emission for VFD panels j) Filled up Data sheet for VFD Transformer and VFD
6	Information Required along with Supply. Maintenance Manuals and Documentation	a) Erection, Commissioning and Maintenance Manuals along with Final Drawings and Documentation – 7 Copies b) 1 no. CD ROM consisting of the above. c) Test and Guarantee Certificates. d) Complete Bill of Material (item wise) for the equipment supplied.



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8.SCOPE of SUPPLY

Sl. No.	Parameters	Quantity (Nos.)
1.	a) Fully Assembled Unit of 6.6kV VFD Panels (IGBT/IGCT/SGCT) with Diode/Active Front End Rectifier, Air Cooled	01 no.
	b) Dry type integrated VFD Input transformer, Indoor mounted	01 no.
	c) Local Control Station mounted near motor	01 no.
	d) Power Cables between Integrated Transformer and VFD	01 Set
	e) Cable Glands,lugs & Termination kits for Power Cables terminations in VFD & Transformer; Cable Glands and Lugs for all cable terminations in Local Operating Panel (LOP); Cable Glands (Flameproof) & Lugs for cables between VFD & LOP terminating in VFD	01 Set
	f)Laptop along with Software for Computer Interface	01 no
	g) Training	01 lot
2.	Mandatory Spares as per the list in page 15	01 Set
3.	Commissioning Spares as per the list in page 15	01 Set
4.	Erection Supervision & Commissioning	01 lot

Note:

- 1) No charges shall be applicable for witnessing of Final tests. Customer will be present for witnessing the tests. Boarding and Lodging will be in Customer account.
- 2) Training charges only to be quoted. Boarding and lodging in Customer account.
- 3) Cable glands, lugs and termination kit must be supplied. No deviation is allowed.
- 4) Transformer must be rated for 110% of CALCULATED VFD rating.
- 5) Equipment Design Temperature will be 45degC. No deviation or change allowed in this temperature
- 6) Forced Cooling should be done by redundant fans only. Loose spare fan/s is not acceptable. This clause overrides the clause in EIL specification.
- 7) Input Transformer should be Dry type only. ONAN Transformer is not acceptable. EIL already amended the VFD job specifications accordingly.



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REVISION HISTORY SHEET

REV. NO.	DATE	NATURE OF CHANGE	REASONS	PREPARED BY	APPROVED BY
00	03-05-2018	FIRST ISSUE	-----		

REVISION 00

APPROVED BY
Amaranath Pramanick

PREPARED BY
M M Bharat Kumar

ISSUED BY
VFD ENGG.

DATE
03-05-2018

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TECHNICAL SPECIFICATION OF VFD FOR 4600kW, 6.6kV SQUIRREL CAGE INDUCTION MOTOR AND LOP FOR RECYCLE GAS COMPRESSOR

MATERIAL CODE: PR0900009144

1. Project Details

Sl. No.	Parameter	Specification
1	Project Location	BPCL Kochi Refinery, Kerala, India
2	Project Title	BS IV MS Block project at BPCL, Kochi
3	Customer	BPCL Kochi Refinery
4	Consultant	Engineers India Ltd.

2. Environment Specifications

Sl. No.	Parameter	Specification
1	Maximum Ambient Temperature	46°C
2	Minimum Ambient Temperature	1.1°C
3	Equipment Design Temperature (IS-9676)	45°C
4	Relative Humidity	86%
5	Altitude	Less than 1000m above mean sea level
6	Location of VFD Panels	Indoor, Ventilated Room with Air Conditioning.
7	Seismic Zone	As per IS-1893-Zone-V

REVISION 00

APPROVED BY

Amaranath Pramanick

PREPARED BY

M M Bharat Kumar

ISSUED BY

VFD ENGG.

DATE

03-05-2018

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3. Input and Transformer Data

Sl. No.	Parameter	Specification
1	System Voltage / Frequency / Phase	6.6kV / 50Hz / 3ph
2	Voltage Variation	±10%
3	Frequency Variation	±5%
4	Combined Voltage and Frequency Variation	±10%
5	Fault Level	40kA/1 sec
6	Transformer Type	Dry type integrated Transformer (In Vendor scope)
7	Rating	Transformer must be designed to carry 110% of calculated VFD rating. Transformer sizing calculation shall be provided along with the offer.
8	Power Cables	Cable glands, Lugs and termination kit suitable for Power cable to be provided by the vendor for Transformer HV side cable termination. The exact no. and size will be intimated during drawing approval stage. Cables in Customer scope.

4. Motor Data

Sl. No.	Parameter	Specification									
1	Type	Squirrel Cage Induction Motor									
2	Scope	Manufactured by BHEL-Bhopal									
3	Rated Output	4600kW, 1495RPM									
4	Rated Voltage and Current	6.6kV, 453A									
5	No load Current	During detailed Engineering									
6	Pull Out Torque (% of FLT)	190%									
7	Fed from	Variable Frequency Drive (V/f Control) with DOL starting									
8	Duty Class	Continuous - S1									
9	Efficiency and Power Factor:	<table><tr><th>% of Load</th><th>Efficiency</th><th>Power Factor</th></tr><tr><td>75</td><td>95.6%</td><td>0.86</td></tr><tr><td>100</td><td>95.8%</td><td>0.88</td></tr></table>	% of Load	Efficiency	Power Factor	75	95.6%	0.86	100	95.8%	0.88
% of Load	Efficiency	Power Factor									
75	95.6%	0.86									
100	95.8%	0.88									
10	Power Cables	Cable glands, Lugs and termination kit suitable Power cable to be provided by the vendor for VFD Output side cable termination. The exact no and size will be intimated during drawing approval stage. Cables in Customer scope.									



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5. Scope:

Sl. No.	Scope of Supply	Description
1	a) 1 Nos. Fully Assembled Unit of 6.6kV VFD Panels with Diode/Active Front End Rectifier, Air Cooled with integrated Dry type transformer b) 1 No of Local Operating Panel mounted near motor(as per EIL approved Vendor list) c) All interconnecting cables along with Cable glands,lugs and termination kit between the VFD and integrated Transformer d) Any special cable other than power and control cables from VFD to other equipment. e) Special tools and Tackles/instruments, if required, the same to be supplied along with main equipment. f) Lifting trolley required for lifting the power modules.	The vendor shall be responsible for engineering and functioning of the complete VFD system, meeting the intent and requirement of this specification, EIL specification and datasheet. This shall include but not be limited to Converter sizing, inverter sizing, transformer sizing, transformer impedance selection, vector group, input and output harmonic filter design and sizing, output dv/dt filter sizing, motor cable selection etc. All necessary interlocks as required for safe and reliable operation of VFD system along with Input breaker shall be provided in VFD system. All other control and protections not included in owner's scope but required for vendors supplied system for synchronization shall be in vendor's scope. VFD to take care 110% Overload for 1 min.



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6. VFD Specifications

Sl. No.	Parameter	Specification
1	Drive	Recycle Gas Compressor
2	Input Voltage	From Integrated dry type Transformer
3	Power/Torque vs Speed	Torque $\propto$ Speed ² ; Constant Torque over specified speed range; constant power over specified speed range
4	Single Line Diagram	See Attachment 1432-70-PR-VFD-1001
5	Output Voltage of VFD	0 to 6.6kV (V/f = Constant)
6	Output Current of VFD	453A at 45 °C (Design Ambient)
7	Output Frequency	0 to 50Hz , Resolution: +/- 0.01% under transient conditions; +/- 0.5% under steady state conditions
8	Speed Regulation	+/- 0.5%
9	Speed Accuracy	+/- 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 is ~450 meters. Vendor to clarify and offer output Filter, if required. If Output Filter required then the cables between VFD and Filter will be in Vendor scope. Cable glands, Lugs and Termination kit for the cables at both the ends must be supplied by Vendor.
13	VFD Panel Construction	a) Protection Class: IP42 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) Cooling: Air Cooled. Cooling system shall include well dimensioned panel, adequate cooling air flow path and module cooling fan. Vendor shall ensure that the panel dimensions and flow paths have been designed for continuous running at the specified ambient without overheating. Low noise, redundant cooling (loose spare fan is not acceptable) fans at the top of the cubicle are required for air cooling. Suitable thermal switch for exit air temperature monitoring shall also be incorporated.

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Sl. No.	Parameter	Specification
13	VFD Panel Construction	d) Busbar Material – Electrolytic grade Copper, colour coded. Sleeving/shrouding for safety purposes shall be done. e) Earth Bus – minimum 50*6 mm Copper. f) Door Interlock: The VFD shall have a door interlock for safety. This shall include an electromechanical interlock system that functions in conjunction with the safety grounding switch and electrical interlocks from the main circuit breaker (external). This interlock system should ensure that none of the power cabinets can be opened until the main source of power is disconnected, the safety grounding switch is closed and the DC link capacitors are discharged. Additionally the same interlock system should ensure that power cannot be initialized to the drive unless the doors are closed and the safety grounding switch has been opened. 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 RAL7032 Paint Thickness: 60 Microns (minimum). Exact paint shade will be confirmed during drawing approval stage. h) Power and Control Wiring shall be done with FRLS cables as per EIL Specification. i) Double compression type Nickel plated brass flame proof 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. Gland Plates shall be minimum 6 mm thick Aluminium (steel not allowed). j) Termination kit, Lugs for the VFD Transformer Input and VFD Output power cables shall be supplied. k) 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. l) All low voltage compartment and cabling shall be electrically and physically separated from the high voltage compartment.



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Sl. No.	Parameter	Specification
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 Temperature	-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 Frequency Interference (RFI) and Electromagnetic Interference (EMI).
18	VFD Efficiency	Shall be > 96%. Exact value to be specified by the Vendor.
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 mode of operation: Local – Operation from VFD Panel for Speed Control on door mounted interface; Remote – Operation from DCS/LCS. 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) Door Mounted Local Start/Stop Push Button to be provided d) Door Mounted Lockable Push-Button to be provided with 4NO + 4 NC contact for Emergency Stop. One normally open contact to be wired to Terminal Block for external Interlocking / Annunciation e) Every Panel shall be provided with CFL/ LED 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. f) 240V, 1phase, 50Hz, 1000W (approximate, exact value 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.



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Sl. No.	Parameter	Specification
20	VFD Requirements	g) 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.
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) Eight (8) 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. 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.



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Sl. No.	Parameter	Specification
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. 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. h) 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. i) The following Control signals must be provided: 1) Local/Remote 2) Emergency stop 3) 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. j) All VFD operating parameter shall be stored in nonvolatile memory. k) The drive shall have built in monitoring of following parameters as minimum on its digital operator interface and these parameter shall also



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Sl. No.	Parameter	Specification
22	Controls and Monitoring	be displayed at Plant DCS through Modbus link: i) Output Frequency ii) Output Current iii) Motor Speed iv) Output Voltage v) DC Bus Voltage vi) Hour run vii) 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) Motor energy meter 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: i) Motor Running ii) Motor Stopped/Tripped iii) AC Mains ON iv) Auxiliary Control Supply ON v) VFD Ready vi) VFD Healthy vii) VFD ON viii) VFD Fault ix) External Fault x) DC Link charged and Ready to Operate xi) Emergency Stop Activated xii) Motor Overspeed xiii) Input Breaker Trip xiv) Motor zero speed xv) Rectifier output 'ON' 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.



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Sl. No.	Parameter	Specification
22	Controls and Monitoring	Included in the scope and the interface protocol (i.e. Modbus only) shall be provided. 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) Motor temperature high 9) Transformer failure 10) 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 105% of the VFD's rated full load output current) c) Ground Fault Protection – 5-10A within 250ms maximum. 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/Fuse Failure 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 l) External faults like Motor Temperature Fault (including motor winding temperature fault/ alarm) and Transformer Fault



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Sl. No.	Parameter	Specification
23	Protection	m) Incoming Line surge protection n) Under/Over voltage protection o) Inverter fault p) System earth fault protection q) The system shall be designed to deliver the motor input current and torque for the complete speed torque characteristics of the driven equipment, with input supply variation of +/-10% and frequency variation of +/-5% r) 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. s) The drive shall trip in case the speed exceeds 105% of the maximum operational speed or reduces to 95% of the minimum operational speed for more than 10 seconds. t) Upon complete loss of the user's speed reference signal, the drive shall automatically run at constant speed as at 80-100% of the last speed reference available prior to the loss of signal. 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.
24	Local Control Station (Flame proof) Features	a) The enclosure shall be made of cast light metal alloy. b) Degree of protection is IP55. LOP shall be provided with integral canopy. The canopy shall be made of at least 2mm galvanized sheet steel or FRP. The canopy shall be suitable for providing protection against rain from top and two sides. c) The LOP shall be provided with gaskets made of non-inflammable and self-extinguishing material. d) Paint shade is Light Yellow shade 355 of IS5.



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Sl. No.	Parameter	Specification
24	Local Control Station (Flame proof) Features	Paint shade will be confirmed during drawing approval stage. e) A warning inscription “Isolate power supply elsewhere before opening” shall be provided on the panel. The warning inscription shall be embossed on the enclosure or a separate warning plate fixed to the enclosure with screws. The warning plate shall be nickel plated brass or stainless steel. f) The LOP shall be provided with two earthing studs with lugs on the external surface of the enclosures suitable for termination of 8 SWG GI wire. g) The Emergency Stop push button shall be mushroom type with stay put feature and lockable in pressed position and 4NO+4NC Auxiliary contacts. h) All control switches shall be provided with a pistol grip handle. i) Meters shall be suitable for the appropriate input and shall be calibrated for the actual parameters. Further, for Bypass operation, the meters shall be capable of reading bypass full load and starting currents, as well as the drive current. 1) 4-20mA Signals for Display from VFD: (i) Actual Current (0-500A) (ii) Actual Speed(0-1500rpm) j) The sub-vendor of LOP shall be as per attached EIL approved sub-vendor list. k) Cable glands (shall be Flameproof & double compression type) and lugs, Termination kit for cable termination shall be provided by the vendor. l) Push Buttons with 2NO + 2NC contacts 1. Start 2. Stop 3. Emergency Stop(4NO+4NC) 4. Speed Increase 5. Speed Decrease m) Switch: 1. Local/Remote Selection



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PURCHASE SPECIFICATION

GROUP: COE/VFD

P.S NO. : PS/445/2598

REV. NO: 00

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Sl.No	Parameter	Specification
24	Local Control Station (Flame proof) Features	n) Indications: 1. VFD Fault 2. VFD Ready to Start 3. VFD Running o) The Pushbutton, Switches, Lamps which are on the Local Operating Panel shall be flameproof certified.
25	Dry type Transformer	Dry type Transformer: Copper only a) HV voltage: 6.6kV with Taps of $\pm 5\%$ 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: H Protection: RTDs (2 nos) to be provided in each limb for winding temperature measurement. Temperature scanner to be provided for winding temperature of all limbs. Alarm and trip contacts required for annunciation for fault and tripping action. Construction: The dry type transformer shall be mounted in a panel which will be mounted along with the VFD panel Connection: HV Incomer: Termination arrangement to be provided for Al, XLPE cable. Termination kit and cable glands, Lugs to be provided by the vendor. The exact number and size will be intimated during drawing approval stage. Cables in customer scope. LV Connection: Cable 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 despatch and the same shall be connected at site. Necessary connection and routing arrangements to be made at Vendor's works.



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PURCHASE SPECIFICATION

GROUP: COE/VFD

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Sl. No.	Parameter	Specification
26	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 $\pm 0.5\%$ 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.
27	Harmonic Limitations – Source	Shall be as per 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.
28	Harmonics at VFD Output / Motor Input	Shall be as per IEC 61800-4 Vendor to specify the maximum amount of voltage and current harmonics at the VFD Output / Motor Input terminals.
29	Switching frequency	To be specified by the vendor
30	Auxiliary Supply	a) 110V DC feeder is provided by the Customer. kVA Rating is to be given by the Vendor. Power supply for electronic modules has to be derived from the UPS supply. b) Auxiliary Supply – 415V, 3 ϕ , 50Hz is provided by Customer. Feeder Power rating (short time & continuous) to be specified by the Vendor. c) 230V AC feeder is provided by the Customer. kVA Rating is to be given by the Vendor. Power supply for motor space heater, cubicle heater & CFL Lamps has to be derived from this supply. d) Other supplies required by the VFD system to be generated internally within the VFD system.



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PURCHASE SPECIFICATION

GROUP: COE/VFD

P.S NO. : PS/445/2598

REV. NO: 00

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31. SPARES

Sl. No.	Parameter	Specification	
A	Mandatory Spares and Commissioning Spares	Supplier should quote item wise price for the following spares. Unpriced List of Spares quoted for shall be provided in the Technical Offer. Vendor shall supply commissioning spares along with main equipment. Any spares consumed over and above the commissioning spares supplied along with main equipment, shall be replaced by vendor at the time of commissioning without any time/cost to BHEL/Customer. Any unused commissioning spare shall be retained by customer.	
Sl no	Items	Mandatory Spares	Commissioning Spares
1	Power cell consisting of Transistors / IGBT /IGCT OR Separate Converter and Inverter module consisting of IGBT/IGCT/SGCT	1 no. of each rating & type	1 no. of each rating & type
2	Set of Control Cards: Cards of each and every type used in the system must be supplied as spare	1 no. of each type	1 no. of each type
3	Power supply card	1 no. of each rating & type	1 no. of each rating & type
4	Power fuses	20% of each rating or 1 no. (Min) of each rating, whichever is more.	20% of each rating or 1 no. (min) of each rating, whichever is more
5	Control fuses / MCB	10 Nos. of each rating & type	10% of each rating & type
6	Indicating lamps	20% OR 1 no. (min.), whichever is more of each type and rating	N/A
7	Indicating Lamp Covers	2 nos of each type	N/A
8	Contactors	10% OR 1 no. (min.), whichever is more of each type and rating	N/A
9	Blocker Diodes	2 nos of each rating and type	N/A
10	Local Operating Panel Push Buttons	20% OR 2 no. (min.), whichever is more of each type and rating	N/A
11	Local Operating Panel Indicating Lamps	20% OR 2 no. (min.), whichever is more of each type and rating	N/A
12	Local Operating Panel Switches	20% or 2 no(min) whichever is more of each type and rating	N/A
13	Power Supply Module	N/A	1 No of each type and rating



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PURCHASE SPECIFICATION

GROUP: COE/VFD

P.S NO. : PS/445/2598

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Sl. No.	Parameter	Specification
32	Testing and Quality Plan	a) Routine Tests shall be carried out on all Panels as per relevant standards. b) Type Test Certificates for similar equipment (90% or more of the job VFD) of the supplied by the Vendor shall be submitted during detailed engineering. If Type test certificates are not available as per attached ITP tests must be done on the supplied equipment with out cost and time implication on BHEL c) Test Protocol and Quality Plan shall be submitted along with the Technical Offer. These documents shall explicitly list out all final tests done as below: 1) Fully assembled VFD Panel at VFD Vendor's works including Temperature Rise Test, Motor Run Test and combined testing of VFD with test bed motor. 2) Temperature Rise Test and Routine Tests on the Transformer at the Transformer vendor's works. d) During fabrication, the drive and Transformer shall be subject to inspection by BHEL/Owner, or by an agency authorized by the BHEL/Owner to assess the progress of work, as well as to ascertain that only quality raw material is used.
33	Inspection, Training and Commissioning Support	a) Final Inspection: BHEL / Customer representative will be present at manufacturer's works for witnessing of final testing. This is to be incorporated in the Quality Plan. No charges shall be applicable for witnessing of final tests. Boarding and Lodging on BHEL/Customer account. b) Training: Training for 5 (FIVE) persons from BHEL / Customer for a period of 3 days at manufacturer's works and 2 days of Training at site for 5(Five) site engineers. Boarding and Lodging on BHEL/Customer account. c) Commissioning: Commissioning of VFD System at BPCL Kochi Refinery 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.
34	Software for Computer Interface	This software must be loaded in a laptop and supplied with Laptop. This software should be an easy to use commissioning tool for drives and full version of this software 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.



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PURCHASE SPECIFICATION

GROUP: COE/VFD

P.S NO. : PS/445/2598

REV. NO: 00

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Sl. No.	Parameter	Specification
35	Maintenance	The procedure for maintenance of VFD panels and the schedule thereof shall be mentioned in the offer.
36	Confirmations/Deviations to Specification	Point-wise confirmation to this 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 35 of this Specification, EIL specification and ITP shall be furnished in the format below. This is mandatory. Deviations furnished below ONLY will be considered by BHEL. Deviations mentioned elsewhere will not be allowed. BHEL have the right to not accept the deviations mentioned by Vendor.

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



PURCHASE SPECIFICATION

GROUP: COE/VFD

P.S NO. : PS/445/2598

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7. Documentation

Sl. No.	Parameter	Specification
1	Attached Documents	a) EIL VFD specifications 6-51-0050 rev02 b) Compressor Torque Curve : 4CM40500934 c) Motor Data Sheet : BP-AME-48003-11-001 d) Single Line Diagram : 1432-70-PR-VFD-1001 e) Sub Vendor list for Local Operating Panel f) Dry Type Transformer specs 6-51-0044 rev05 g) Local Control Panel specs 6-51-0006 rev04 h) Experience record B034-000-16-50-DS-1009 i) Inspection and test plan 6-81-1050 rev02 6-81-1044 Rev02 j) datasheet VFD B034-000-16-50-DS-0561 revB k) Job specs VFD B034-0MR-16-50-SP-5210 revB
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. d) Confirmation / Clarification / Information / Deviation List as per Point 36 above. e) Confirmation / Clarification / Deviation List to EIL Specifications and other documents in (1) above f) Sizing Calculation for Transformer and VFD. g) Filledup Experience record sheet A702-014-16-50-DS-5165
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 during detailed Engineering. 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.



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PURCHASE SPECIFICATION

GROUP: COE/VFD

P.S NO. : PS/445/2598

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Sl. No.	Parameter	Specification
4	Technical (unpriced) and Commercial (priced) Bids – For Evaluation	a) VFD System b) Commissioning Charges(lumpsum) c) Commissioning Spares with itemwise prices. d) Mandatory Spares with itemwise prices
5	Information required for Customer / Consultant Approval (within 2 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, 230V AC 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 rating equipment 1)Short circuit test and Impulse withstand for transformer 2) Degree of protection and EM immunity and Emission for VFD panels j) Filled up Data sheet for VFD Transformer and VFD
6	Information Required along with Supply. Maintenance Manuals and Documentation	a) Erection, Commissioning and Maintenance Manuals along with Final Drawings and Documentation – 7 Copies b) 1 no. CD ROM consisting of the above. c) Test and Guarantee Certificates. d) Complete Bill of Material (item wise) for the equipment supplied.



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PURCHASE SPECIFICATION

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P.S NO. : PS/445/2598

REV. NO: 00

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8.SCOPE of SUPPLY

Sl. No.	Parameters	Quantity (Nos.)
1.	a) Fully Assembled Unit of 6.6kV VFD Panels (IGBT/IGCT/SGCT) with Diode/Active Front End Rectifier, Air Cooled	01 no.
	b) Dry type integrated VFD Input transformer, Indoor mounted	01 no.
	c) Local Operating Panel mounted near motor	01 no.
	d) Power Cables between Integrated Transformer and VFD	01 Set
	e) Cable Glands,lugs & Termination kits for Power Cables terminations in VFD & Transformer; Cable Glands and Lugs for all cable terminations in Local Operating Panel (LOP); Cable Glands (Flameproof) & Lugs for cables between VFD & LOP terminating in VFD	01 Set
	f)Laptop along with Software for Computer Interface	01 no
	g) Training	01 lot
2.	Mandatory Spares as per the list in page 15	01 Set
3.	Commissioning Spares as per the list in page 15	01 Set
4.	Erection Supervision & Commissioning	01lot

Note:

- 1) No charges shall be applicable for witnessing of Final tests. Customer will be present for witnessing the tests. Boarding and Lodging will be in Customer account.
- 2) Training charges only to be quoted. Boarding and lodging in Customer account.
- 3) Cable glands, lugs and termination kit must be supplied. No deviation is allowed.
- 4) Transformer must be rated for 110% of CALCULATED VFD rating.
- 5) Equipment Design Temperature will be 45degC. No deviation or change allowed in this temperature
- 6) Forced Cooling should be done by redundant fans only. Loose spare fan/s is not acceptable. This clause overrides the clause in EIL specification.
- 7) Input Transformer should be Dry type only. ONAN Transformer is not acceptable. EIL amended the VFD job specifications accordingly.

Induction Machine Technical Data

Enq. Ref: AME/O2017-1641AL

Rev. 03

Customer: M/s. BPCL Kochi thru IPM for MS BLock

Note: Data furnished below is subject to IS:325 / IS/IEC:60034-1 tolerances unless stated otherwise.

No.	Description	Data
1	APPLICATION	COMPRESSOR
2	MACHINE DESCRIPTION	SCIM (Ex'p')
3	RATING (KW) / RATED RPM	4600 / 1495
4	(a) RATED VOLTAGE & VARIATION	6600 / $\pm 10\%$
	(b) RATED FREQUENCY & VARIATION	50 / $\pm 5\%$
	(c) COMBINED VARIATION	10%
5	FRAME TYPE / DOR(UNI./BI.)	1SB1903-4 / Uni-directional
6	ENCLOSURE / PROTECTION / METHOD OF COOLING	CACA/ IP55 / IC611
7	INSULATION CLASS / TYPE	F / Resin Poor VPI
8	AMBIENT / TEMP. RISE (DEG.C)	45/75
9	FULL LOAD / NO LOAD CURRENT(AMPS)	458 / 98
10	EFFICIENCY(%) AT 100% / 75% / 50% FL	96.5 / 96.3 / 95.3
11	POWER FACTOR AT 100% / 75% / 50% FL	0.91 / 0.90 / 0.86
12	LOCKED ROTOR CURRENT (%FLC) AT RV	Depends On VFD
13	FULL LOAD TORQUE (kg-m)	2997
14	LOCKED ROTOR TORQUE (%FLT) AT RV	Depends on VFD
15	PULL OUT TORQUE (%FLT) AT RV	205
16	STATOR CONNECTION / ROTOR TYPE	Star / CAGE
17	STARTING TIME (SEC.) AT 100% RV / 80% RV	Depends on VFD
18	LRW TIME AT RV HOT / COLD (SEC.)	22.0 / 26.0
19	MOTOR GD2 (KGM2) / WEIGHT (KG) (Approx.)	14000 / 20000
20	BEARING TYPE / NOS.	Sleeve / 2
21	LUBRICATION TYPE	FOLS
22	MOUNTING / EXTERNAL THRUST (Tons)	Horizontal / NA
23	METHOD OF STARTING	VFD
24	METHOD OF COUPLING	Rigid
25	BRG. VIBRATION LEVEL(um) / NOISE(dB)	37 / 85 at 1 (Mtr)
NOTE: FOLS is not in motor manufacturer scope of supply.		

Name	Sign	Date
D. Mandal		23-Oct-2017
AKS		23-Oct-2017

Induction Machine Technical Data

Enq. Ref: AME/O2017-1641BL

Rev. 00

Customer: M/s. BPCL Kochi thru IPM for MS BLock

Note: Data furnished below is subject to IS:325 / IS/IEC:60034-1 tolerances unless stated otherwise.

No.	Description	Data
1	APPLICATION	COMPRESSOR
2	MACHINE DESCRIPTION	SCIM (Ex'p')
3	RATING (KW) / RATED RPM	5640 / 1495
4	(a) RATED VOLTAGE & VARIATION	6600 / $\pm 10\%$
	(b) RATED FREQUENCY & VARIATION	50 / $\pm 5\%$
	(c) COMBINED VARIATION	10%
5	FRAME TYPE / DOR(UNI./BI.)	1SB1905-4 / Uni-directional
6	ENCLOSURE / PROTECTION / METHOD OF COOLING	CACA/ IP55 / IC611
7	INSULATION CLASS / TYPE	F / Resin Poor VPI
8	AMBIENT / TEMP. RISE (DEG.C)	45/75
9	FULL LOAD / NO LOAD CURRENT(AMPS)	555 / 105
10	EFFICIENCY(%) AT 100% / 75% / 50% FL	96.6 / 96.3 / 95.3
11	POWER FACTOR AT 100% / 75% / 50% FL	0.92 / 0.92 / 0.90
12	LOCKED ROTOR CURRENT (%FLC) AT RV	Depends On VFD
13	FULL LOAD TORQUE (kg-m)	3674
14	LOCKED ROTOR TORQUE (%FLT) AT RV	Depends on VFD
15	PULL OUT TORQUE (%FLT) AT RV	205
16	STATOR CONNECTION / ROTOR TYPE	Star / CAGE
17	STARTING TIME (SEC.) AT 100% RV / 80% RV	Depends on VFD
18	LRW TIME AT RV HOT / COLD (SEC.)	22.0 / 26.0
19	MOTOR GD2 (KGM2) / WEIGHT (KG) (Approx.)	16000 / 22000
20	BEARING TYPE / NOS.	Sleeve / 2
21	LUBRICATION TYPE	FOLS
22	MOUNTING / EXTERNAL THRUST (Tons)	Horizontal / NA
23	METHOD OF STARTING	VFD
24	METHOD OF COUPLING	Rigid
25	BRG. VIBRATION LEVEL(um) / NOISE(dB)	37 / 85 at 1 (Mtr)
NOTE: FOLS is not in motor manufacturer scope of supply.		

Name	Sign	Date
D. Mandal		28-Sep-2017
AKS		28-Sep-2017

List of Accessories/ Instrument

Enq. Ref: AME/O2017-1641BL

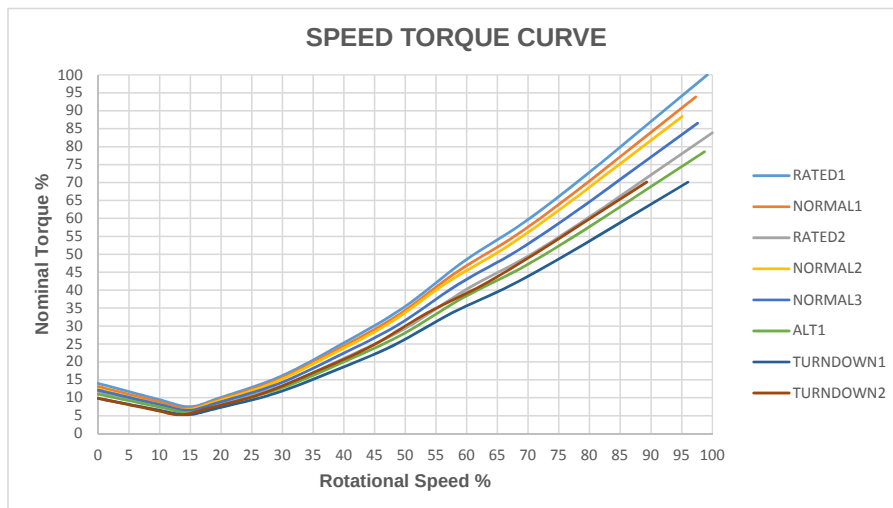
Rev. 00

Customer: M/s. BPCL Kochi thru IPM For MS BLock

No.	Description	Qty.
1	WINDING RTDs - PT100, Simplex, 3 WIRE	12
2	BEARING RTDs - PT100, Duplex, 4 WIRE	2
3	DTTs for bearings- Mercury in Steel Without Contacts	2
4	Hot + Cold Air RTDs PT100, Duplex, 3 WIRE	1/1
5	DTTs for Hot/Cold Air - Mercury in Steel Without Contacts	-
6	Stator Terminal Box: Elastimold (Fault withstand current: 25kA for 0.17s) (RHS From DE)	6
7	Rotor Terminal Box (RHS From DE)	NA
8	Neutral Terminal Box (Non PSTB) - Suitable for mounting CTs (LHS From DE)	1
9	Current transformer: (As per customer specification)	3
10	CT Secondary Terminal Box	YES
11	Space heater (240 V AC, 1Ph) - Ex'd' Type Type Total 1000 watts (1 X 1000 watts each)	1
12	Terminal Box for Space Heaters (In-Built (Ex'd' Type))	YES
13	Terminal Box for RTDs, BTDs (Ex'd')	1
14	Coolers (CACW)	YES
15	Water leakage detector with 2 contacts: Contact rating 5A, 240 V AC (2 Probes + 1 Control)	YES
16	Water Flow Indicators with 2 contacts: Contact rating 5A, 240 V AC	YES
17	Bearing - Sleeve Lubrication: FOLS	2
18	Force oil lubrication system (Not in BHEL scope of supply)	NA
19	Oil level Gauge (Without any switch)	YES
20	Insulation of Bearing (BOTH Side)	YES
21	Earthing Brush	YES
22	Holding down bolts	YES
23	Grounding pad with 2 tapped holes for earthing conductor (In Motor body/Terminal Box)	2/2
24	Drain holes at bottom of machine frame	NO
25	NDE shaft extention	NA
26	Tacho Generator	NA
27	Speed Switch (240V, 1ph AC)	NA
28	Cable Glands: Main terminal/RTDs/Space heater	YES
29	Vibration Pads (80 mm ³) for mounting bearing vibration probes/sensors	YES
30	Mounting arrangement for shaft vibration probes	NA
31	Vibration Probes/Sensors (Not in BHEL scope of supply)	NO
32	Piping arrangement for pressurization	YES
33	pressurization control system	YES

Name	Sign	Date
D. Mandal		28-Sep-2017
AKS		28-Sep-2017

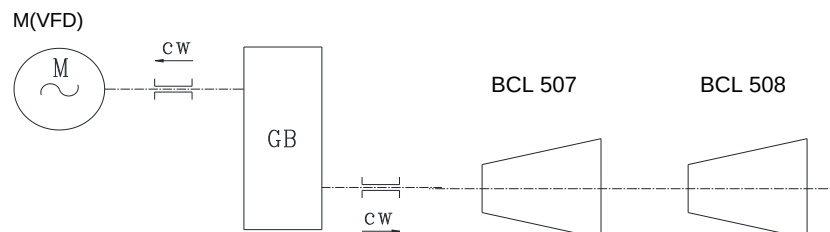
PROJECT : BPCL Kochi MS-Block
SERVICE : Net Gas Compressor
CUSTOMER : M/s BPCL
CONSULTANT : EIL
No. OF UNITS : 1



The motor is provided with VFD in order to realize different operating conditions as specified by the customer. These are indicated by the curves as shown above.

Motor Rating	5640 kW
Nominal Power	5127 kW
Motor Speed	1485 rpm
Nominal Torque at Full speed (Case: RATED2)	2840 kgm
Max Torque (Case: RATED1)	3386 kgm
Static Torque (MAX)	507.9 kgm
GD2 (Referred to Motor Speed)	8720 kgm ²
Direction of Rotation seen from Coupling end (for Motor)	CW
Shaft end cylindrical diameter	250 mm #
No. of Keys on Shaft end	1
Speed Range % :	70-105%
Connection for Hub on Shaft Cylindrical fit of H6 / m5	
Compressor Power is referred to low speed shaft of step up Gear Box	

ARRANGEMENT OF MACHINES



(#) Considered for coupling sizing. Motor group to check adequacy and confirm.
 Please refer enquiry specification for all other technical details to finalize the motor design

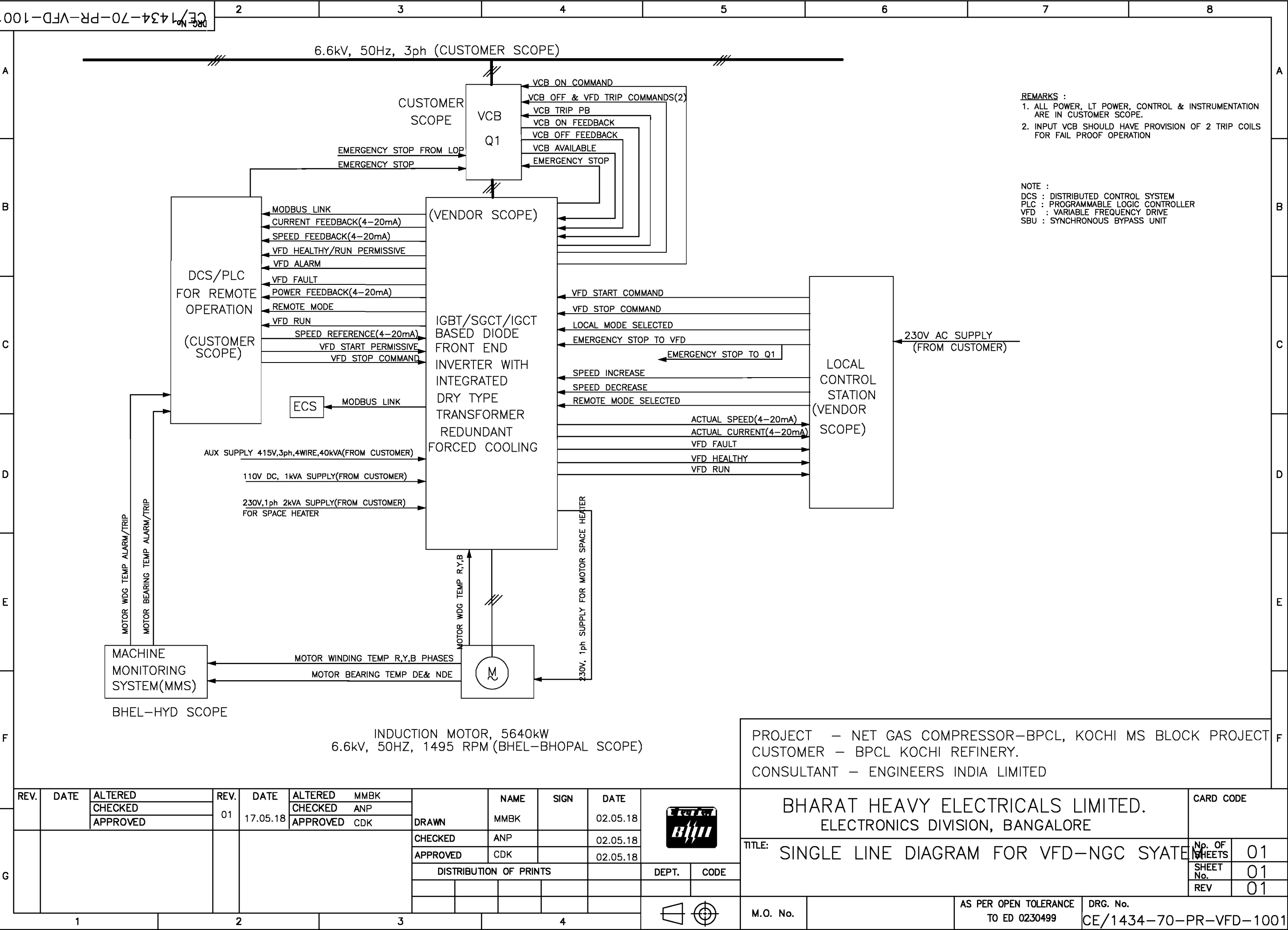
STEAM TURBINES AND COMPRESSORS				Date	Dept. code
				26-09-2017	420
Format No.	Prepared	Checked	Approved	Drawing No.	Rev
CA0-1-034-00	KARTEEK	SRIDHAR	NEMA	C1721012/ ST	0

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REF. DRG. No.

SIGN. & DATE

FORM No. A3-03



PROJECT - NET GAS COMPRESSOR-BPCL, KOCHI MS BLOCK PROJECT
CUSTOMER - BPCL KOCHI REFINERY.
CONSULTANT - ENGINEERS INDIA LIMITED

REV.	DATE	ALTERED	REV.	DATE	ALTERED	MMBK		NAME	SIGN	DATE	
		CHECKED	01	17.05.18	CHECKED	ANP		MMBK		02.05.18	
		APPROVED			APPROVED	CDK					
							DRAWN				
							CHECKED	ANP		02.05.18	
							APPROVED	CDK		02.05.18	
							DISTRIBUTION OF PRINTS			DEPT.	CODE

BHARAT HEAVY ELECTRICALS LIMITED. ELECTRONICS DIVISION, BANGALORE		CARD CODE	
TITLE: SINGLE LINE DIAGRAM FOR VFD-NGC SYATEM		Np. OF SHEETS	01
		SHEET No.	01
		REV	01
M.O. No.	AS PER OPEN TOLERANCE TO ED 0230499	DRG. No.	CE/1434-70-PR-VFD-1001

A3 SIZE

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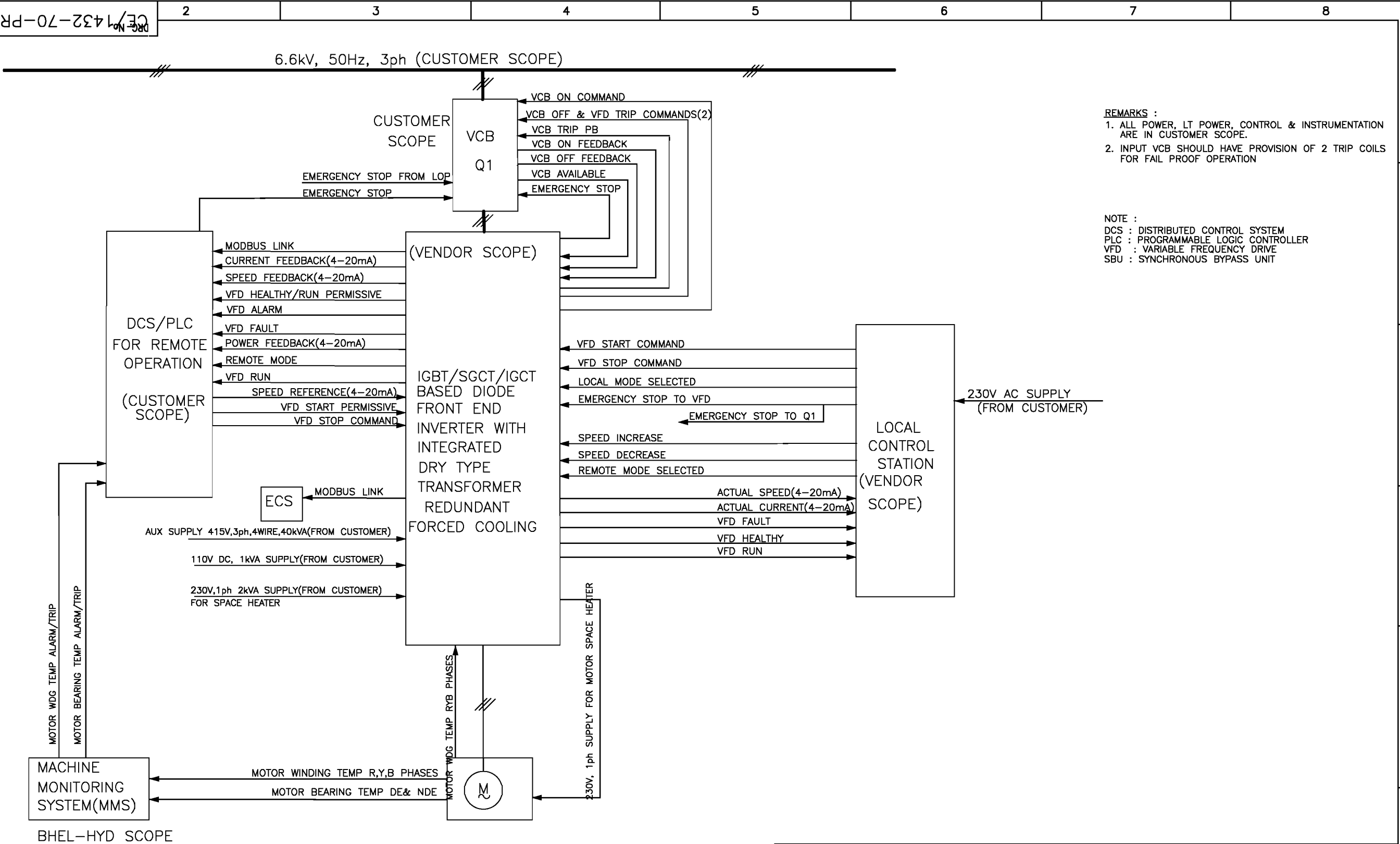
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REF. DRG. No.

SIGN. & DATE

INVENTORY No.

REV.	DATE	ALTERED	REV.	DATE	ALTERED	DRAWN	NAME	SIGN	DATE		DEPT.	CODE
		CHECKED			CHECKED							
		APPROVED			APPROVED							
						CHECKED	ANP		02.05.18			
						APPROVED	CDK		02.05.18			
						DISTRIBUTION OF PRINTS						



REMARKS :
1. ALL POWER, LT POWER, CONTROL & INSTRUMENTATION ARE IN CUSTOMER SCOPE.
2. INPUT VCB SHOULD HAVE PROVISION OF 2 TRIP COILS FOR FAIL PROOF OPERATION

NOTE :
DCS : DISTRIBUTED CONTROL SYSTEM
PLC : PROGRAMMABLE LOGIC CONTROLLER
VFD : VARIABLE FREQUENCY DRIVE
SBU : SYNCHRONOUS BYPASS UNIT

INDUCTION MOTOR, 4600kW
6.6kV, 50HZ, 1495 RPM (BHEL-BHOPAL SCOPE)

PROJECT-RECYCLE GAS COMPRESSOR-BPCL,KOCHI MS BLOCK PROJECT
CUSTOMER - BPCL KOCHI REFINERY.
CONSULTANT - ENGINEERS INDIA LIMITED

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

CARD CODE

TITLE: SINGLE LINE DIAGRAM FOR VFD-RGC SYATEM

No. OF SHEETS	01
SHEET No.	01
REV	00

M.O. No.

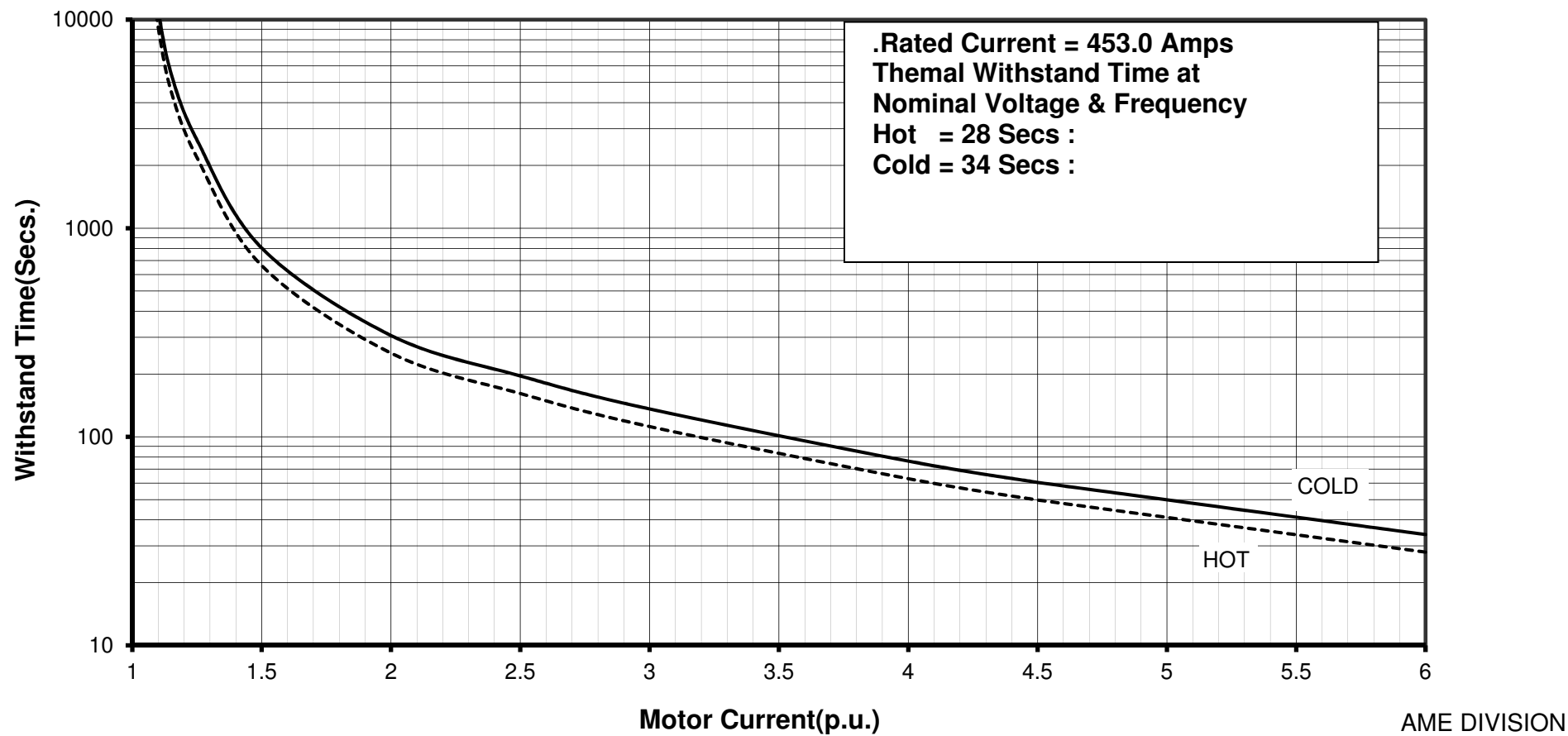
AS PER OPEN TOLERANCE
TO ED 0230499

DRG. No.
CE/1432-70-PR-VFD-1001



Thermal Withstand Curves

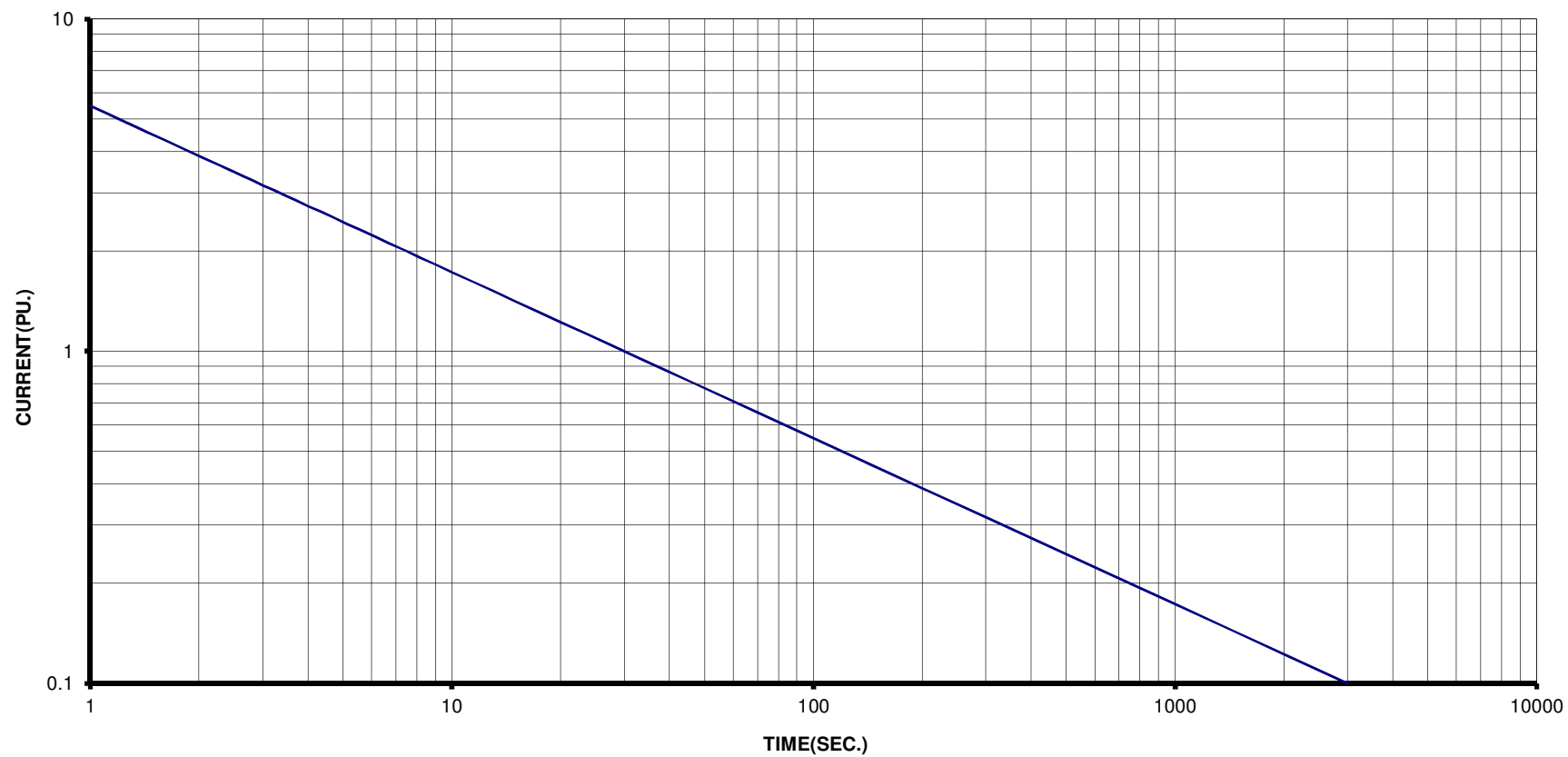
Rating : 4600 KW, 6.6 kV, 4 P , CACA, Ex p motor.





NEGATIVE SEQUENCE CURVE

Rating : 4600 KW, 6.6 kV, 4 P , CACA, Ex p motor.

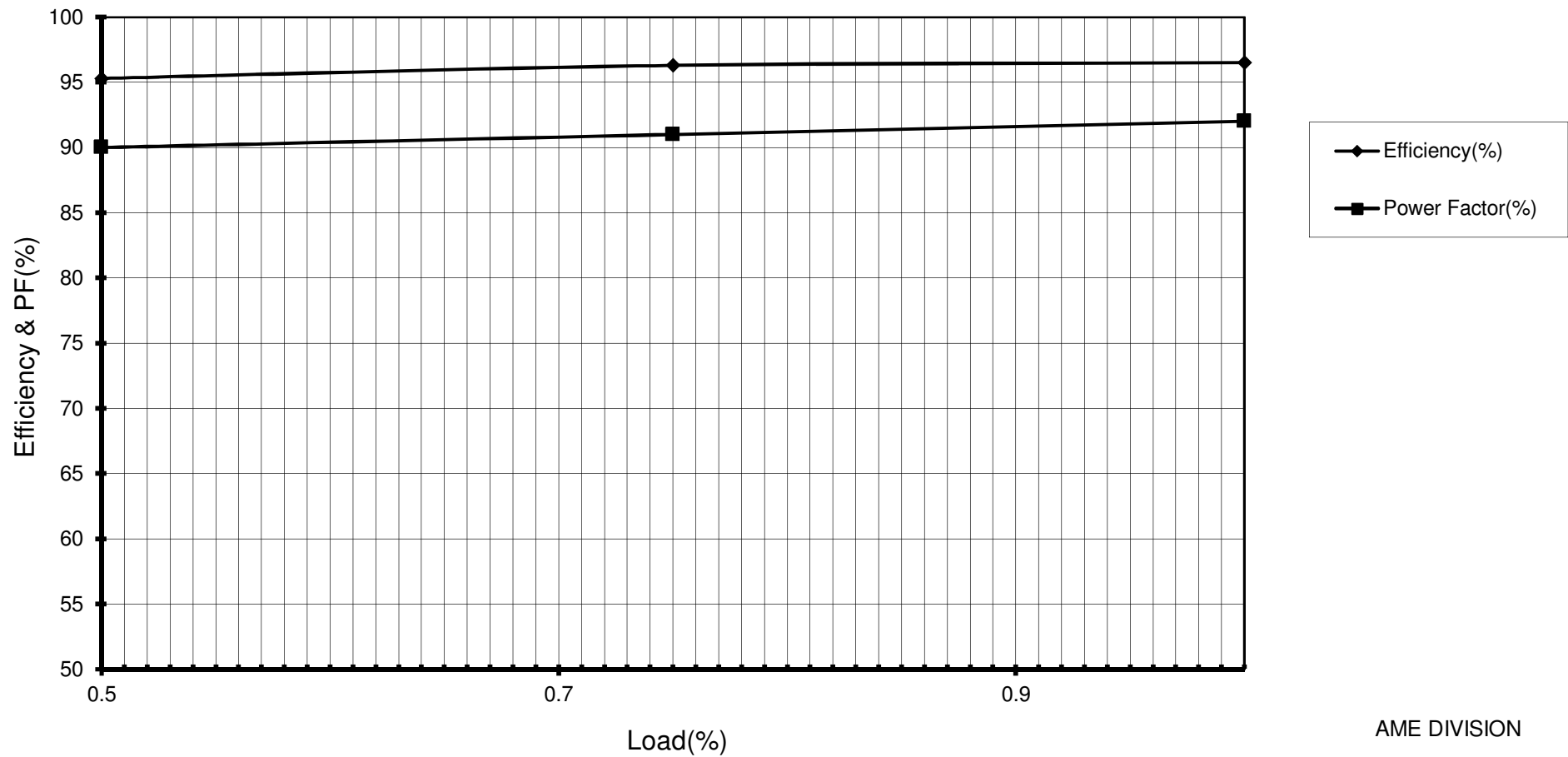


AME DIVISION



Efficiency, PF Vs Load Curves

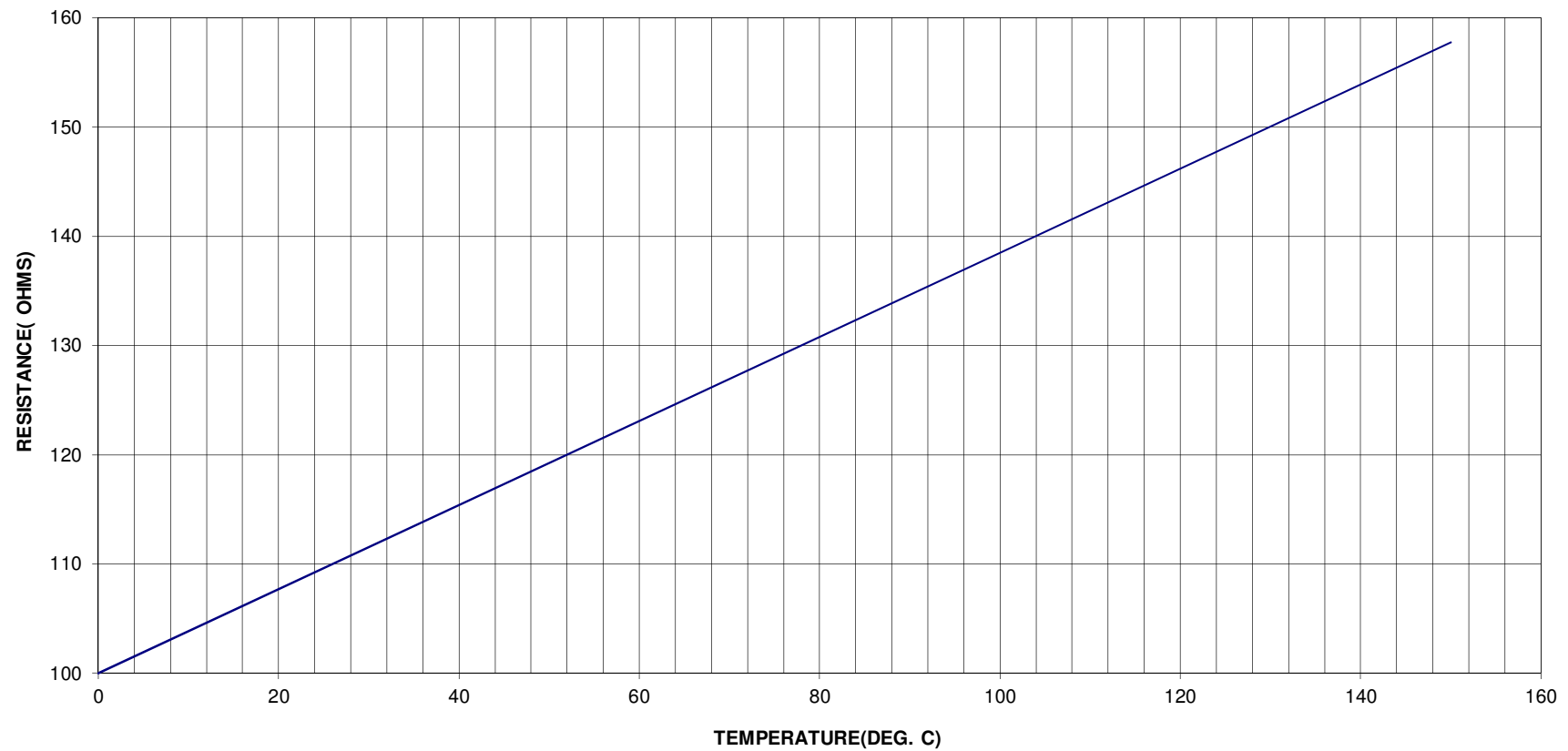
Rating : : 4600 KW, 6.6 kV, 4 P , CACA, Ex p motor.





CALIBRATION CURVE FOR RTD/BTD - PT100

Rating : 4600 KW, 6.6 kV, 4 P , CACA, Ex p motor.



AME DIVISION

PURCHASER's DATA									
A. Site conditions									
1	Ambient temperature,	minimum:	1 °C	3	Atmospheric condition:	Humid & highly corrosive			
		maximum:	46 °C	4	Altitude:	< 1000 m			
		design:	45 °C	5	Location:	Outdoor			
2	Relative humidity:	95 %							
B. Technical particulars									
1	Motor tag no.:			17	Hazardous area classification:	Zone-2			
2	Driven equipment name:	Net Gas compressor		18	Gas group:	IIC, Temp. Class T3			
3	Voltage:	6.6. kV (Nominal)		19	Type of explosion protection:	Ex p			
4	Phase:	Three		20	Type of ingress protection:	IP 55			
5	Frequency:	50 Hz (Nominal)		21	Reacceleration:	No			
6	Fault level:	40 kA		22	Diff. protection CTs:	NA			
7	Fault duration:	0.25 sec.			CT specs.:	NA			
8	System earthing:	Resistance Earthed		24	Color shade:	632 as per IS 5			
9	Duty:	Continuous		25	Thermistors:	☐ Required ☒ Not required			
10	Method of starting:	VFD		26	RTD: (Note-2)	☒ Required ☐ Not required			
11	Cable size:	Customer to Furnish Cable Details mm²		27	BTD: (Note-2)	☒ Required ☐ Not required			
12	Cable type:	Al. cond. XLPE insulated		28	RTD/BTD monitoring device:	Not in motor vendor scope			
13	Temperature rise:(By resistance method)	75 °C							
14	Cooling:	CACA IC611							
15	Insulation class:	F with temp. rise limited to Class B		29	Applicable specification:	EIL spec. 6-51-0031 Rev 05			
16						6-51-50 Rev 02 and IS/IEC codes			
DRIVEN EQUIPMENT MANUFACTURER's DATA									
1	Suggested motor rating:	5640 kW		9	Coupling type:	Flexible			
2	Manufacturer:	BHEL Hyderabad		10	Torque required, starting:	507.9 kgm			
3	Type of driver mounting:	Horizontal		11	maximum:	3386 kgm			
4	Driven equipment:	Net Gas compressor		12	GD² of eqpt., including flywheel:	NA kgm²			
5	Shaft kW:	5127 kW			excluding flywheel:	8720 kgm²			
6	kW at maximum load:	5127 kW		13	Maximum thrust:	Nil kg			
7	Speed:	1495 RPM		14	Pulsation rate:	NA			
8	Rotation of eqpt. from coupling end:	CW		15	Starting condition:	On VFD for Curve No. C1721012/ST			
MOTOR MANUFACTURER's DATA									
1	Rating:	5640 kW							
2	Manufacturer:	BHEL Bhopal		19	Space heater-Ex d- voltage & power:	1000 W, 1Ph 240V AC			
3	Frame designation:	1SB1903-4		20	Moment of inertia, GD²:	1576 kgm²			
4	No. of poles:	4		21	DE/NDE bearing type & no.:	DIN Standard Bearing 1 No DE & 1 NDE			
5	Full load speed:	1495 RPM		22	Type of lubrication:	FOLS (5.4 LPM / Per Brg., ISO VG 46)			
6	Mounting:	Horizontal (B3)		23		Elastimold (In Pressurized Terminal Box)			
7	Full load torque (FLT):	3674 kgm		24	Type of main terminal box:	Pressurized Terminal Box			
8	Starting torque:	DEPENDS ON VFD		25	Type of neutral terminal box:	Pressurized Terminal Box			
9	Break down or pull out torque:	225 % of FLT		26	No. of Terminals	6			
10	Full load current (FLC):	555 A		27	Weight of motor:	20000 kg			
11	Starting current at 100% voltage: (Note-3)	DEPENDS ON VFD			Thermistors, quantity:	NA no.			
12	Rotation viewed from coupling end:	CW		28	make: type:				
13	Starting time at 85%/100% voltage:	DEPENDS ON VFD			RTD, quantity:	12 no.			
14	Locked rotor withstand time (cold/hot) at,			29	make: BHEL Approved Vendor type:	PT 100 3 Wire Simplex			
	80% voltage:	53 / 44 sec.			BTD, quantity:	1 No per Bearing			
	100% voltage:	34 / 28 sec.		30	make: BHEL Approved Vendor type:	PT 100 3 Wire Duplex			
15	Time (Te) for Increased Safety Motor at 100% Voltage	NA sec.		31	Shaft voltage: NA (As Both Bearing are insulated) V				
				32	Critical speed, 1 st /2 nd stage:	Shall be provided latter			
16	Efficiency at 75%/100% Load:	96.3/96.6 %			Pressurization panel:	☒ Applicable ☐ Not applicable			
17	Power factor at 75%/100% load:	0.92/0.92		33	make: After Finalization of Vendor	☒ Required ☐ Not required			
18	Heating/Cooling Time Const. (min.)	30/90 min		34	type: Electro-pneumatic				
					Canopy:	NO			
					Fan rotation Design	Fixed			

1. Starting time calculations shall be based on operating conditions specified in Material Requisition eg. open valve condition/closed valve condition, at no load/under load, as applicable.

2. Thermistors, RTDs and BTDs are applicable for motors as per EIL Specification 6-51-0031.

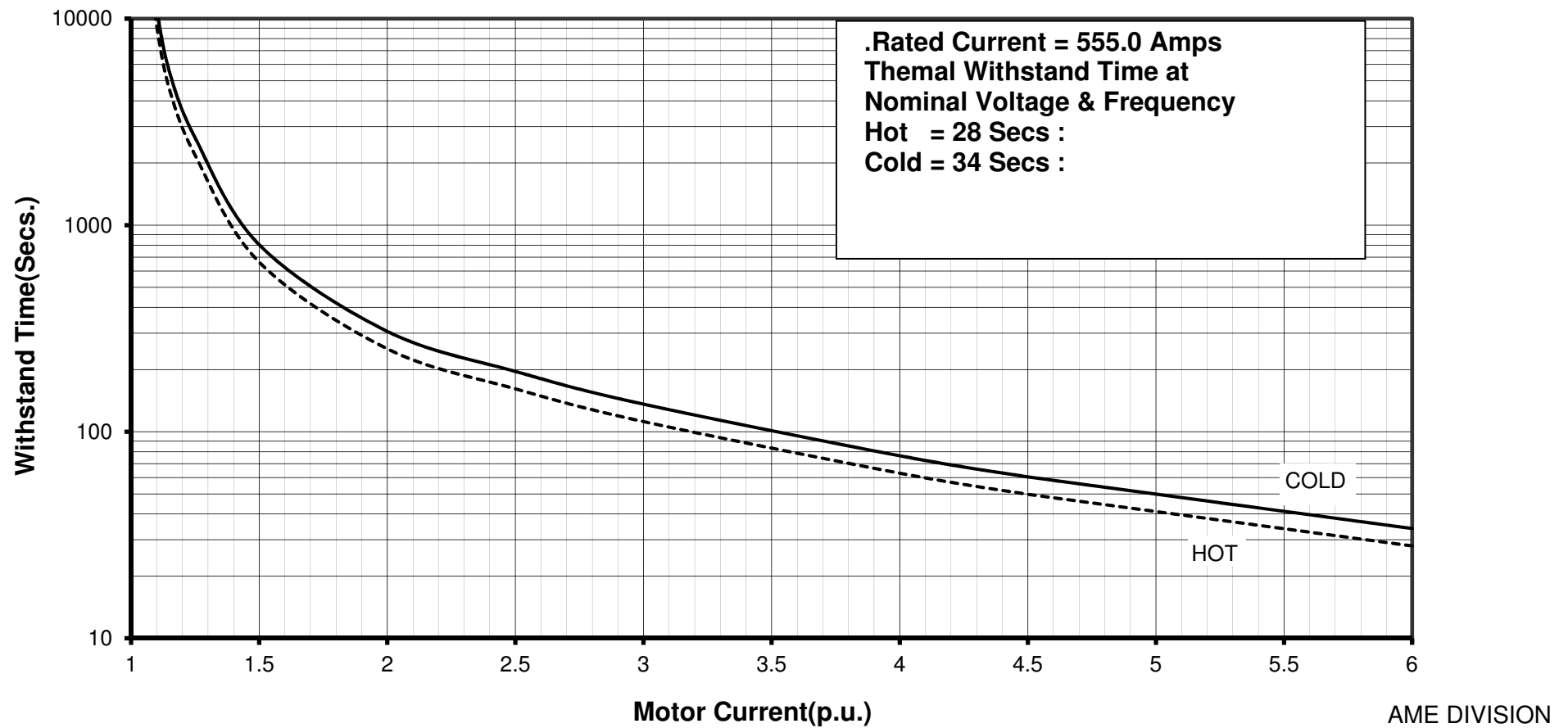
3. The HV motors for VFD start/run shall be designed such that the starting current is100-150% of FLC (inclusive of +ve tolerance).

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A	25.05.2017	Issued with MR	NV	DA	HK
Rev.	Date	Purpose	Prepared	Checked	Approved



Thermal Withstand Curves

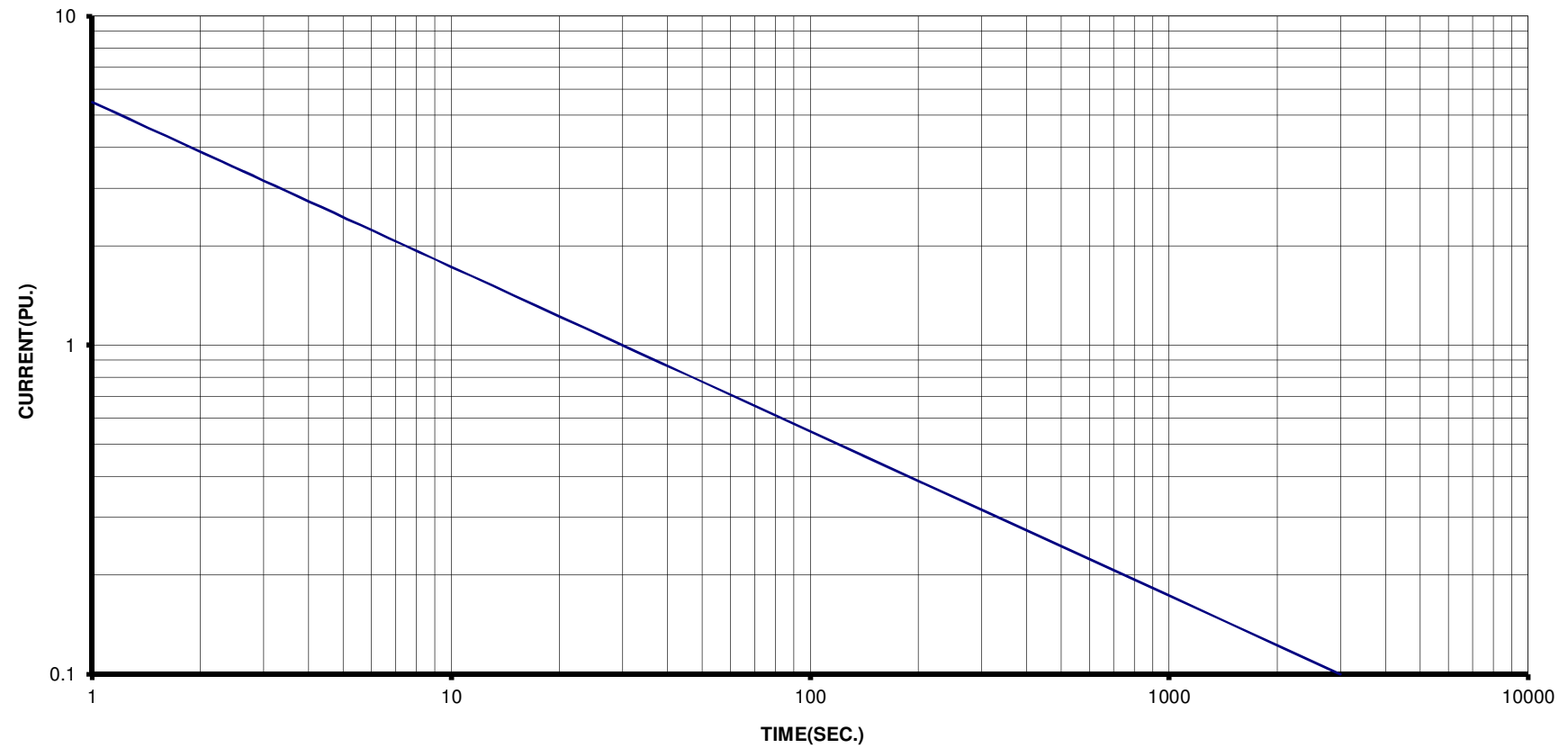
Rating : 5640 KW, 6.6 kV, 4 P , CACA, Ex p motor.





NEGATIVE SEQUENCE CURVE

Rating : 5640 KW, 6.6 kV, 4 P , CACA, Ex p motor.

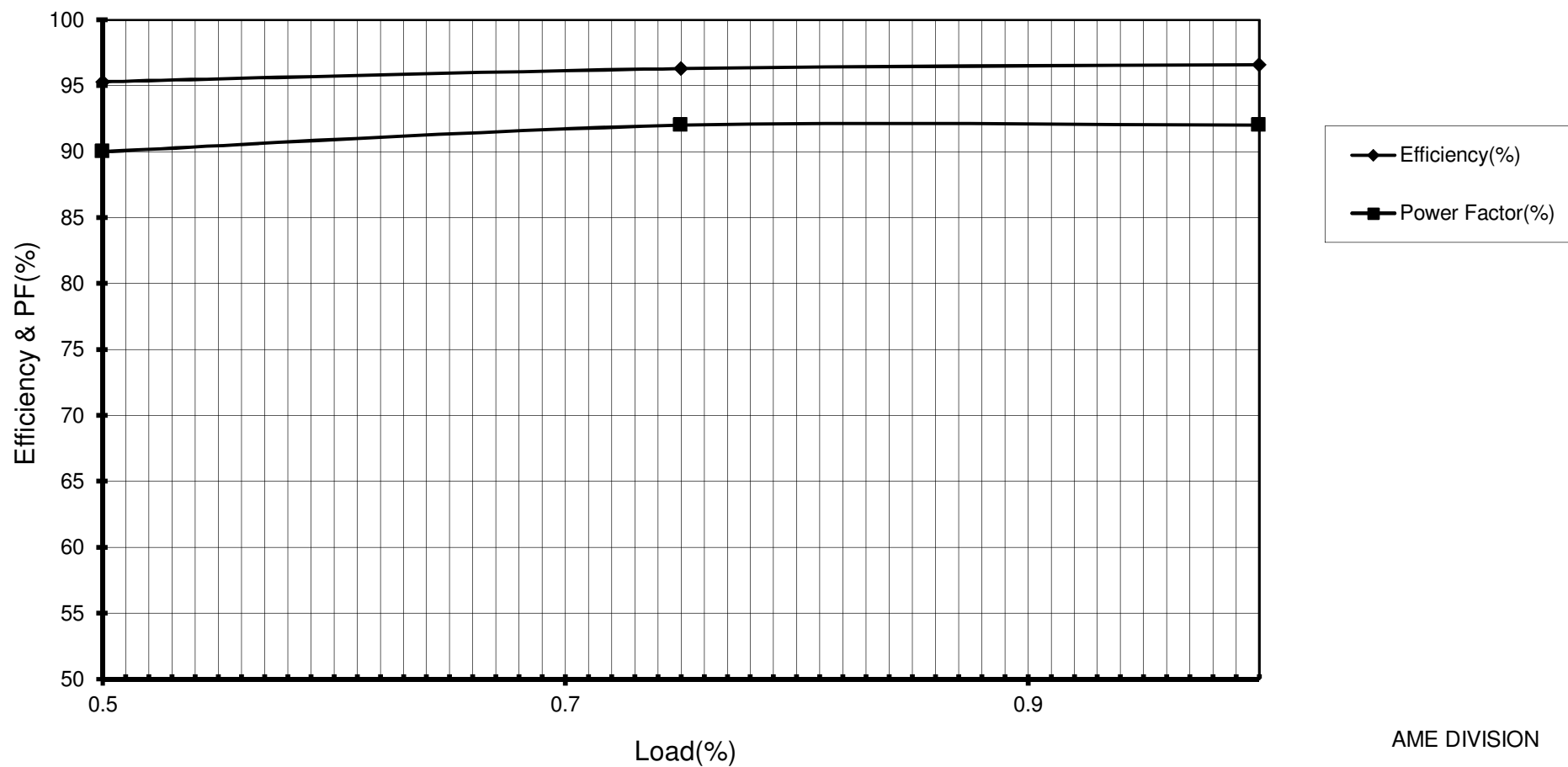


AME DIVISION



Efficiency, PF Vs Load Curves

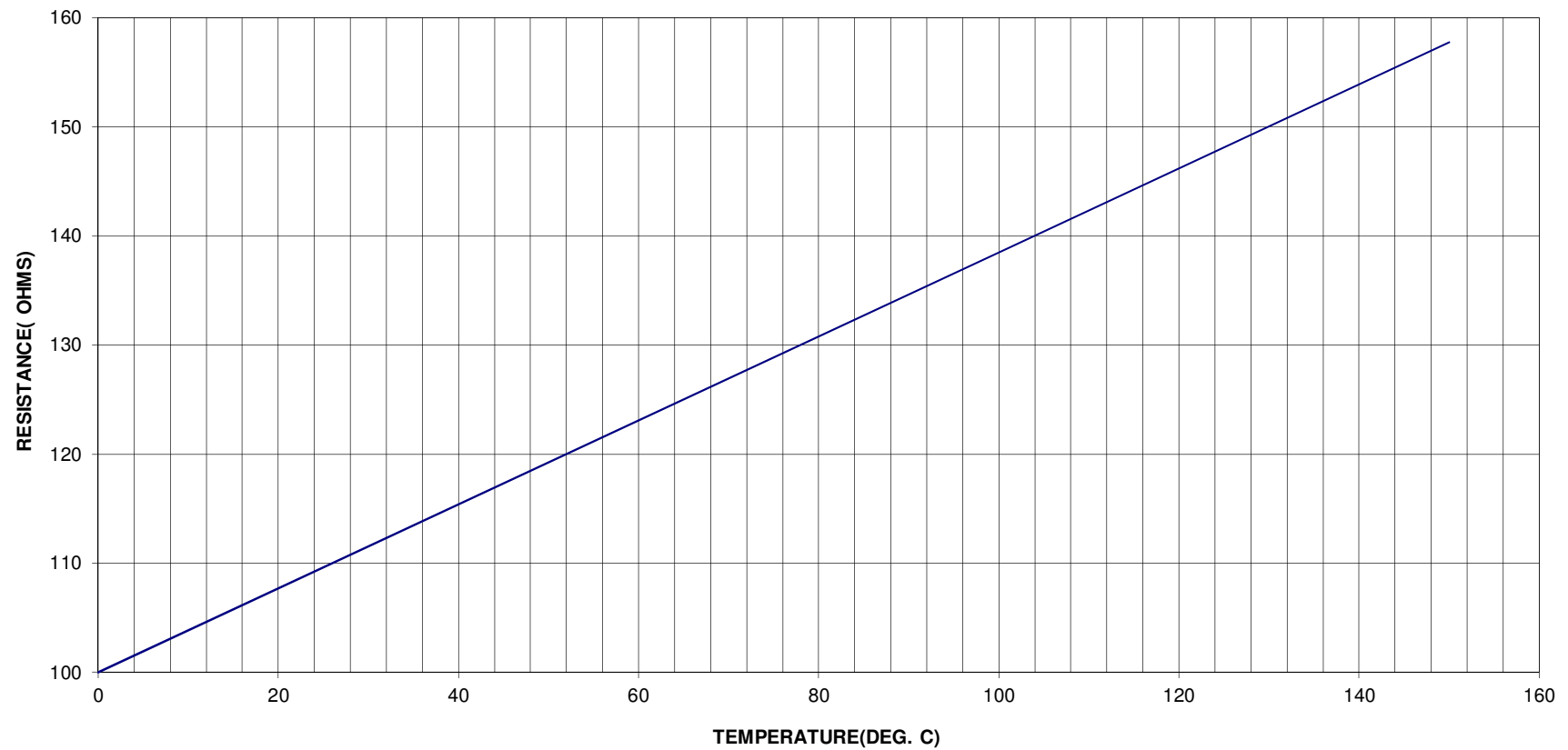
Rating : 5640 KW, 6.6 kV, 4 P , CACA, Ex p motor.





CALIBRATION CURVE FOR RTD/BTD - PT100

Rating : 5640 KW, 6.6 kV, 4 P , CACA, Ex p motor.



AME DIVISION

DATA SHEET – HV VARIABLE FREQUENCY DRIVE
Part-I (Data to be filled in by purchaser)

1. Applicable standards : EIL spec. 6-51-0050
2. Rated output capacity (KW) : *
3. Rated Output voltage : *
4. Motor Details
 - a) Drive system : Single
 - b) Motor tag no. : #
 - c) Type of motor : Squirrel cage induction motor
 - d) KW rating : *
 - e) Starting condition : Soft start
 - f) Frequency range : *
 - g) Voltage range : *
 - h) Full load current : *
 - i) Full load PF
 - pf at lowest KW : *
 - pf at Highest KW : *
 - j) Starting current : * (1-1.5 times of motor full load current)
 - k) Load torque details : *(As per Cl . 5.1.3 of 6-51-0050)
5. **SITE CONDITIONS:**
 - a) Ambient temperature : Max. 46° C / Min.10° C
 - b) Design temperature : 45° C
 - c) Altitude : Less than 1000M
 - d) Installation : Indoor
 - e) Location : Substation VFD room
6. **INPUT POWER SUPPLY SYSTEM CONDITIONS**
 - a) No. of phases : 3
 - b) AC input voltage : 6.6kV
 - c) Voltage fluctuation : ± 10%
 - d) Rated frequency : 50 Hz
 - e) Frequency fluctuation : ± 3%
 - f) System fault level : Max 40kA & Min 10kA
7. **SYSTEM REQUIREMENTS**
 - a) Speed range required : As per process requirement specified elsewhere in MR
 - b) Adjustment of speed : Auto (from DCS) & Manual (from LCS – As per process requirement) & VFD
 - c) Speed Reference by measurement of the stator voltage frequency through voltage transformer : *
 - d) Reference Signal : 4 - 20 mA (from DCS).
 - e) By pass Breaker : Not Required
 - f) Acceleration time : *
 - Deceleration time : *

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i)	Fault diagnostic	:	Required
j)	Braking	:	Not required
k)	Regeneration	:	Not required
l)	Cable length between swbd and I/P trafo.	:	100 m
m)	Cable length between VFD and Motor	:	450 m
n)	Separate PE Conductor b/n VFD & Motor	:	Not Envisaged, Vendor to confirm. Else vendor to provide this cable.
o)	Communication facility with data concentrator on open protocol	:	Required

*** - Data to be provided by vendor/equipment supplier**

- As per job specifications

Note:

1. RS-485 serial port shall be provided for communication to data concentrator/HMI
2. For HV circuit breaker feeding the HV VFD, owner shall provide two no's shunt trip coils, operating at different control supplies.
3. Any special cable required between VFD and motor including encoder cable shall be in VFD vendor's scope. Only power and control cables shall be supplied by Owner.

PART-II (to be filled in by vendor)

1. Make :
2. Model No. :
3. Rating :
4. Applicable code/standards :
5. Speed range :
6. Speed reference :
7. Input power supply ratings
 - a) Voltage : ± %
 - b) Frequency : ± %
8. Overload capability
 - a) 125% : minutes
 - b) 150% : secs.
 - c) Inrush current 250% I_n for : secs.
9. Overall efficiency at
 - a) 100% load :
 - b) 75% load :
 - c) 50% load :
 - d) 25% load :
10. Overall power factor at
 - a) 100% load :
 - b) 75% load :
 - c) 50% load :
 - d) 25% load :
11. AC Output
 - a) Output voltage range :
 - b) Voltage accuracy :
 - c) Frequency range :
 - d) Frequency accuracy :
12. Transient voltage
 - a) fluctuation ratio :
 - b) Its recovery time :
13. Transient Torque
 - 13.1 Max. Transient air gap torque/duration :
 - 13.2 Max. Transient torque/duration :

Same shall be furnished at the coupling of VFDs, accounting for the motor and the driven equipment in the case of a two and a three phase short-circuit at the motor terminal.
14. Wave form distortion factor (% harmonics) in output/
Input waveform :
(Number of harmonics and magnitude of each harmonic generated shall be furnished).
15. Output short circuit capability and duration :
16. Deration of motor at
 - a) Maximum speed :
 - b) Minimum speed :
17. **Rectifier/Inverter**
 - a) Make :
 - b) Type/Model No. :
 - c) Diodes/GTOs configuration :
 - d) Total No. of Diodes/GTOs :

- e) Cooling system
- Type :
- Redundancy in cooling Units :
- f) Type of feedback for speed control :
18. **DC Reactor**
a) Make :
b) Type :
c) Rating :
d) Inductance of the reactor :
e) Air Core/Iron Core :
19. **Output Filter**
a) Make :
b) Type / Model No. :
c) Rating :
d) Rated Voltage :
20. **Output Power Isolating Device**
a) Make :
b) Type :
c) Model No. :
d) Cont. Current Rating :
e) Short Circuit Rating :
f) Rated Voltage :
g) Applicable Standard :
h) Panel details :
- Overall Length :
- Height :
- Depth :
- Degree of protection :
21. **Main Transformer** : Suitable for Converter duty/ VFD application
a) Make :
b) Type of Transformer : Oil Filled/ ~~Dry type~~
c) KVA Rating :
d) Voltage ratio :
e) Vector group :
f) Impedance :
g) Overall dimension :
(LxBxH)
22. **VFD PANEL DETAILS**
a) Overall Length :
b) Height :
c) Depth :
d) Weight of cubicle :
(Dimensional details of all panels shall be furnished)
e) Degree of protection for enclosure. :
f) Paint shade :
g) Heat output of Panel :
h) Type of cooling :
23. **Auxiliary Power Requirement:**
a) KW :
b) Voltage :

- | | | | |
|-----|--|---|-------------------------|
| 24. | LCS/LCP required as per spec | : | Yes |
| 25. | Requirement of earthing cable between motor & drive | : | By Vendor (if required) |
| 26. | Address of Manufacturing Location | : | |
| 27. | Address of Shop Testing Location | : | |
| 28. | Since when the proposed type of semiconducting power devices are being used in the offered drive model | : | |
| 29. | List of equipments / Components to be sourced from India | : | |

PURCHASER'S DATA

A Site conditions					
1	Maximum ambient temperature:	46 °C	4	Relative humidity:	95 %
2	Minimum ambient temperature:	1 °C	5	Altitude above MSL:	< 1000 m
3	Design ambient temperature:	45 °C	6	Environment:	Humid & corrosive
B Technical particulars					
1	Tag no.:				
2	Duty:	Converter duty (Continuous)			
3	Service	VFD	25	Terminal connection	
4	No. of windings:			HV side	
5	Type of cooling:	ONAN		LV side	
6	Rated MVA		26	Cable Size/Type	
7	Rated voltage			HV side	Later
	HV winding	6.6 kV		LV side	Later
	LV winding		27	Neutral CT specification:	
8	System earthing:			51G	
	HV side	Resistance		64R	
	LV side	Solidly earthed		V _k	
9	Rated frequency:	50 Hz ± 3%		I _m at V _k /2	
10	No. of phases:	Three		RCT	
11	Fault level on HV side:(1Sec)	40 kA	28	Differential CT ratio 87 T	Not applicable
12	Connection			V _k	
	HV side			I _m at V _k /2	
	LV side			RCT	
13	Vector group:				
14	Impedance at max. MVA:		29	Installation	Outdoor (Transformer bay)
15	Insulation class:		30	Painting & colour	RAL-7031
16	Insulation level:		31	AC Auxiliary voltage	415 V ± 10% TPN
	P. f withstand		32	DC Auxiliary voltage	110 V ± 10% DC
	HV winding		33	Bidirectional roller type	NA
	LV winding		34	¢ distance of flat rollers	NA
	Impulse withstand		35	Applicable specifications	UOP Spec. EIL spec Not applicable
	HV winding		36	Loss Capitalization	
	LV winding		a	Rate for copper loss Rs./kW:	Not applicable
17	Winding insulation type:	Uniform	b	Rate for iron loss Rs./kW:	Not applicable
18	Creepage distance:		37	Accessories requirement	
	HV winding			Two temp. sensing	
	total			devices in each limb	
	protected			Marshalling box(IP-55)	
	LV winding			Temp. sensing relay	
	total			Channels, towing lugs :	
	protected			Rollers	
19	Tap changer			Neutral bushing	
	Location			outside terminal box	
	Type			with connector assembly	
	Range			Indicating platinum	
	No. of steps			resistance type	
				thermometer with contacts	
				Busduct flange on LV	
				Lugs and cable glands	
			38	Tests requirements	
				Impulse test:	Not required
				Heat run test:	Required

Note

- All unfilled data shall be filled in by contractor/ vendor.
- Losses shall be inclusive of positive tolerance and shall be at nominal tap.
- Valid test reports in lieu of test to be provided
- For VFD input transformer- HV winding shall be suitable for 6.6kV ± 10%

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A	25.05.2017	ISSUED FOR BIDS	NV	DA	HK

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20	Normal load:		39	Partial discharge test	Not required
21	Max. efficiency at 0.8 p.f:				
22	Load at which max eff. occurs:	MVA		Short circuit test:	Test Certificate
23	Power flow:	Unidirectional		Acoustic sound	Test Certificate
24	Terminal location:				
	HV side	Larger side			
	LV w.r.t HV	180°			

MANUFACTURER'S DATA

A	Make				
B	Rated power at ambient temperature of				
	25 °C			40 °C	
	30 °C			45 °C	
	35 °C			50 °C	
B	Insulation type				
C	Performance				
1	No load loss at		6	Eff. at half load at 75 °C	
2	100% voltage	kW		at 0.8 p.f	%
	110% voltage	kW		at 1.0 p.f	%
3	Full load copper loss at 75 °C	kW	7	Load at which max eff. occurs	MVA
4	No load current at		8	Regulation at 75 °C	%
	100% voltage	A		at 0.8 p.f	%
	110% voltage	A		at 1.0 p.f	%
5	Efficiency at full load at 75 °C		9	Maximum efficiency	%
	at 0.8 p.f	%			
	at 1.0 p.f	%			
D	Mechanical data				
1	Core & winding weight	Kgs.	4	Overall dimensions	
2	Total weight	Kgs.		Length	mm
3	Wheel gauge			Breadth	mm
				Height	mm

Note

- Losses shall be inclusive of positive tolerance and shall be at nominal tap.

EXPERIENCE RECORD - For Hazardous Area Induction Motor & VFD System

Motor Tag No. :
Offered motor ratings :
Motor Supplier :

Sr. No.	Parameter	Information on Offered Model	Information on Operating Installation		
			1	2	3
	<u>Ex'p' HV Induction Motor</u>				
1	Motor Frame Designation, Voltage rating & kW				
2	Place of manufacturing				
3	Applicable Code				
4	BKW / PF / Terminal Voltage				
5	Insulation Class / Full Load Temp Rise Limited To Class				
6	Enclosure weather protection Class				
7	Type of Cooling (Air Cooled/Water Cooled)				
8	Type of starting – VFD/ DOL				
9	Type of running – VFD/ Bypass/ Other				
10	Output transformer provided – Yes/ No				
11	Starting current				
12a	Hazardous area protection class				
12b	Hazardous area Certification details (attach relevant documents from country of origin)				
13	Frequency / full load speed				

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			B034-000-16-50-DS-1009	15.05.2017	A



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Sr. No.	Parameter	Information on Offered Model	Information on Operating Installation		
			1	2	3
14	Type of bearing (DE and NDE)				
15	Service / Details of driven equipment				
	<u>Input Transformer for VFD</u>				
1	Make				
2	Integral/Separate				
3	Rating				
4	Transformer Type (Dry/Oil Filled)				
5	Voltage ratio				
6	Impedance				
7	Vector Group				
8	Dimensions (LXBXH)				
	<u>VARIABLE FREQUENCY DRIVE</u>				
1	Make				
2	Model				
3	Technology (LCI/VSI)				
4	Bypass Mode provided (Yes/No)				
5	VFD Output Voltage				
6	Input Supply Voltage				
7	Type of Cooling (Air cooled/water cooled)				
8	Any special requirement of upstream breakers (two trip coils etc)				

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Sr. No.	Parameter	Information on Offered Model	Information on Operating Installation		
			1	2	3
9	Encoder (required/not required)				
10	Special earthing cable				
11	Heat Load				
12	Dimensions (LXWXH)				
	<u>Other Details</u>				
1	Combined testing of input transformer, VFD and motor done at which place (motor works/vendor works)				
2	Date of supply & commissioning				
3	No. of operating hours completed as on date of bid opening				
4	Purchaser/Owner- Name Contact number				
5	Location of Machine (complete address) TELEPHONE /FAX / E MAIL NOS. CONTACT PERSON				

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			B034-000-16-50-DS-1009	15.05.2017	A



अग्निरोधक नियंत्रण स्टेशन के लिए विनिर्देश

SPECIFICATION FOR FLAMEPROOF CONTROL STATIONS

4	11.04.11	REVISED AND ISSUED AS STANDARD SPECIFICATION	<i>Suresh</i> PS	<i>Pragat</i> ANPS	<i>Patel</i> UAP	<i>Ami. H. Patel</i> DM
3	24.08.07	REVISED AND ISSUED AS STANDARD SPECIFICATION	ANPS	UAP	JMS	VC
2	30.01.02	REVISED AND ISSUED AS STANDARD SPECIFICATION	UAP	AAN	VPS	GRR
1	19.08.96	REVISED AND ISSUED AS STANDARD SPECIFICATION	AP	VPS	SG	AS
0	12.01.83	ISSUED AS STANDARD SPECIFICATION	KVS	SG	GNT	AK
Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

Abbreviations:

AC	:	Alternating Current
BIS	:	Bureau of Indian Standards
BS	:	British Standards
CEA	:	Central Electricity Authority
CCE	:	Chief Controller of Explosives
CIMFR	:	Central Institute of Mines and Fuel Research (formerly CMRI)
CPRI	:	Central Power Research Institute
CT	:	Current Transformer
DGFASLI	:	Directorate General of Factory Advice Service and Labour Institutes
DGMS	:	Directorate General of Mines Safety
ERTL	:	Electronics Regional Test Laboratory
FM	:	Factory Mutual Research Corporation
FRP	:	Fibre Reinforced Plastic
GI	:	Galvanised Iron
IEC	:	International Electro-technical Commission
IEEE	:	Institute of Electrical and Electronics Engineers
IP	:	Ingress Protection
IS	:	Indian Standards
LCIE	:	Laboratoire Central des Industries Electriques
LED	:	Light Emitting Diodes
NEMA	:	National Electrical Manufacturers Association
PESO	:	Petroleum and Explosives Safety Organisation
PVC	:	Poly Vinyl Chloride
SWG	:	Standard Wire Gauge
VDE	:	Verband Der Electrotechnik, Elecktronik und Information Stechnik
UL	:	Underwriters Laboratory

Electrical Standards Committee

Convenor: Mr. UA Patro

Members: Mr. AK Tickoo
Mr. MP Jain
Mr. BR Bhogal
Mr. Arun Kumar
Mr. KK Gera
Mr. Saeed Akhtar

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1.0 SCOPE

This specification covers the requirements of design, manufacture, testing, packing and supply of flameproof control stations and accessories suitable for installation in locations handling flammable liquids and gases.

2.0 CODES AND STANDARDS

2.1 The equipment shall comply with the requirements of latest revision of the following standards issued by BIS:

IS-5	: Colours for ready mixed paints and enamels.
IS-1248	: Direct acting indicating analogue measuring instruments and their accessories.
IS-2148	: Flameproof enclosures for electrical apparatus.
IS-6381	: Electrical apparatus for explosive gas atmospheres – Increased safety “e”.
IS / IEC 60079-0	: Electrical apparatus for explosive gas atmospheres (General Requirements).
IS / IEC 60079-1	: Electrical apparatus for explosive gas atmospheres (Equipment Protection by Flameproof Enclosures “d”).
IS / IEC 60079-7	: Electrical apparatus for explosive gas atmospheres (Equipment Protection by Increased Safety “e”).
IS / IEC 60529	: Degree of protection provided by enclosures (IP Code).
IS / IEC 60947	: LV switchgear and control gear.

2.2 In case of imported equipment, standards followed in the country of origin shall be applicable, if these standards are equivalent or more stringent than the applicable Indian Standards.

2.3 The equipment shall also conform to the provisions of CEA Regulations and other statutory regulations currently in force in the country.

2.4 In case Indian standards are not available for any equipment, standards issued by IEC/ BS/ VDE/ IEEE/ NEMA or equivalent agency shall be applicable.

2.5 In case of any conflict between requirements specified in various applicable documents for the project, the most stringent one shall prevail. However, Owner’s decision in this regard will be final and binding.

3.0 GENERAL REQUIREMENTS

3.1 The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.

3.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least 10 years from the date of supply.

4.0 SITE CONDITIONS

The equipment shall be suitable for installation and satisfactory operation in classified hazardous locations in tropical, humid and corrosive atmosphere as prevalent in refineries, petrochemical and fertilizer plants. Unless otherwise specified, a design ambient temperature of 40° C and an altitude not exceeding 1000 m above mean sea level shall be considered.

5.0 CERTIFICATION

The equipment shall have test certificates issued by recognised independent test house (CIMFR/ CPRI/ ERTL/ Baseefa/ LCIE/ UL/ FM or equivalent). All indigenous equipment shall conform to Indian standards and shall be certified by Indian testing agencies. All equipment (indigenous & imported) shall also have valid statutory approvals as applicable for the specified location. All indigenous flameproof equipment shall have valid BIS license and marking as required by statutory authorities.

6.0 TECHNICAL REQUIREMENTS

6.1 Construction

- 6.1.1 The enclosures of the control stations shall be made of cast light metal alloy.
- 6.1.2 The control stations shall be suitable for use in outdoor open locations and shall have IP-55 degree of protection. They shall preferably be provided with integral canopy. However, where the enclosure has been certified without integral canopy, a separate canopy can be accepted. The separate canopy shall be made of at least 14 SWG (2mm) galvanised sheet steel or FRP. The canopy shall be suitable for providing protection against rain from top and two sides.
- 6.1.3 The control stations shall be provided with gaskets made of non-inflammable and self-extinguishing material.
- 6.1.4 All metal surfaces shall undergo manufacturer's standard cleaning/ painting cycle. After preparation of under surface, the equipment shall be painted with two coats of epoxy based final paint with colour shade as below:

- Flame proof (Gas group IIA/ IIB) : Dark admiralty grey shade 632 of IS-5/
RAL 7035
- Flame proof (Gas group IIC) : Light yellow shade 355 of IS-5

All unpainted steel parts shall be suitably treated to prevent rust formation. If these parts are moving elements then they shall be greased.

- 6.1.5 A warning inscription "Isolate power supply elsewhere before opening" shall be provided on each enclosure. The warning inscription shall be embossed on the enclosure or a separate warning plate with above inscription shall be fixed to the enclosure with screws. The warning plate shall be of nickel plated brass or stainless steel.
- 6.1.6 All accessories like nuts, bolts, washers etc. shall be made of stainless steel SS-304.
- 6.1.7 The control stations shall be provided with two earthing studs with lugs on the external surface of the enclosures suitable for termination of 8 SWG GI wire.
- 6.1.8 The control station shall be provided with bottom cable entries. Required number of flameproof double compression nickel plated brass cable glands and flameproof nickel plated brass sealing plugs shall be provided.
- 6.1.9 The control stations shall have external fixing lugs for mounting on wall or column. The holes provided on these lugs shall be of oblong type.
- 6.1.10 A nameplate indicating Tag Number shall be provided on each control station. Separate nameplate shall also be provided to indicate the details of testing agency (CIMFR or equivalent), test certificate no. with date, statutory approval no. with date and agency (PESO/ CCE/ DGFASLI/ DGMS), BIS license number and date, applicable gas group etc. The nameplates shall be engraved type and permanently fixed on the equipment. In case the standard details given above are embossed on the enclosures, the same need not be repeated on the name plate.

6.2 Component Specification

- 6.2.1 Push buttons for START and STOP shall be of GREEN and RED colour respectively. Each push button shall have one NO and one NC contact. The STOP push button shall be mushroom type with stay put feature and lockable in pressed position.
- 6.2.2 All control switches shall be provided with a pistol grip handle. Circuit breaker control switch, wherever specified, shall have three positions (START - NEUTRAL - STOP) with spring return to neutral from START position and stay put in STOP position. All control/ selector switches shall have minimum two poles for each position. Each position of switch shall be indelibly marked on the control station.
- 6.2.3 All ammeters shall be of moving iron type having an accuracy class of 3 and suitable for 1 Ampere CT secondary. Minimum size of ammeter shall either be 72mm x 72 mm or 65 mm diameter. 80% of the scale length shall cover 100% of the CT primary current uniformly and the balance 20% of the scale shall cover 100-800% of the CT primary. A red mark corresponding to the full load current of the motor shall be provided on the ammeter dial. The ammeter front glass shall be toughened.
- 6.2.4 Indicating lamp(s) wherever provided shall be clustered LED type (with minimum 3 numbers LEDs, preferably connected in parallel), mounted inside an enclosure of minimum diameter of 15mm.

6.3 Terminals & Wiring

- 6.3.1 The control stations shall be provided with sufficient number of terminals. More than 2 wires per terminal shall not be permitted. If required, additional terminal with shorting link may be used. Each terminal for external cable connection shall be suitable for termination of 2.5 mm² solid copper conductor. Tinned copper lugs shall be provided for cable termination.
- 6.3.2 All internal wiring shall employ 2.5 mm², 660V grade, PVC insulated copper conductor wires.
- 6.3.3 For flameproof equipments, terminal box can be provided in 'Exe' execution.

7.0 INSPECTION, TESTING AND ACCEPTANCE

- 7.1 During fabrication, the equipment shall be subjected to inspection by EIL/ Owner or by an agency authorized by the Owner, if specified/ agreed in Inspection Test Plan. Manufacturer shall furnish all necessary information concerning the supply to EIL/ Owner's inspector. All routine/acceptance tests shall be carried out at manufacturer's works under his care & expense.
- 7.2 Type test certificates from CIMFR or equivalent test house, applicable PESO/ CCE/ DGFASLI/ DGMS approval certificates, BIS license and original drawings referred in type test certificates shall be shown to the inspection agency on demand during inspection. The certificates and BIS license must be valid at the time of despatch.
- 7.3 Test certificates of bought out components shall be shown to the inspection agency on demand during inspection.
- 7.4 All equipments shall be subjected to various routine / acceptance tests as per standards but not limited to the following:
- 7.4.1 General visual inspection
- 7.4.2 Dimensional inspection
- 7.4.3 Verification of mechanical and electrical operations
- 7.4.4 Dielectric tests
- 7.4.5 Over pressure test
- 7.4.6 Any other routine and acceptance test as per applicable standards.

8.0 PACKING AND DESPATCH

All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for the selected mode of transportation, i.e. by ship/ rail or trailer, and shall be wrapped in polythene sheets before being placed in crates/ cases to prevent damage to finish. The crates/ cases shall have skid bottom for handling. Special notations such as 'Fragile', 'This side up', 'Center of gravity', 'Weight', 'Owner's particulars', 'PO no.' etc., shall be clearly marked on the packages together with other details as per purchase order.

The equipment may be stored outdoors for long periods before installation. The packing shall be completely suitable for outdoor storage, in areas with heavy rains/ high ambient temperature.

उच्च वोल्टेज वैरीएबल फ्रीक्वेन्सी
ड्राइव सिस्टम
के लिए विनिर्देश

**SPECIFICATION
FOR
HV VARIABLE FREQUENCY
DRIVE SYSTEM**

2	16.10.14	REVISED AND ISSUED AS STANDARD SPECIFICATION	MK/SA	HK	BRB	SC
1	24.04.09	REVISED AND ISSUED AS STANDARD SPECIFICATION	AM	SG	JMS	ND
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Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

Abbreviations:

AC	:	Alternating Current
BIS	:	Bureau of Indian Standards
BS	:	British Standard
CEA	:	Central Electricity Authority
CFL	:	Compact Fluorescent Lamp
CIMFR	:	Central Institute of Mining and Fuel Research (formerly CMRI)
CRCA	:	Cold Rolled Cold Annealed
CW	:	Cooling Water
DC	:	Direct Current
DCS	:	Distributed Control System
DOL	:	Direct On Line
ECS	:	Electrical Control System
EM	:	Electromagnetic
HV	:	High Voltage
IEC	:	International Electrotechnical Commission
IEEE	:	Institute of Electrical and Electronics Engineers
IEGT	:	Injection Enhanced Gate Transistors
IGBT	:	Insulated Gate Bipolar Transistor
IGCT	:	Insulated Gate Commutated Transistor
I/O	:	Input/Output
IP	:	Ingress Protection
IS	:	Indian Standard
LED	:	Light Emitting Diode
mA	:	Milliampere
MCB	:	Miniature Circuit Breaker
MTBF	:	Mean Time Between Failure
MTTR	:	Mean Time to Repair
NEMA	:	National Electrical Manufacturer's Association
PLC	:	Programmable Logic Controller
PO	:	Purchase Order
PVC	:	Poly Vinyl Chloride
SGCT	:	Silicon Gate Commutated Transistor
THD	:	Total Harmonic Distortion
V_{BO}	:	Break Over Voltage
VDE	:	Verband Deutscher Electrotechniker
VFD	:	Variable Frequency Drive

Electrical Standards Committee

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1.0 SCOPE

- 1.1** The scope of this specification is to define the minimum technical requirements for the design, manufacture, testing and supply of High Voltage, AC Variable Frequency Drive system. The VFD system shall be complete with Squirrel Cage Induction Motor/ Synchronous Motor as specified in data sheet, Converter, Converter input transformer (if required), drive output transformer (unless specifically agreed, drive output transformer shall not be provided), DC link reactor with associated auxiliaries, harmonic filters (if required) and field mounted local motor control panel.
- 1.2** The Vendor shall be responsible for engineering and functioning of the complete system, meeting the intent and requirement of this specification and data sheets. 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, motor cable selection and motor sizing/selection.
- 1.3** This specification applies to drive systems having converter input voltage above 1000 V AC and up to and including 11000V AC.

2.0 CODES AND STANDARDS

- 2.1** The equipment shall comply with the latest editions of the following standards unless specified otherwise:

IS:325	Three-phase Induction Motors
IS:3700	Essential Ratings and Characteristics of Semiconductor Devices
IS:3715	Letter symbols for semi-conducting devices
IS:4411	Code of designation of semi-conducting devices
IS:5001	Guide for preparation of drawings of semiconductor devices and Integrated Circuits
IS:5469	Code of practice for the use of semiconductor Junction Devices
IS:8789	Values of Performance characteristics for Three Phase induction motor
IS:12615	Energy Efficient Induction Motors Three Phase Squirrel Cage
IS:12729	Common specification for High-Voltage Switchgear and Controlgear standards
IS:14901	Semi-conductor devices- Discrete devices & Integrated Circuits
IS:15880	Three Phase Cage Induction motors when fed from IGBT Converters- Application Guide
IEC:60146-1-3	Semiconductor Convertors general requirements and line commutated convertors-Transformer & reactors
IEC:61800	Adjustable speed electrical power drive systems
IEEE:519	Recommended Practices and requirements for Harmonics Control in Electrical Power Systems

- 2.2** In case of imported equipment, the standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian standards.
- 2.3** The equipment shall also conform to the provisions of CEA Regulations and other statutory regulations currently in force in the country.

2.4 In case Indian standards are not available for any equipment, standards issued by IEC/ BS/ VDE/ IEEE/ NEMA or equivalent agency shall be applicable.

2.5 In case of any conflict between requirements specified in various applicable documents, the most stringent one shall prevail. However, owner's decision in this regard shall be final and binding.

3.0 SITE CONDITIONS

3.1 The drive system shall be designed to operate under specified site conditions as specified in the data sheets. If not specifically mentioned therein, a design ambient temperature of 40°C and an altitude not exceeding 1000 metres above mean sea level shall be considered.

3.2 The AC drive shall be installed indoors in a non-hazardous, air-conditioned or pressurized room, as specified in data sheet. Transformer installation (outdoor/ indoor) shall be as indicated in datasheet. Motor shall be installed outdoors in safe or hazardous area as specified in datasheet.

3.3 All the equipment shall be designed for continuous duty as per nameplate rating under the specified ambient conditions.

4.0 GENERAL REQUIREMENTS

4.1 The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.

4.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least 10 years from the date of supply.

4.3 Vendor shall give a notice of at least one year to the end user of equipment and EIL before phasing out the product/spares to enable the end user for placement of order for spares and services.

4.4 Vendor shall ensure proper co-ordination with the driven equipment supplier in selection / sizing of offered variable frequency drive system.

5.0 TECHNICAL REQUIREMENT

5.1 Performance Requirement

5.1.1 The system shall be energy efficient, designed as standard product and shall provide very high reliability, high power factor, low harmonic distortion and low vibration / wear / noise. It shall be easy to install in minimum time and expense and no special tools shall be required for routine maintenance.

5.1.2 The system shall be designed to deliver the motor input current and torque for the complete speed torque characteristics of the driven equipment, with input supply variation of $\pm 10\%$ and frequency variation of $\pm 3\%$. The system shall be suitable for the load characteristics and the operational duty of the driven equipment. It shall be capable of withstanding the thermal and dynamic stresses and the transient mechanical torque, resulting from short-circuit.

5.1.3 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 in the data sheet:

- a. Variable torque changing as a function of speed i.e. Speed squared
- b. Constant torque over a specific speed range
- c. Constant power over a specific speed range where the torque decreases when speed increases
- d. Any other as specified in data sheet

- 5.1.4 The drive controller shall be equipped with microprocessor based digital regulator with programmable functions. The power control regulator logic shall provide for an acceleration/deceleration current limit curve and shall be capable of field adjustments without shutting the system down. Linear acceleration and deceleration shall be separately programmable from 0.1 to 20 seconds.
- 5.1.5 The System shall be suitable for single quadrant operation and the speed variation shall be with range 10-100 % unless otherwise specified in data sheet with speed set accuracy of $\pm 1\%$ of rated maximum speed and steady state regulation of $\pm 0.5\%$ of rated speed.
- 5.1.6 The total harmonic distortion (THD) of the voltage and current at inverter output shall be as per IEC 61800 and same shall be considered in the design of the motor. The dv/dt limits & Vpeak shall also be as per IEC-61800-2.
- 5.1.7 Harmonics at the supply side of the drive system at primary of the main input transformer shall be restricted within the maximum allowable levels of current and voltage distortion as per recommendations in the latest edition of IEEE-519. The vendor shall perform design calculation for harmonic filter system considering VFD connected to the power system and including the supply of harmonic filters along with all accessories which shall be installed at owner's power system unless otherwise specified. These harmonic studies shall be conducted with maximum and minimum system fault level, cable capacitance, system equipment reactance etc. The studies shall highlight but not be limited to maximum load current, expected resonant frequencies, need of harmonic filters, sequence of switching of filters, voltage wave form, rating of equipments/ feeder for feeding filters from owner's switchgear etc.
- 5.1.8 Unless otherwise specified, the overload capacity of the controller shall be 150% of rated current of 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. If load demands exceed the current limit for more than 1 minute, the drive shall shutdown to prevent over heating of the motor and damage to the drive.
- 5.1.9 During operation, the system shall be capable of developing sufficient torque under all load conditions to respond to a 20% alteration in speed set point within a time limit upto 60 seconds.
- 5.1.10 The integrator action of the speed set point alteration shall be independently adjustable for both an upward and a downward alteration. The minimum time interval between set point adjustments by the distributed control system shall be considered as 10 seconds.
- 5.1.11 The drive shall trip in case the speed exceeds 105% of the maximum operational speed or reduces to 95% of the minimum operational speed for more than 10 seconds.
- 5.1.12 Maximum noise level from the drive at 1-meter distance, under rated load with all normal cooling fans operating shall not exceed 85 dBA.
- 5.1.13 Variable frequency drive shall be arranged so that it can be operated in an open circuit mode, disconnected from the motor for start up adjustments and troubleshooting/ maintenance.
- 5.1.14 Voltage at motor neutral shall be maintained at ground potential for the total operating condition.
- 5.2 Control Requirement**
- 5.2.1 The system shall operate on constant V/f supply with required voltage boost capability in low frequency mode of operation.
- 5.2.2 Short time voltage dips up to 20% of nominal voltage (e.g. in case of a large motor start up connected to the same bus as VFD) shall not cause the control system to stop functioning and shall not trip the drive system.

- 5.2.3 The system shall also be equipped with a momentary powerloss ride through feature which will restart the system in case of voltage dip over 20% or power interruptions for less than 2 seconds, with recovery of the voltage to its nominal value.. The drive shall have the facility to block this feature, if required by the operator. Upon restart, the converter shall be capable of synchronizing onto a rotating motor and develop full acceleration torque within 10 seconds.
- 5.2.4 The system shall be suitable for number of starts as per attached EIL specification for High Voltage Motors.
- 5.2.5 The power controller shall be controlled to always start the motor in the forward direction. Logic shall be provided to prevent the motor from being started in the reverse direction.
- 5.2.6 The drive motor shall be speed controlled corresponding to 4-20 mA or 0-10 V reference input signal. Unless otherwise specified, upon complete loss of the user's speed reference signal, the drive shall automatically run at constant speed as at 80-100% of the last speed reference available prior to the loss of signal.
- 5.2.7 It shall be possible to vary the speed of the drive in either manual or auto mode. Auto/Manual selection shall be from VFD panel unless otherwise specified.
 - a) With the selector switch in "manual" mode, the operator shall be able to set the speed through key pad (mounted on front of the drive panel) or from speed increase/decrease push buttons (from the field). Motor operated potentiometer shall be provided as a speed set point device.
 - b) With the selector switch in "auto" mode, speed of the motor shall be controlled from a 4-20 mA signal, from owner's PLC/DCS (Process Control) system. Necessary equipment required for interfacing with PLC/DCS shall also be provided in the VFD panel.
 - c) Local/Remote selector switch shall be provided in local control station (in Field). With the selector switch in "Local" mode, the operator shall be able to start and set the speed through local control station (in Field). With the selector switch in "Remote" mode, speed of the motor shall be controlled either from VFD panel or from Owner's PLC/DCS as explained in a) and b) above. (For local control station, also refer Cl. 5.5.7 below).
- 5.2.8 The required provision for the interface with remote PLC/DCS located at control room shall be either through hardwired connection (with potential free contacts and transducers as described elsewhere in this specification) or through serial communication link as defined in the datasheet.
- 5.2.9 Drive system shall have provision for interface with upper level automation such as Substation monitoring system or electrical control system in case specified in the data sheet/job specification.
- 5.2.10 The closed loop control feed back for the drive system having out put transformer shall be tapped from the secondary side of the output transformer.

5.3 Panel Construction

- 5.3.1 The panel shall include suitable semi conducting power devices (Diodes/IGBT/IGCT/ IEGT/SGCT) modules with protective devices, reactors (if required) , filters (if required), control circuit, control accessories, indication and annunciation etc. The construction of the panel shall provide effective protection against electromagnetic emissions and shall meet the design requirement of relevant standards.
- 5.3.2 Upstream breaker 'ON/OFF/TRIP' indications and remote breaker closing and trip push buttons shall be provided on the front door.

- 5.3.3 Safety Interlock shall be provided so that power cabinet can't be opened unless the up stream breaker is disconnected, safety-grounding switch is closed and DC link capacitor is discharged. Power source breaker can only be closed once the earthing switch is open and panel door is closed with lock defeat facility.
- 5.3.4 The drive shall be suitably housed in sheet steel panels and shall be fabricated using cold rolled sheet steel. The sheet steel used for the panel shall be of minimum 1.6 mm CRCA. The panel shall be suitable for indoor installation, if not otherwise specified. The panel shall be free standing with degree of enclosure protection as IP-31. Maximum and minimum operating height shall be 1900 mm and 300 mm respectively.
- 5.3.5 Bolted un-drilled gland plate shall be provided at bottom. Clamp type terminals shall be used for connection of all wires up to 10 mm² and terminal for higher sizes shall be bolted type suitable for cable lugs. Minimum space for power cable termination shall be 600mm clear from bottom of the cable gland plate.
- 5.3.6 Bus bars shall be of electrolytic copper/aluminium, sleeved, color coded separately for AC and DC system. All the live parts shall be sleeved / shrouded to ensure complete safety to personnel intending to carry out routine inspection by opening the panel doors. All the equipment inside the panel and on the doors shall be provided with suitable nameplate.
- 5.3.7 All the switches, component and accessories which are essential for normal and emergency operation shall preferably be mounted on the door and shall be operable externally. All the analogue instruments, where provided, shall be switchboard type, back connected & of size 96x96mm. Scale shall have red mark indicating maximum permissible operating rating.
- 5.3.8 Each panel shall be provided with illuminating lamp/11 W CFL with switch and fuse. 5/15A, 240V power socket with switch and fuse shall be provided. Each panel shall have space heater with switch fuse and variable setting thermostat.
- 5.3.9 Copper earth bus of min. 30x6 sq.mm. upto short circuit withstand capacity of 31.5kA and 50x6 sq.mm. for a short circuit withstand capacity above 31.5kA shall be provided in the panel with provision for connection to owner's plant earth grid. All the non-metallic components/parts shall be connected to the main earth bus bar. Separate earth bus bar and stud for electronic control system if required shall be provided.
- 5.3.10 All panels shall be of same height so as to form a uniform line-up, to give good aesthetic appearance.
- 5.3.11 All the control wiring shall be enclosed in plastic/ metal channel. Each wire shall be identified at both ends by self-sticking wire marker tapes or PVC ferrules. Power and control wiring inside the panel shall be done with BIS approved, PVC insulated, fire retardant, low smoke, copper conductor wire 1.5mm² size wire shall normally be used provided the control fuse rating is 10 Amps or less and 2.5 mm² size for control fuse rating above 16 A for electrical circuits and 0.5mm² for electronic circuits. All wires shall be ferruled and terminals shall be properly numbered, minimum 20% spare terminals shall be provided.
- 5.3.12 All electronic modules and components shall be accessible from front of panel only. Modular assemblies for both the system control electronic equipments and power electronic equipments shall be used.
- 5.3.13 Low voltage compartment and cabling shall be electrically and physically separated from the high voltage compartment.
- 5.3.14 DC link capacitor and pre-charging & discharging circuit shall be preferably mounted in the rear of the panel.
- 5.3.15 Suitable eyebolts/ lifting clamps/ strap & cradle arrangement shall be provided for lifting of the panel/shipping section. The bolts, when removed shall not leave any opening in the panel.
- 5.3.16 Acrylic type transparent insulating material shall be used for covering live components.

5.3.17 Drive keypad, operator control panel required for control, monitoring and measurements shall be supplied and installed outside the panel on the front door. It shall be accessible for operation without opening the front door and shall be non-removable type.

5.3.18 All equipment shall be complete with cable glands, lugs etc. and cable glands shall be single or double compression type for indoor and outdoor equipment respectively. Cable glands shall also be suitable for the hazardous area application if specified in data sheet.

5.4 Cooling

5.4.1 The drive panel shall be naturally cooled or water cooled type as per manufacturer's standards. However, it is preferred to have natural air cooled system. If unavoidable, forced type-cooling system shall be provided. Cooling system shall include well-dimensioned panel, adequate cooling airflow path, modular cooling fan and if necessary, panel cooling fan or water-cooling system shall be considered. Vendor shall ensure that the panel dimensions and flow paths have been designed for continuous running at the specified ambient without overheating. For fan cooled drives, redundant ventilating fans (N+1) shall be provided. In case redundant cooling fan is not possible to be mounted in the panel, same shall be supplied loose.

5.4.2 For water-cooled drives, entire cooling system including but not limited to heat exchanger, flow and pressure meters and pumps shall be in vendor's scope. The system shall be provided with closed circuit water cooling system, requiring only make up water required for topping up. The cooling water pumps, in case provided, shall have 100% redundancy. Water quality/characteristics shall be as defined in the data sheet and selected cooling water system components/material shall be suitable for the same. Adequate safety measures shall be incorporated in water cooled drives such that no leakage is there which results in malfunctioning of electronic devices. Proper segregation between water cooling system and other equipment shall be provided. It is preferred that cooling cabinet panel shall be separated from the main panels.

5.4.3 Necessary starters shall be provided within the VFD panels for the Ventilation fans, Cooling Water circulation pumps, any other auxiliary motor etc. The system provided shall be interfaced with drive starting and shutdown so that safety interlocks such as start permit from cooling system to drive and trip signal from cooling system to drive in case of cooling system failure etc., are incorporated in the overall sequence logic.

5.4.4 MCB for motor space heater, auxiliary power supply if required for local panel, drive panel space heater etc. shall be included and mounted in easy accessible location.

5.5 Equipment/ Component Specification

5.5.1 Motor

The motor shall be designed, constructed and tested in accordance with the latest revision of EIL's Specification /data sheet for High Voltage Induction / Synchronous Motor, in addition to the following requirements:

- The motor shall be suitable for operation with a solid-state power supply consisting of an adjustable frequency inverter for speed control.
- The motor shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive.
- The motor shall be designed to operate continuously at any speed over the range (10-100%) of rated speed unless otherwise specified in data sheet.
- The permitted voltage variation should take into account the steady state voltage drop across the AC drive and all other system components upstream of the motor.

- e. Motors required to be transferred to DOL by-pass mode shall be rated for specified variations in system line voltage and frequency. Starting current of motor in DOL bypass mode shall be limited to value specified in motor specifications, unless otherwise specified in datasheets.
- f. The motor shall be constructed to withstand torque pulsations resulting from harmonics generated by the solid-state power supply.
- g. The motor insulation shall be designed to accept the applied voltage waveform, within the V_{peak} and dv/dt limits as per IEC-61800-4 and necessary co-ordination between the VFD manufacturer & motor manufacturer w.r.t. incorporation of VFD output parameter in the design of motor shall be carried out.
- h. The drive manufacturer shall be solely responsible for proper selection of the motor for the given load application and the output characteristics of the drive.
- i. Motors shall be provided with Resistance Temperature Detectors (RTDs).

5.5.2 Converter Transformer/ Output transformer (if specifically agreed by Purchaser)

- a. The converter transformer shall be dry type or oil filled type as specified in the data sheet. In case of the dry type transformer, it shall be mounted in the drive system panel unless specified otherwise in the datasheet. Offered transformer shall be as per enclosed EIL Specifications/data sheet.
- b. The impedances of converter input transformers with more than one secondary windings for 12/18/24/36 pulse systems shall be selected to ensure equal load/current sharing between the secondary windings, the converters and the motor windings under all operational conditions including starting and restarting.
- c. Drive out put transformer considered only for the purpose of meeting standard rated motor voltage i.e. 3300, 6600V, 11000V shall not be provided unless otherwise agreed between purchaser and the manufacturer.

5.5.3 Power Converter

- a. The static power converter shall consist of a line side power converter for operation as a rectifier and a load side power converter for operation as a fully controlled inverter. Power converter shall be fast switching, most efficient and low loss type.
- b. Adequate short circuit and over voltage protection shall be provided for the converter and inverter system.
- c. All power converter devices shall include protective devices, snubber networks and dv/dt networks as required.
- d. 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 entire speed range.
- e. All power diodes shall be of silicon type with minimum V_{BO} rating as 2.5 times the rated operating voltage.
- f. 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 due to harmonic currents generated by the inverter operation.
- g. 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.
- h. 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.

- i. Offered system shall also take into account the distance between Drive panel and motor and system shall include all material and accessories to make system suitable for a distance of 350m unless otherwise specified in the data sheet.

5.5.4 DC Link Reactor

- a. Smoothing reactors for the DC link shall be designed to sufficiently decouple the rectifier and inverter portion of the converter and to limit fault currents in this circuit.
- b. Unless otherwise specified, the reactor shall be air-cooled or fan cooled type located within the panel.
- c. Reactor shall be suitable for operation with the non-sinusoidal current wave shapes and DC components under all operational conditions of the system without exceeding its temperature limits.

5.5.5 Output Filter

VFD output current waveform should be inherently sinusoidal at all speeds, with harmonic limits as specified in this specification. Output filter shall be provided, if required. Output filter capacitors shall be provided with discharge circuits to ensure that all residual stored charge is reduced to less than 50 V DC within 300 seconds after a loss of AC voltage. All capacitor shall be maintenance-free and self-healing type.

The VFD system shall inherently protect motor from high voltage dv/dt stress, independent of cable length to motor. Output filter shall be an integral part of the VFD system and included within the VFD enclosure.

5.5.6 Bypass Feature

- a. Bypass feature along with motor protection relay and output side isolator/breaker shall be provided by purchaser unless otherwise specified in the datasheet. All necessary interlocks as required for safe and reliable operation of VFD system along with bypass feeder and output side isolator/breaker provided by Purchaser shall be provided in VFD system.
- b. Bypass starter shall be in separate compartment and switching scheme shall be such that in case of drive mal-operation, the motor could be taken on bypass control manually, while the drive could be attended independently. Suitable interlock shall be provided such that bypass mode and VFD mode shall not operate simultaneously.

5.5.7 Local Motor Control Station

- a. The local motor control station, to be installed in the field near the motor shall conform to the attached EIL specifications. Components and accessories that are required in the local motor control station may be mounted on the local field mounted panel envisaged for the driven equipment.
- b. Meters in the local control station shall be suitable for 4-20mA transducer outputs and shall be calibrated for the actual motor current. Further, for drives with bypass facility, the meters shall be capable of reading bypass mode full load and starting currents as well as the VFD mode drive current.

5.6 Protection, Control, Metering, Indication and Annunciation

- 5.6.1 The system vendor shall provide all the necessary system control, protection, alarm and metering equipment for the entire drive system and its auxiliary equipment.
- 5.6.2 Automatic sequence control shall include start-up of cooling system, auxiliary system of the motor, interlock checking, automatic start and run-up of drive, planned and emergency shutdown. The same shall be processed through microprocessor-based system.

5.6.3 Operator Control Panel

- a. Each drive shall be equipped with a front mounted operator control console consisting of a backlit alphanumeric display and a keypad with keys for parameterization and adjusting parameter which shall not be limited to Start/Stop, Local/Remote, Auto/Manual, Increase/Decrease, menu navigation and protection and measurement parameter selection, etc.
- b. All parameter names, fault messages, warnings and other information shall be displayed in complete English words or standard English abbreviations to allow the user to understand the display without the use of a manual or cross-reference table. This shall also be used for the modification of all electrical values, configuration parameters, drive menu parameters, application and activity function access, faults, local control, adjustment storage, self test and diagnostics. Keypad shall be operable with password for changing the protection setting, safety interlock etc. However, the parameters such as measurements, setting, mode of drive etc. shall be allowed to be viewed without any password.
- c. Operator console shall have facility/ port to connect external hardware such as Laptop etc. Console shall have facility to upload and download all parameter settings from one drive to another identical drive for start-up and operation.
- d. Drive system control shall also have facility to receive tripping signal from upstream breaker for tripping and also provision for closing upstream breaker after all required process parameters are achieved.
- e. User-friendly software for operation and fault diagnostic shall be loaded in the drive system panel before commissioning.

5.6.4 Protective Features

The system shall incorporate adequate protective features, properly coordinated for the drive control and for the motor but not limited to the following:

- i. Incoming line surge protection
- ii. Under / Over voltage protection
- iii. Phase loss protection.
- iv. Programmable over current protection and under load protection.
- v. Inverter Fault.
- vi. Over frequency/Over speed of motor
- vii. Ventilation loss (In case same is not provided, drive shall generate an over temperature fault alarm and suitable sensors, as required for same, shall be provided).
- viii. Over temperature of equipment.
- ix. Specific motor protection, including motor winding, bearing temperatures, over-current, overload, negative phase sequence and earth fault protections etc.
- x. System earth fault protection.
- xi. Excitation system protection for synchronous motor
- xii. Over and under frequency, rotor earth fault (if applicable), field failure protection for synchronous motor
- xiii. Additional protection, if any for the drive system

5.6.5 Control

The following controls shall be provided as a part of the Operator Control Panel or through separate switches.

- i. Start/Stop
- ii. Speed control (Raise/Lower)
- iii. Forward/Reverse (if specified)
- iv. Auto/Manual /Test mode
- v. Local/Remote
- vi. Emergency stop
- vii. Start/Stop for bypass starter (where specified)
- viii. Trip-Remote Breaker
- ix. Excitation control system for synchronous motors
- x. Sequential switching of filters

5.6.6 Indications

Vendor shall provide indications as required for normal operation and for ease of maintenance, which shall not be limited to the following indications.

- i. Motor running
- ii. Motor stopped
- iii. VFD System Fault
- iv. System ready to start
- v. AC mains ON
- vi. Motor over speed
- vii. Rectifier output 'ON'
- viii. Motor zero speed
- ix. Remote breaker trip
- x. Excitation system healthy for synchronous motors

Above indications may be provided as a part of the operator control panel, i.e. door mounted keypad or through hardwired LEDs. LEDs provided for indication shall be cluster type with adequate brightness and minimum 2 Nos LEDs chips per light. LEDs shall be connected in parallel and each LED chip having diameter not less than 3mm.

Potential free contacts for items i to iv shall be wired separately for remote indications in DCS system.

5.6.7 Metering

Digital display of the following parameters shall be as a part of the Operator Control Panel, selectable by the operator.

- i. Output voltage
- ii. Output current-VFD mode/ Bypass mode
- iii. Output frequency
- iv. Drive thermal state
- v. Motor speed

- vi. Motor energy meter
- vii. Hour Run
- viii. Voltage and current meter for excitation system of synchronous motor
- ix. KVAR, power factor meter for synchronous motors
- x. Necessary transducer shall be provided with 4-20mA output for indicating motor speed and motor current in DCS unless otherwise specified for other parameters.

5.6.8 Audio-visual Annunciations

- a. The system shall incorporate audio-visual annunciations for protection, for various fault conditions, for the Drive motor, Supply cables, DC Reactor and the Converter, out put transformer etc.
- b. Alarms shall also be included for the failure of various auxiliaries together with identification of the failing unit, loss of cooling system, various protection devices provided for converter transformer etc.
- c. Audio-visual window annunciations shall be provided on the front of the panel. All annunciations as required for normal and satisfactorily operation of the drive system shall be included as per vendor standards. These annunciations can be part of operator console panel or separately mounted type.
- d. Vendor shall include audio-visual alarm as required for normal operation and maintenance of the system but not be limited to the following.
 - i. Rectifier fuse failure/Drive fault
 - ii. Main AC failure
 - iii. Inverter fuse failure/Drive fault
 - iv. Inverter overload
 - v. Inverter high temperature/Drive fault
 - vi. Cooling system failure
 - vii. Motor failed to start/Drive fault
 - viii. Transformer failure
 - ix. Excitation system failure for synchronous motor
 - x. Battery monitoring healthiness
 - xi. Communication and measurement system unhealthy
 - xii. Motor temperature high
 - xiii. Harmonic filters monitoring

All drive internal faults will be annunciated as drive fault.

Common potential free contacts shall be provided for above annunciations and these shall be wired up to terminal block for owner's use for remote alarm and monitoring.

5.7 Fault Diagnostic

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, shutdown of the system, shall be available for a period of minimum 4 days (96 hours) after a shutdown, even though no supply would be available to the system. The system may be totally de-energized for maintenance or otherwise. It shall be possible to retrieve the record of events prior to tripping of the system or de-energisation. Auxiliary supply to the system components or to the electronics (firmware) for the diagnostics / display shall be taken care by the manufacturer for this purpose.

5.8 External Power supply for auxiliary and Control Circuit

Auxiliary power supply for devices external to VFD module, space heater supply for Motor, VFD panel space heater, auxiliary power supply for transformers, cubicle 11W CFL lamps, indicating lamps, digital meters (Ammeter, Speedometer) etc. shall operate on 240 volts single phase AC supply provided by purchaser.

All control circuit shall operate at maximum voltage of 240V AC or 220V DC unless otherwise specified in the datasheet.

Vendor shall include supply of all control transformers, protective devices, associated accessories etc. and any other control supply voltage required for the system shall be derived by the vendor from the power supply made available by purchaser.

5.9 Reliability Features

The expected lifetime of the drive system shall be min. 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.

5.10 Maintenance features

The controller design shall incorporate the following maintenance features:

- Modular construction
- All components shall be easily accessible.
- Standard diagnostics to aid maintenance personnel. These shall include LED or alphanumeric displays, test or measurement points.

5.11 Painting

5.11.1 After preparation of the under surface, the panel shall be spray painted with two coats of epoxy based final paint or shall be powder coated. The colour shade of final paint shall be as RAL 7032, unless specified otherwise. Panel finish shall be free from imperfections like pinholes, orange peels, runoff paint, etc.

5.11.2 All unpainted steel parts shall be zinc passivated, cadmium plated or suitably treated to prevent rust and corrosion. If these parts are moving elements, then these shall be greased.

6.0 INSPECTION, TESTING AND ACCEPTANCE

6.1 During fabrication, the drive shall be subject to inspection by EIL / Owner, or by an agency authorized by the Owner, to assess the progress of work, as well as to ascertain that only quality raw material is used. The manufacturer shall furnish all necessary information concerning the supply to EIL / Owner's inspectors.

6.2 All tests shall be carried out at the manufacturer's works under his care and expense. The tests shall be witnessed by an inspector of EIL/ Owner or of an agency authorized by the owner. Prior notice of minimum 4 weeks shall be given to the inspector for witnessing the tests.

6.3 All Routine & Type Tests shall be conducted as per the ITP for HV variable frequency drive 6-81-1050 as per IEC 61800-2. However, combined test for VFD and motor at vendor's works shall be carried out if specified in the datasheet.

6.4 Additional tests on switchgears and transformers shall be carried out based on the requirement defined in the EIL's specification of respective equipment.

6.5 String Test with driven equipment

If a string test with driven equipment is specified in the data sheet of the driven equipment, it shall be carried out with the job equipment.

7.0 CERTIFICATION

The motors and associated Variable frequency drive system equipment shall have test certificates issued by recognized independent test house (CIMFR/ BASEEFA/ LCIE/UL/FM or equivalent). All indigenous motors shall conform to Indian Standards and shall be certified by Indian testing agencies. All motors (indigenous and imported) shall also have valid statutory approvals as applicable for the specified hazardous location. All indigenous flameproof motors shall have valid BIS license and marking as required by statutory authorities.

Also the motor nameplate shall clearly indicate that the motor is suitable for operation with variable frequency drive along with VFD make and model number.

8.0 PACKING AND DESPATCH

All the equipment shall be divided in to several shipping sections for protection and ease of handling during transportation. The equipment shall be properly packed for selected mode of transportation i.e. ship/rail or trailer. The equipment shall be wrapped in polyethylene sheets before being placed in wooden crates/cases to prevent damage to the finish. Crates/cases shall have skid bottoms for handling. Special notations such as 'Fragile', 'This side up', 'Weight', 'Owner's particulars', 'PO nos.' etc., shall be clearly marked on the package together with other details as per purchaser for scrutiny.

The equipment may be stored outdoors for long periods before installation. The packing shall be completely suitable for outdoor storage, in areas with heavy rains/high ambient temperature.

शुष्क किस्म के डिस्ट्रीब्यूशन ट्रांसफॉर्मर के लिए निरीक्षण एवं परीक्षण योजना

INSPECTION AND TEST PLAN FOR DRY TYPE DISTRIBUTION TRANSFORMER

2	30.01.2014	Revised and Re-issued	MJ	RS	SCG	SC
1	29.06.2012	Revised and Re-issued	RKP	HVJ	AKC	DM
0	08.12.2008	Issued for implementation	RB	SKD	SKP	VC
Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

INSPECTION AND TEST PLAN FOR DRY TYPE DISTRIBUTION TRANSFORMER

Abbreviations

AS	:	Alloy Steel	MPT/MT	:	Magnetic Particle Testing
BASEEFA	:	British Approval Service for Electrical Equipment in Flammable Atmospheres	MRT	:	Mechanical Run Test
BIS	:	Bureau of Indian Standards	MTC	:	Material Test Certificate
CCE or CCOE	:	Chief Controller of Explosives	MOC	:	Material of Construction
CEIL	:	Certification Engineers International Limited	NPSH	:	Net Positive Suction Head
CIMFR	:	Central Institute of Mining & Fuel Research	NDT	:	Non Destructive Testing
CE	:	Carbon Equivalent	NEMA	:	National Electrical Manufacturers Association
DFT	:	Dry Film Thickness	PO	:	Purchase Order
DT	:	Destructive Testing	PESO	:	Petroleum Explosive Safety Organization
DPT	:	Dye Penetrate Testing	PQR	:	Procedure Qualification Record
ERTL	:	Electronics Regional Test Laboratory	PR	:	Purchase Requisition
FCRI	:	Fluid Control Research Institute	PMI	:	Positive Material Identification
FM	:	Factory Mutual	PVC	:	Poly Vinyl Chloride
FLP	:	Flame Proof	QC	:	Quality Control
HIC	:	Hydrogen Induced Cracking	RT	:	Radiography Testing
ITP	:	Inspection and Test Plan	TC	:	Test Certificate
IP	:	Ingress Protection	TPI or TPIA	:	Third Party Inspection Agency
IC	:	Inspection Certification	UT	:	Ultrasonic Testing
IGC	:	Inter Granular Corrosion	UL	:	Under writer Laboratories
IEC	:	International Electro technical Commission	VDR	:	Vendor Data Requirement
JEC	:	Japanese Electro technical Committee	WPS	:	Welding Procedure Specification
LPT	:	Liquid Penetrate Testing	WPQ	:	Welders Performance Qualification
			XLPE	:	Cross Linked Poly Ethylene

Inspection Standards Committee

Convenor : Mr. S C Gupta

Members:

Mr. R.K. Singh	Mr. Rajeev Kumar	Mr. Himangshu Pal
Mr. Neeraj Mathur	Mr. T Kamalakannan	Mr. Deepak Gupta (Project)
Mr. Mayank Jain		

INSPECTION AND TEST PLAN FOR DRY TYPE DISTRIBUTION TRANSFORMER

1.0 SCOPE

This Inspection and Test Plan covers the minimum testing & inspection requirements of Dry Type Distribution Transformer.

2.0 REFERENCE DOCUMENTS

PO/PR & Standards referred there in /Job specifications / Approved documents.

3.0 INSPECTION AND TEST REQUIREMENTS

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
1.0	Procedures	--	--	--	--	--	--
2.0	Material Inspection						
2.1	Incoming Raw Material like Marshalling box, cables, fasteners and bolts, copper flexible, insulators, gauges, CTs, OLTC(if Applicable) etc	- Material Identification - Operational checks - Physical and Dimensional tests (as applicable)	100%	Sub-Supplier's TC / Supplier Test Records/ Third party lab	H	H	R (For major items only)
3.0	Inprocess Inspection						
3.1	Transformer assembly	Visual, Dimensions, Bill of materials.	100%	Supplier's Test Records	-	H	-

**INSPECTION AND TEST PLAN
FOR
DRY TYPE DISTRIBUTION TRANSFORMER**

STANDARD SPECIFICATION NO.

6-81-1044 Rev. 2

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
4.0	Final Inspection						
4.1	Transformer (Routine Tests)	- Physical and Dimensional check. - Verification of Bill of Material. - Measurement of winding resistance - Measurement of voltage ratio and check of voltage vector relationship - Measurement of impedance voltage, short-circuit impedance and load loss. - Measurement of no-load loss and current - Induced over voltage withstand test - Separate –source voltage withstand test (HV Test) - Measurement of Insulation Resistance before and after HV test. - Noise level check. - Tests on OLTC(if applicable).	100%	Inspection test records	-	H	H
4.2	Transformer (Special Tests)	Temperature Rise Test	1 No. of Sample/Rating	Inspection test records	-	H	H
4.3	Transformer (Type Tests)	- Impulse withstand test. - Short circuit test. - Partial Discharge test - Degree of Protection of Enclosure.	1 No. of Sample/Rating	Inspection test records	-	H	R
5.0	Painting						
5.1	Painting of Transformers	Pre treatment, primer and final paint, shade, thickness	100%	Test records	-	H	--

**INSPECTION AND TEST PLAN
FOR
DRY TYPE DISTRIBUTION TRANSFORMER**

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
6.0	Documentation and IC						
6.1	Documentation and IC	- Review of Internal Test Reports. - IC issuance	100%	Supplier's Test Records / Inspection Certificate (IC)	-	H	H
6.2	Final Document submission	Compilation of Inspection reports ,drawings, etc as per VDR / PR	100%	Final data folder /Completeness certificate	-	H	H

Legends: H- Hold (Do not proceed without approval, R-Review, RW-Random witness (As specified or 10 % - Samples must include min 1 No of each type), W- Witness (Give due notice, work may proceed after scheduled date).

NOTES :-

- This document describes the generic test requirements. Any additional test or inspection scope if specified in contract documents shall also be applicable. (Unless otherwise agreed upon).
- Acceptance Norms for all the activities shall be as per PO/PR/ Standards referred there in/ Job specifications /Approved documents

INSPECTION AND TEST PLAN
FOR
HV VARIABLE FREQUENCY DRIVE SYSTEM

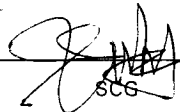
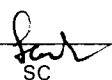
STANDARD SPECIFICATION NO.

6-81- 1050 Rev.2

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उच्च वोल्टेज वैरीएबल फ्रीक्वेन्सी ड्राइव सिस्टम
के लिए निरीक्षण एवं परीक्षण योजना

INSPECTION AND TEST PLAN
FOR
HV VARIABLE FREQUENCY DRIVE SYSTEM

2	30.01.2014	Revised and Reissued	 MJ	RS	 SCG	 SC
1	29.06.2012	Revised and Reissued	AB	RJD	AKC	DM
0	08.12.2008	Issued for implementation	RB	SKD	SKP	VC

Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
						Approved by

INSPECTION AND TEST PLAN **FOR** **HV VARIABLE FREQUENCY DRIVE SYSTEM**

STANDARD SPECIFICATION NO.

6-81-1050 Rev. 2

Page 2 of 6

Abbreviations

AS	:	Alloy Steel	MPT/MT	:	Magnetic Particle Testing
BASEEFA	:	British Approval Service for Electrical Equipment in Flammable Atmospheres	MRT	:	Mechanical Run Test
BIS	:	Bureau of Indian Standard	MTC	:	Material Test Certificate
CCE or CCOE	:	Chief Controller of Explosives	MOC	:	Material of Construction
CEIL	:	Certification Engineers International Limited	NPSH	:	Net Positive Suction Head
CIMFR	:	Central Institute of Mining & Fuel Research	NDT	:	Non Destructive Testing
CE	:	Carbon Equivalent	NEMA	:	National Electrical Manufacturers Association
DFT	:	Dry Film Thickness	PD	:	Partial Discharge
DT	:	Destructive Testing	PO	:	Purchase Order
DPT	:	Dye Penetrate Testing	PESO	:	Petroleum Explosive Safety Organization
ERTL	:	Electronics Regional Test Laboratory	PQR	:	Procedure Qualification Record
FCRI	:	Fluid Control Research Institute	PR	:	Purchase Requisition
FM	:	Factory Mutual	PMI	:	Positive Material Identification
FLP	:	Flame Proof	PVC	:	Poly Vinyl Chloride
HT	:	Heat Treatment	QC	:	Quality Control
HIC	:	Hydrogen Induced Cracking	TC	:	Test Certificate
ITP	:	Inspection and Test Plan	TPI or TPIA	:	Third Party Inspection Agency
IP	:	Ingress Protection	UT	:	Ultrasonic Testing
IC	:	Inspection Certification	UL	:	Under writer Laboratories
IGC	:	Inter Granular Corrosion	VDR	:	Vendor Data Requirement
IEC	:	International Electro technical Commission	WPS	:	Welding Procedure Specification
JEC	:	Japanese Electro technical Committee	WPQ	:	Welders Performance Qualification
LPT	:	Liquid Penetrate Testing	XLPE	:	Cross Linked Poly Ethylene

Inspection Standards Committee

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Mr. Mayank Jain		

INSPECTION AND TEST PLAN FOR HV VARIABLE FREQUENCY DRIVE SYSTEM

STANDARD SPECIFICATION NO.

6-81-1050 Rev. 2

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1.0 SCOPE

This Inspection and Test Plan covers the minimum testing requirements of HV Variable Frequency Drive System (VFD).

2.0 REFERENCE DOCUMENTS

PO/PR/ Standards referred there in/Job specifications/Approved documents.

3.0 INSPECTION AND TEST REQUIREMENTS

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
1.0	Procedures	--	--	--	--	--	--
2.0	Material Inspection						
2.1	Incoming Material like fabricated panels, Power semiconductors, IGBT/SCRs, relays, meters, CT/PT, transducers transformer unit, rectifier unit, filter etc.	- Material Identification - Operational checks	100%	Material Test Certificates / Test Lab Certificates	H	H	R
3.0	In process Inspection						
3.1	VFD Assembly	Visual ,Dimensional, Bill of Materials	100%	Supplier's records	-	H	R
4.0	Final Inspection						

INSPECTION AND TEST PLAN **FOR** **HV VARIABLE FREQUENCY DRIVE SYSTEM**

STANDARD SPECIFICATION NO.

6-81-1050 Rev. 2

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
4.1	Final Inspection ** (Acceptance tests)	• Visual and Dimensional • Check calibration status of all testing equipment. • Bill of Material. • Simulation check of control signals • Check of Speed/rpm at different frequency at constant Torque/ Voltage/ Power Mode, as applicable • Memory function check of fault diagnostics • Insulation Test • Light Load and Functional test • Load characteristics • Load duty test • Check Auxiliary Devices • Check the properties of the control equipment • Check the Protective Devices • Check control and functional requirements • High voltage test • Leakage and pressure test for cooling system where provided • Automatic restart/re-acceleration. • Noise Level Measurement	100%	Supplier's Records	-	H	H
4.2	Final Inspection (Type Tests)	• Load current versus speed at different frequency at constant torque/ Voltage/Power Mode as applicable. • Efficiency • Temperature rise • Voltage division	One sample from each type/rating	Supplier's records	-	H	H

INSPECTION AND TEST PLAN **FOR** **HV VARIABLE FREQUENCY DRIVE SYSTEM**

STANDARD SPECIFICATION NO.

6-81-1050 Rev. 2

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
		- Line side current distortion content - Power factor - Dynamic performance test - Current limit and current loop test - Speed loop test capability to ride through voltage dips upto 20 % - Test capability to restart the system and resynchronize converter onto running motor after a voltage interruption. - Noise Level Measurement. - Harmonic measurement at output of VFD for Volatge and Current Integral Test is to be carried out along with job motor, as per PR/ EIL Standard Specification.					
4.3	Submission of certificates /documents	- Degree of protection certificate as per latest IS/IEC. - Type test certificates from recognized independent test house such as ERTL, CIMFR,BASEEFA,FM/UL, PTB, ATEX etc for rated current test, power loss determination, temperature rise, EM Immunity and EM Emission	Sample/Prototype	Statutory Approval Certificates / Type Test Certificates	-	H	R
5.0	Painting						
5.1	Painting and Packing	- Visual - Protection against damage during transportation.	100%	Packing list / Supplier's Records	-	H	-

INSPECTION AND TEST PLAN FOR HV VARIABLE FREQUENCY DRIVE SYSTEM

STANDARD SPECIFICATION NO.

6-81-1050 Rev. 2

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SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
6.0	Documentation and IC						
6.1	Documentation and IC	- Review of Internal Test Reports and MTCs. - IC issuance	100%	Supplier's Test Records / Inspection Certificate (IC)	-	H	H
6.2	Final Document submission	Compilation of Inspection reports ,drawings, etc as per VDR / PR	100%	Final data folder /Completeness certificate	-	H	H

** All the load tests/ Functional Checks are to be carried out either with the job motor or with Shop Motor

Legends: H- Hold (Do not proceed without approval, R-Review, RW-Random witness (As specified or 10 % - Samples must include min 1 No of each type), W- Witness (Give due notice, work may proceed after scheduled date).

NOTES :-

- This document describes the generic test requirements. Any additional test or inspection scope if specified in contract documents shall also be applicable. (Unless otherwise agreed upon).
- Acceptance Norms for all the activities shall be as per PO/PR/ Standards referred there in/ Job specifications /Approved documents

JOB SPECIFICATION (ELECTRICAL) FOR CENTRIFUGAL GAS COMPRESSOR (MR No. – B034-0MR-KA-MR-5210)

PROJECT : PROPYLENE DERIVATIVES PETROCHEMICAL PROJECT

OWNER : M/s BPCL-KR

JOB NO. : B034

B	28.07.2017	REVISED & REISSUED WITH MR	NV	DA	HK
A	25.05.2017	ISSUED WITH MR	NV	HK	HK
Rev. No	Date	Purpose	Prepared by	Checked by	Approved by

1. GENERAL

- 1.1 The specification defines the basic requirements of the electrical works in vendor's scope for the Centrifugal Gas Compressors for MS-Block project, Kochi of M/s BPCL-KR. This job specification shall be read in conjunction with EIL standard specifications, data sheets and documents attached with the Material Requisition. In case of any conflict amongst various documents enclosed or referred with MR, the most stringent requirement shall govern and Owner/EIL decision in this regard shall be final.
- 1.2 The equipment shall conform to this specification, enclosed data sheets and standard specifications.

2. SCOPE

For vendor's scope of work and supply refer elsewhere in the MR.

3. EXCLUSIONS

For list of exclusion refer elsewhere in the MR.

4. UTILIZATION VOLTAGE

Utilization voltage for VFD fed motor, auxiliary motors & heaters, anti-condensation heaters based on their ratings shall be as listed below:

- | | | |
|--|---|--------------------------|
| a.) VFD fed motors rated above 700kW | : | 3 phase, 6.6kV $\pm$ 10% |
| b.) Motors rated upto 160kW (Aux. of Compressor) | : | 3 phase, 415V $\pm$ 10% |
| c.) Electric heater (Aux. of Compressor) | : | 3 phase, 415V $\pm$ 10% |
| d.) Anti-condensation heaters | : | 1 phase, 240V $\pm$ 10% |
| e.) Control supply for VFD | : | 110V DC $\pm$ 10% |

5. SPECIAL REQUIREMENTS

- 5.1 Motors shall fulfill the following requirements:-
- VFD fed HV motors (>1100V) shall conform to EIL Specification 6-51-0031 and 6-51-0050 and motor data sheet no. B034-000-16-50-DS-0452.
 - MV motors (415 V) shall conform to EIL Specification 6-51-0064 and motor data sheet no. B034-000-16-50-DS-0501.
- 5.2 In addition to above, VFD fed HV motors shall conform to requirements specified in EIL specification 6-51-0050, IEC-TS-60034-25. It is the responsibility of the main package vendor to coordinate with VFD & motors manufactures for ensuring suitability of VFD/ motors meeting MR requirements.
- Induced voltage at the shaft end of the motor at no load shall not exceed 250 mV rms for roller and ball bearings and 400 mV for sleeve bearings. The non driving end bearing shall be insulated from the motor frame to avoid circulating current. The insulated bearing end shield or pedestal shall bear a prominent warning.
 - A joint declaration shall be provided by main Compressor vendor, VFD vendor and motor vendor post order confirming that VFDs and associated motors compatibility have been ensured & motor is suitable for inverter duty application. dv/ dt value of VFDs along with dv/dt withstand capacity of motors shall be also mentioned in the declaration.
- 5.3 The enclosure type / area classification requirement for motors and their auxiliaries, Electric Heaters, Trolley mounted motors/ starters, LCS/ LCP etc shall be as listed below:

S. No.	Tag No./ Description	Enclosure Type	Area Classification
Recycle Compressor package (MR-C-01)			
1.	6.6 kV Compressor motors for MR-C-01	Ex-p	Zone-2, IIC, Temp. Class T3
2.	Auxiliaries motors for MR-C-01	Ex-d	Zone-2, IIC, Temp. Class T3
3.	Trolley mounted motors, Starters	Ex-d	Zone-2, IIC, Temp. Class T3
4.	Local Control Station (LCS)/	Ex-d	Zone-2, IIC, Temp. Class T3

S. No.	Tag No./ Description	Enclosure Type	Area Classification
	Local Control Panel (LCP)		
5.	Electric Heater	Ex-d	Zone-2, IIC, Temp. Class T3
	Net Gas Compressor package (MR-C-02)		
6.	6.6 kV Compressor motors for MR-C-02	Ex-p	Zone-2, IIC, Temp. Class T3
7.	Auxiliaries motors for MR-C-02	Ex-d	Zone-2, IIC, Temp. Class T3
8.	Trolley mounted motors, Starters	Ex-d	Zone-2, IIC, Temp. Class T3
9.	Local Control Station (LCS)/ Local Control Panel (LCP)	Ex-d	Zone-2, IIC, Temp. Class T3
10.	Electric Heater	Ex-d	Zone-2, IIC, Temp. Class T3

5.4 HV Motors shall have minimum enclosure protection Ex-p and meet the requirements of IS/IEC 60079-2 & 60079-0. MV Motors shall have enclosure protection Ex-d and meet the requirements of IS/IEC 60079-1 & 60079-0. Ex-de MV motors are also acceptable having flameproof enclosure (Ex-d concept) with increased safety terminal box (Ex-e concept).

5.5 All motors shall be provided with fabricated GI canopy.

5.6 Exact cable sizes of power and control cables shall be finalised during detailed engineering. Provisions, as required in Vendor's equipment for termination of the same, shall be made accordingly without any cost & time implications to Owner. Cable sizes indicated under clause 6.2.5 of specification 6-51-0064 is only for guidance/estimation purpose.

5.7 Trolley mounted pumps shall be powered from a nearby 5 pin plug socket supplied by Owner. Vendor to provide trolley mounted flameproof motor starters suitable for use in Zone-2, Gas Group IIC, Temp. Class T3, with 20 meters of armoured copper conductor trailing cable.

5.8 The trolley mounted pumps shall be complete with integral starters, connection between motor & starter through armoured copper conductor cable and shall have motor protections, other hardware & basic control / indications as shown in the data sheet B034-000-16-50-DS-0205.

5.9 The control supply for the equipment mounted on the trolley shall be derived by the vendor from the incoming 3 phase, 4 wire supply.

5.10 Vendor to note that the MV motors (415V and up to 160kW) supplied shall be of Energy efficient (IE2) type as per IS 12615 (2011).

5.11 For Main motor, auxiliary motor and heaters etc. controls shall be provided in the Local Control Panel/ Local Control Station (LCS). Following facilities shall be provided as a minimum on LCP/LCS

- Start/Stop push buttons for motor/ heater.
- Ammeters for driver motor rated above 55kW.
- Selector switches as required.
- Emergency Stop Push button.
- Speed raise Push Button (Applicable for VFD fed motors only)
- Speed Lower Push Button (Applicable for VFD fed motors only)
- ON/OFF/READY/FAULT indication
- RPM Meter (Applicable for VFD fed motors only)

For all other control and indication requirements refer elsewhere in MR. Local control panels/Local control stations shall be provided with canopy. All digital meters shall be highly reliable, accurate, compact and self powered.

5.12 The VFDs supplied with the package shall fulfill the following requirements

- The VFD system having converter input voltage above 1000 & upto 11000V shall conform to EIL specification 6-51-0050 and VFD datasheet no. B034-000-16-50-DS-0561.
- The VFDs for compressor motors shall be rated for the full capacity of the drives being fed from them.
- All control and protections required for vendors supplied system shall be in vendor's scope.

- d.) Input transformer for VFD shall be Oil filled type suitable for outdoor installation in transformer bay alongside the substation and comply with UOP project specification no. 9010436-537 as applicable for VFD however transformer shall be Oil filled type. Accordingly, mention of dry type transformer in UoP specification shall be ignored. The transformers shall be suitable for converter / VFD application and shall comply with EIL specification 6-51-0041.

Motors shall comply to EIL specification 6-51-0031 and codes / standards referred therein. Therefore, reference of UOP standard specification 7-12 (for induction motor) mentioned in Cl. No. 7.0 of UOP project specification no. 9010436-537 for Motor is not applicable. Motor shall be suitable for converter duty (VFD fed) application.

- e.) VFDs shall be installed in Air-Conditioned area but it shall be suitable for operation in non-air-conditioned area also.
- f.) Requirement of dedicated clean earth for VFD system (if any) shall be suitably indicated by the vendor in the offer.
- g.) RS-485 serial port shall be provided for communication to data concentrator/HMI.
- h.) For HV circuit breaker (by owner) feeding the HV VFD, owner shall provide two no's shunt trip coils, operating at different control supplies i.e., 110V DC & 110V AC UPS.
- i.) HV power cable (6.6kV, XLPE insulated, armoured, Overall PVC sheathed FRLS cable), MV power cable (415V, PVC insulated, armoured, Overall PVC and control cables (660V, PVC insulated, armoured, Overall PVC sheathed FRLS cable) shall be provided by owner.
- j.) Combined testing of motors and associated VFDs shall be carried out under stringent operating scenario as per process requirement & temperature rise measured to ensure that the same is within permissible limits. This test may not be required in case same make / type / rating of motor & VFD as a unit has been already tested and copy of test certificate will be furnished for EIL/Owner's reference.
- k.) Any special cable required between VFD and motor including encoder cable shall be in VFD vendor's scope and price of same shall be included in base price. For cable length refer Cl. No. 5.14 below. Only power and control cables shall be supplied by Owner.
- l.) 240V, 1-Phase power supply to the motor space heater shall be derived from VFD. Necessary arrangement for these supplies shall be made available in VFD panels.
- m.) All VFDs shall be provided with 110V DC supply as control supply. Any converter / inverter module required by vendor shall be suitable taken care by vendor in the supplied VFD.
- n.) VFD system electronic cards shall have conformal coating as per IEC-60721-3-3 for Class 3C3.
- o.) VFD operation philosophy: LOCAL/ REMOTE selector switch provided on VFD panel.
- On LOCAL selection on the above switch – STRAT / STOP, SPEED RAISE, SPEED LOWER operations from VFD panel shall be possible (for VFD test purpose only).
 - On REMOTE selection on the above switch – LOCAL / REMOTE selection of LCS shall come into action
 - i. On LOCAL selection on the LCS switch – STRAT / STOP, SPEED RAISE, SPEED LOWER operations from LCS shall be possible.
 - ii. On REMOTE selection on the LCS switch – STRAT / STOP, SPEED RAISE, SPEED LOWER operations from DCS shall be possible

5.13 Vendor to ensure that the offered VFD shall be designed for the maximum frequency bandwidth available with them.

5.14 Maximum lengths for various cables to be considered for design of the VFD for Compressors, as mentioned in the Data sheet no. A307-000-16-50-DS-0561 Rev B shall be as listed below :

- | | | |
|--|---|------|
| a.) Cable length between switchboard and VFD | : | 100m |
| b.) Cable length between VFD and Motor (MR-C-01) | : | 450m |
| c.) Cable length between VFD and Motor (MR-C-02) | : | 450m |

5.15 Power cable specifications shall be 6.6 kV (unearthed), XLPE insulated, PVC outer sheath, armored Al conductor cable complying with the specification 6-51-0051. Vendor to note that there is no PE conductor envisaged between VFD and motor. Else, vendor to confirm same is not required. If the same is required vendor to include the same in his scope of supply.

- 5.16 Exact cable sizes of power and control cables shall be finalized during detailed engineering. Provisions, as required in Vendor's equipment for termination of the same, shall be made accordingly without any cost & time implications to Owner.
- 5.17 Cable glands to be supplied with the motor shall meet all the requirement of IS/IEC-60079-0.
- 5.18 Vendor to note that, if there is any requirement of emergency electrical power for the auxiliary equipments supplied with the main motor/compressor, same shall be highlighted at the bid stage only.
- 5.19 All electrical equipment for use in hazardous areas shall be certified by CIMFR, PTB, Baseefa, UL, FM or equivalent independent testing Agency for the service and the area in which it can be used. All the equipment indigenous and imported shall have a valid statutory approval of CCOE/PESO and copies of the same (CCOE/PESO) shall be furnished during detailed engineering stage which is mandatory as per local rules/regulations.
- 5.20 Type test certificate from the authorized agency of country of origin for all hazardous area electrical equipment/items shall be provided by vendor.
- 5.21 Cable glands to be supplied with the motor shall meet all the requirement of IS/IEC-60079-0. For outdoor equipment, double compression type Nickel plated brass Flameproof & Weatherproof cable glands shall be supplied. Thread shall be ET type.
- 5.22 All motors shall be supplied with cable entries duly sealed by weatherproof (IP-55) metallic sealing plugs in the respective terminal boxes i.e. main terminal box, space heater terminal box, any other terminal box, as required to render it weatherproof during transit and storage at site till installation and cable termination. However, same shall be replaced by associated flameproof cable glands and lugs to be also supplied by vendor along with motors as specified in MR.
- 5.23 All lugs to be supplied shall be heavy duty, long barrel, crimping type and made of tinned copper. Sector shaped/circular barrel lugs shall be provided for making connections for cables having sector shaped/circular geometry of conductors respectively.
- 5.24 Vendor to note that feeders for MV motors shall be of 415V, 3-phase, 3 wire type and for the trolley mounted motors (if applicable), it shall be of 415V, 3 phase, 4 wire type.
- 5.25 Packaging of electrical equipment shall also include plastic wrapping for transportation from works to site.

6. SPARES

For requirements of commissioning spares, mandatory spares, special tools& tackles and two year recommended spares for all electrical equipments, refer elsewhere in the MR.

7. MAKES OF EQUIPMENT AND COMPONENTS

- 7.1 List of approved vendors for Electrical equipment/components is as mentioned elsewhere in the Master Vendor List, attached in the MR.
- 7.2 In case of imported equipment, the contractor shall furnish the reference list of customers and shall ensure that type test certificates for similar type of equipment are available, which is essential for technical acceptability. Additional makes of imported items shall be subject to Owner/EIL's approval during detailed engineering.
- 7.3 Vendor may procure material from any of the listed vendors. However current validity and range of approval as per EIL enlistment letter, workload, stability and solvency need to be verified by the vendor before placement of order.
- 7.4 For HV Hazardous area motors (Ex 'p'), in the absence of approved Vendor list, Vendor shall select suitable motor vendor meeting the following requirements:-
- a.) The vendor must be a regular manufacturer and supplier of HV hazardous area motors.
 - b.) The vendor must have designed, engineered, manufactured, tested and supplied at least one similar motors in terms of type of motor, voltage, kW rating etc. to any continuous process industry, as being offered for this project.
 - c.) The offered motors shall be manufactured and tested at the same works as for the reference equipment. In case bidder offers equipment from different unit / works, then certification from TPI (Third Party Inspection) agency shall be required certifying that the

necessary facilities, infrastructure, manpower, machinery etc. are equivalent or better than unit / works for which PTR (Proven Track Record) is given.

- d.) The system must have been in operation for a period of one year as on the date of bid opening.
- e.) Vendor shall furnish the duly filled-in "Experience Record Format" (Doc NO. B034-000-16-50-DS-1008) post order to prove that the offered motors meet the above requirements.

7.5 Variation / Clarifications against the standard specification of HV Motor 6-51-0031, MV Motor 6-51-0064, shall be as per the MOU agreed with EIL by respective motor manufacturer. No further deviations shall be entertained.

8. Equipment earthing schedule as given below,

Sl. No.	Type of Equipment	Earth conductor size
1.	Motors upto 3.7 kW	10 mm ²
2.	Welding receptacles	25 mm ²
3.	Motors from 5.5 kW to 30 kW	25 mm ²
4.	Motors from 30 kW to 110 kW	120 mm ²
5.	Motors above 110 kW and HT motors	185 mm ²
6.	Building columns	185 mm ²
7.	Storage tank (Vertical and Horizontal)	185 mm ²
8.	Loading racks	185 mm ²
9.	Pipe racks, vessels and heat exchangers	25 mm ²
10.	Small equipment, panels and instruments	10 mm ²
11.	Lighting, power and instrument panels	25 mm ²
12.	Main earth bus	75x10 mm GI in substation area 50x6 mm GI strip in units, offsite areas and in earth grid for high mast / street lighting, wherever required
13.	Transformers and switchgears	300 mm ²
14.	Receptacles & pushbuttons	10 mm ²
15.	Street light poles	25 mm ²
16.	Bonding of piping system	25 mm ² flexible Cu cable
17.	Lighting transformer	120 mm ²

NOTES:

- a. Earth connections to individual equipment from nearest earth plate / grid shall be done using single core, Aluminium conductor, PVC insulated cable (Green colour) as specified above. Connections shall be made using crimp type tinned copper lugs.
- b. Green color sleeving (about 50 mm length) shall be also provided at both ends to denote earthing.

9. **ATTACHMENTS:**

Sr. No.	Title	Document No.	Rev.
1.	Data Sheet – HV switchboard transformer feeder for VFD	B034-000-16-50-DS-0042	A
2.	Data Sheet – Contactor feeder for trolley mounted motor	B034-000-16-50-DS-0205	A
3.	Data Sheet – HV Induction Motor-VFD	B034-000-16-50-DS-0452	A
4.	Data Sheet – Scheme For Induction Motor With VFD	B034-000-16-50-DS-0456	A
5.	Data Sheet – MV Motors	B034-000-16-50-DS-0501	A

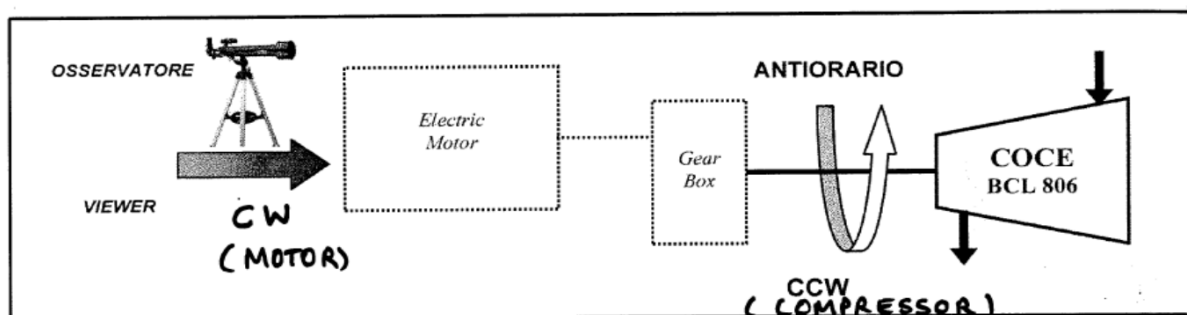
Sr. No.	Title	Document No.	Rev.
6.	Data Sheet – HV Variable Frequency Drive	B034-000-16-50-DS-0561	B
7.	Datasheet Oil filled Transformer for VFD	B034-000-16-50-DS-566	B
8.	Data Sheet – Load Data Format	B034-000-16-50-DS-1002	A
9.	Data Sheet – Experience Record	B034-000-16-50-DS-1009	A
10.	Vendor Data Requirement	B034-0MR-16-50-VR-5210	A
11.	Specification for Flameproof Control stations	6-51-0006	5
12.	Specification for HV Induction Motors	6-51-0031	5
13.	Specification for Energy efficient MV Induction Motors	6-51-0064	1
14.	Specification for High Voltage Variable Frequency Drive System	6-51-0050	2
15.	Specification for medium and high voltage cables & accessories	6-51-0051	8
16.	Specification for field inspection, testing and commissioning of electrical installations	6-51-0087	3
17.	Specification for oil filled transformers	6-51-0041	5
18.	Inspection & Test Plan for Flameproof Control stations	6-81-1006	3
19.	Inspection & Test Plan for HV Induction Motors	6-81-1031	3
20.	Inspection & Test Plan for MV Motors	6-81-1032	5
21.	Inspection & Test Plan for HV Variable Frequency Drive System	6-81-1050	2
22.	Inspection and test plan for medium and high voltage cables and accessories	6-81-1051	3
23.	Inspection & test plan for oil filled transformers	6-81-1041	3
24.	Variable Frequency Drive Requirements For Centrifugal Compressor Drivers	9010436-537	0

PROJECT : BPCL KOCHI CCR
SERVICE : RGC
CUSTOMER : M/S BPCL
CONSULTANT : M/S EIL
No. OF UNITS : 1

The motor is provided with VFD in order to realize different operating conditions as specified by the customer. Refer to enclosed inputs for BHGE. (SOS111111) (2 sheets)

ARRANGEMENT OF MACHINES

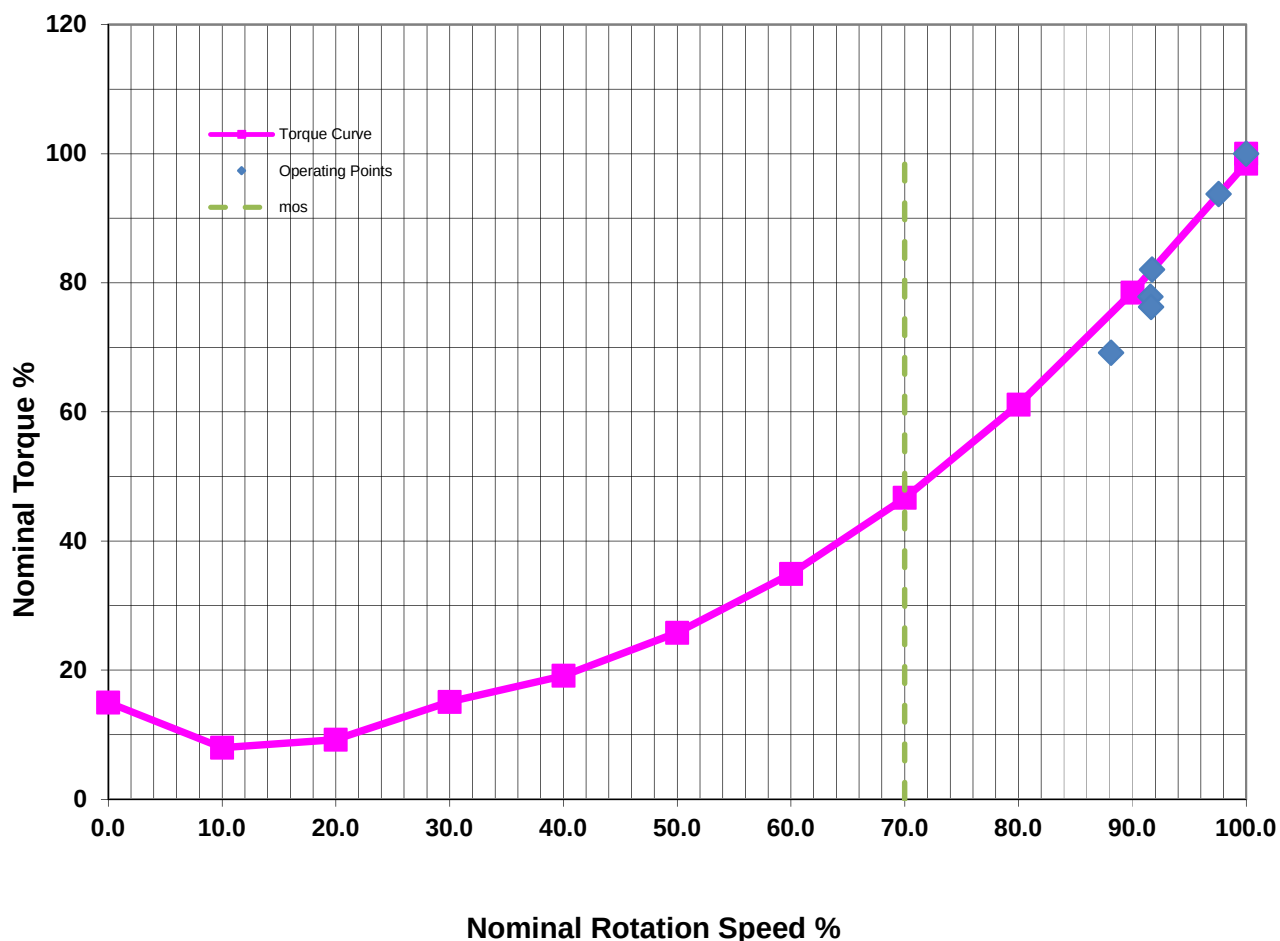
M/S BPCL KOCHI - CCR (DRIVE MOTOR)



Please refer Purchase specification for all other technical details to finalize the motor design

STEAM TURBINES AND COMPRESSORS				Date	Dept. code
				08-05-2018	420
Format No.	Prepared	Checked	Approved	Drawing No.	Rev
CA0-1-034-00	NEMA	YVRL	YVRL	4CM40500934	0

BCL806



CC Absorbed Power (incl. Mech. Losses)	4041 kW
100 %CC rotation speed	6090 RPM
100% EM rotation speed	1500 RPM
Transmission Ratio	4.06 -
Nominal (100%) torque *	26323 N*m
Static torque *	3948 N*m
Compressor inertia *	2233.53 Kg*m ²
Gearbox inertia *	172.61 Kg*m ²
Total inertia *	2406.14 Kg*m ²
*NOTE referred to driver shaft speed	

						JOB/COMM.
						ITEM
						SOS111111
0	EMISSIONE - ISSUE					Lingua-Lan. PAGINA / SHEET
REV.	DESCRIZIONE - DESCRIPTION	Prep'd	Cont-Chk'd	Cont-Chk'd	Data - Date	A 1/2

Nuovo Pignone

FIRENZE

STARTING TORQUE

REMARKS

- The curve represents the expected values, not including any additional margin (such as API margin)
- The curve is referred to the Data Sheet case with maximum absorbed torque (worst condition)
- The curve is referred to driver shaft speed

NOTE

- Gearbox data according to following docs:
- Compressor speed range 70 - 105%
- Motor Rating shall be 4600 kW

DS OPERATING POINT		
NAME	SPEED	TORQUE
	rpm	Nm
Rated (Certified Point)	6090	6483
Normal1	5942	6078
Normal 2	5586	5321
Normal 3	5577	5047
Turndown 1	5367	4484
Turndown 2	5582	4943
Turndown 3	5350	4621
Dry Out N2	4263	3800
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0

TORQUE CURVE TABULAR VALUES			
Selected point speed		Torque	
%	rpm	Nm	%
0.0	0	3948	15
10.0	609	2106	8
20.0	1218	2432	9
30.0	1827	3975	15
40.0	2436	5034	19
50.0	3045	6790	26
60.0	3654	9192	35
70.0	4263	12290	47
80.0	4872	16093	61
90.0	5481	20664	79
100.0	6090	25919	98
100.0	6090	26323	100

Note: Removed speed value higher than mos

		JOB/COMM.
		ITEM
		SOS111111
0	EMISSIONE - ISSUE	
REV.	DESCRIZIONE - DESCRIPTION	Lingua-Lan. A PAGINA / SHEET 2/2

PURCHASER'S DATA

A Site conditions					
1	Maximum ambient temperature:	46 °C	4	Relative humidity:	95 %
2	Minimum ambient temperature:	1 °C	5	Altitude above MSL:	< 1000 m
3	Design ambient temperature:	45 °C	6	Environment:	Humid & corrosive
B Technical particulars					
1	Tag no.:				
2	Duty:	Converter duty (Continuous)			
3	Service	VFD	25	Terminal connection	
4	No. of windings:			HV side	Cable box
5	Type of cooling:	ANAN		LV side	Cable box
6	Rated MVA		26	Cable Size/Type	
7	Rated voltage			HV side	Later
	HV winding	6.6 kV		LV side	Later
	LV winding		27	Neutral CT specification:	
8	System earthing:			51G	
	HV side	Resistance		64R	
	LV side	Solidly earthed		Vk	
9	Rated frequency:	50 Hz ± 3%		Im at Vk/2	
10	No. of phases:	Three		RCT	
11	Fault level on HV side:(1Sec)	40 kA	28	Differential CT ratio 87 T	Not applicable
12	Connection			V _k	
	HV side			Im at Vk/2	
	LV side			RCT	
13	Vector group:				
14	Impedance at max. MVA:		29	Installation	Indoor (Panel Mounted)
15	Insulation class:	H	30	Painting & colour	RAL-7032
16	Insulation level:		31	AC Auxiliary voltage	415 V ± 10% TPN
	P. f withstand		32	DC Auxiliary voltage	110 V ± 10% DC
	HV winding	20 kV	33	Bidirectional roller type	As applicable
	LV winding		34	¢ distance of flat rollers	NA
	Impulse withstand		35	Applicable specifications	EIL std. 6-51-44
	HV winding	60 kV _p	36	Loss Capitalization	Not applicable
	LV winding		a	Rate for copper loss Rs./kW:	Not applicable
17	Winding insulation type:	Uniform	b	Rate for iron loss Rs./kW:	Not applicable
18	Creepage distance:		37	Accessories requirement	
	HV winding			Two temp. sensing devices in each limb	Yes
	total			Marshalling box(IP-55)	Yes
	protected			Temp. sensing relay	Yes
	LV winding			Channels, towing lugs :	Yes
	total			Rollers	As applicable
	protected			Neutral bushing	Yes
19	Tap changer			outside terminal box	
	Location	HV winding		with connector assembly	
	Type	Offcircuit		Indicating platinum resistance type	Yes
	Range	±5		thermometer with contacts	
	No. of steps	5		Busduct flange on LV	Not applicable
				Lugs and cable glands	Required
			38	Tests requirements	
				Impulse test:	Not required
				Heat run test:	Required

Note

- All unfilled data shall be filled in by contractor/ vendor.
- Losses shall be inclusive of positive tolerance and shall be at nominal tap.
- Valid test reports in lieu of test to be provided
- For VFD input transformer- HV winding shall be suitable for 6.6kV ± 10%

C	22.07.2017	ISSUED WITH TECHNICAL AMENDMENT	NV	DA	HK
B	28.07.2017	REVISED & REISSUED FOR BIDS	NV	DA	HK
A	25.05.2017	ISSUED FOR BIDS	NV	DA	HK
Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by

20	Normal load:		39	Partial discharge test	Not required
21	Max. efficiency at 0.8 p.f:				
22	Load at which max eff. occurs:	MVA		Short circuit test:	Test Certificate
23	Power flow:	Unidirectional		Acoustic sound	Test Certificate
24	Terminal location:				
	HV side	Larger side			
	LV w.r.t HV	180°			

MANUFACTURER'S DATA

A	Make				
B	Rated power at ambient temperature of				
	25 °C			40 °C	
	30 °C			45 °C	
	35 °C			50 °C	
B	Insulation type				
C	Performance				
1	No load loss at		6	Eff. at half load at 75 °C	
2	100% voltage	kW		at 0.8 p.f	%
	110% voltage	kW		at 1.0 p.f	%
3	Full load copper loss at 75 °C	kW	7	Load at which max eff. occurs	MVA
4	No load current at		8	Regulation at 75 °C	%
	100% voltage	A		at 0.8 p.f	%
	110% voltage	A		at 1.0 p.f	%
5	Efficiency at full load at 75 °C		9	Maximum efficiency	%
	at 0.8 p.f	%			
	at 1.0 p.f	%			
D	Mechanical data				
1	Core & winding weight	Kgs.	4	Overall dimensions	
2	Total weight	Kgs.		Length	mm
3	Wheel gauge			Breadth	mm
				Height	mm

Note

- Losses shall be inclusive of positive tolerance and shall be at nominal tap.

शुष्क किस्म के डिस्ट्रीब्यूशन ट्रांसफार्मर के लिए विनिर्देश

SPECIFICATION FOR DRY TYPE DISTRIBUTION TRANSFORMERS

5	23.11.16	REVISED AND REISSUED AS STANDARD SPECIFICATION	NT	SA	BRB	RN
4	11.04.11	REVISED AND REISSUED AS STANDARD SPECIFICATION	MK	SA	UAP	DM
3	21.03.11	REVISED AND REISSUED AS STANDARD SPECIFICATION	NT	SA	UAP	DM
2	20.09.05	REVISED AND REISSUED	ND	AKT	AAN	VJN
1	08.11.01	REVISED AND REISSUED	NS	AAN	VPS	MRR
Rev No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
Approved by						

Abbreviations:

BIS	:	Bureau of Indian Standards
BS	:	British Standards
CEA	:	Central Electricity Authority
CT	:	Current Transformer
GI	:	Galvanised Iron
HV	:	High Voltage
IEC	:	International Electrotechnical Commission
IEEE	:	Institute of Electrical and Electronics Engineers
IP	:	Ingress Protection
IS	:	Indian Standard
KVA	:	Kilo Volt Amperes
MV	:	Medium Voltage
NEMA	:	National Electrical Manufacturers Association
PVC	:	Poly Vinyl Chloride
SWG	:	Standard Wire Gauge
VDE	:	Verband Der Electro technik and information Stechnik
51G	:	Back up Earth Fault Protection Relay
64R	:	Restricted Earth Fault Protection Relay

Electrical Standards Committee

Convener: Mr. B.R. Bhogal

Members: Ms. Sumita Anand
Mr. Parag Gupta
Mr. M.K. Sahu
Ms. N.S. Bhattacharya
Mr. Saeed Akhtar (Inspection)
Ms. N.P. Guha (Projects)

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1.0 SCOPE

The intent of this specification is to define the requirements for design, manufacture, testing, packing and supply of cast resin / resin impregnated dry type distribution transformers.

2.0 CODES AND STANDARDS

2.1 The equipment shall comply with the requirements of the latest revision of the following standards issued by BIS (Bureau of Indian Standards) unless otherwise specified.

IS: 5	:	Colours for ready mixed paints and enamels
IS: 1271	:	Thermal evaluation and classification of electrical insulation
IS: 2705	:	Current transformers
IS: 10028	:	Code of practice for selection, installation and maintenance of transformers
IS: 11171	:	Dry type power transformers
IS/IEC: 60529	:	Degrees of Protection Provided by Enclosures (IP Code)

2.2 In case of imported equipment, standards of the country of origin shall be applicable, if these standards are equivalent to or stringent than the applicable Indian standards.

2.3 The equipment shall also conform to the provisions of the CEA Regulations with latest amendments and other statutory regulations currently in force in the country.

2.4 In case Indian standards are not available for any equipment, standards issued by IEC/ BS/ VDE/ IEEE/ NEMA or equivalent agency shall be applicable.

2.5 In case of any conflict between requirements specified in various applicable documents for the project, the most stringent one shall prevail. However Owner's / EIL's decision in this regard will be final and binding.

3.0 GENERAL REQUIREMENTS

3.1 The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.

3.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least 10 years from the date of supply.

3.3 Vendor shall give a notice of at least one year to the end user of equipment and EIL before phasing out the product/spares to enable the end user for placement of order for spares and services.

4.0 SITE CONDITIONS

Transformer shall be suitable for installation and satisfactory operation in tropical, humid and corrosive atmospheres found in refineries, Petrochemical and Fertiliser Plants or as specified in the Material Requisition / Tender . The transformer shall be designed to operate under site conditions as specified in data sheet. If not specifically mentioned therein, design ambient temperature of 40°C and altitude not exceeding 1000m above MSL shall be considered.

5.0 CONSTRUCTION

5.1 The transformers shall have core type construction. The core shall be assembled out of low-loss, nonageing, high permeability cold rolled grain oriented steel laminations.

- 5.2 The windings shall be of high-grade electrolytic copper. The insulation system for cast resin transformers shall comprise of windings cast under vacuum, free of voids in a homogenous uniform laminate of epoxy resin/ polyester resin. The totally assembled core and coil assembly, for resin impregnated transformers, shall be vacuum pressure impregnated to effectively make it impermeable to moisture, dirt, salt, air and other industrial contaminants.
- 5.3 The entire core assembly shall be covered with a resin-based lacquer for corrosion protection.
- 5.4 Lifting lugs shall be provided for core and winding assemblies.
- 5.5 The HV and MV windings shall have class 'F' or better insulation. The temperature rise of windings under continuous full load shall not exceed the maximum allowable temperature for the appropriate class of insulation as per IS 11171, above the design temperature specified in the data sheet.
- 5.6 The insulation material used shall be non-hygroscopic, non- inflammable and self-extinguishing if ignited by direct flame or arc. No toxic or harmful gases shall form during heating and /or burning. The insulation materials shall be sufficiently resistant to ageing.
- 5.7 The transformers shall be capable of withstanding the thermal and mechanical effects of a dead short circuit on any or all winding terminals with full voltage maintained on other windings as per IS. The transformers shall sustain a symmetrical short circuit on secondary terminals for 2 seconds without damage or impairment.
- 5.8 Each limb shall have two solid state winding temperature monitoring elements to initiate an alarm and trip for winding over temperature.
- 5.9 The transformers for Indoor & outdoor location shall have minimum degree of protection as IP 23 & IP 43 respectively. However the marshalling box, cable termination box, bus-duct termination chamber etc. shall have a degree of protection not less than IP-55.
- 5.10 All fasteners and bolts shall be galvanised.
- 5.11 The transformers shall be spray-painted or powder coated with epoxy paint. Colour shade of final paint shall be as specified in the data sheet.
- 6.0 TERMINAL AND MARSHALLING BOX**
- 6.1 Windings shall be brought out on suitable nickel-plated copper terminals for cable termination. HV side termination shall be from the bottom. Suitable disconnection chambers shall be provided to permit the transformer to be removed without disconnecting the cable termination. The MV side termination shall be by bus-duct or cable as defined in datasheet / job specification.
- 6.2 The high voltage and medium voltage cable termination arrangement shall be complete with cable box and bolted type undrilled cable gland plates. Non-magnetic gland plate shall be provided for single core cables.
- 6.3 Primary cable box shall be able to withstand specified primary system fault level for 0.2 secs.
- 6.4 Terminal chamber for busduct termination shall have a gasketed cover plate, bolted to it. Separate inspection covers shall be provided to facilitate connection and inspection.

- 6.5 All protection, alarm and indication devices and neutral CTs shall be wired by means of PVC insulated cables upto the marshalling box. There shall be two gland plates, one for internal wiring to the marshalling box from various devices which shall be glanded and pre-wired, while the second gland plate shall be removable and undrilled for glanding outgoing cables.
- 6.6 One neutral terminal inside the cable box/ MV bus-duct connection chamber and a separate neutral terminal outside shall be provided for earthing of transformer winding neutral on the secondary side. The neutral terminal shall be complete with connector block assembly for easy termination of GI earth strip/cable.
- 6.7 The neutral CT shall be mounted as below:-
- CT for 51G shall be located in the earth path after bifurcation of neutral.
 - CT for 64 R can be located before bifurcation of neutral.
- 6.8 Two earthing terminals shall be provided on the transformer frame for transformer body earthing. Suitable lifting arrangement shall be provided in the transformer frame. The transformer shall be supported on flat rollers.
- 7.0 **COOLING**
- Type of Cooling shall be in accordance with the datasheet.
- 8.0 **TAPPINGS AND CONTROLS**
- Primary off-circuit rotary type tap changer shall be provided and shall have a range as specified in the data sheet. Tap changing arrangement through links is not acceptable. Under conditions of external short circuit, the tap changing device shall be capable of carrying the same current as the windings.
- 9.0 **ACCESSORIES**
- 9.1 Accessories as specified on data sheet shall be included in the scope of supply. All protective, alarm and indicating devices shall have minimum 1 no. potential free contact each for alarm and trip. All transformers must be provided with at least the following:
- Bi-directional flat rollers
 - Rating and terminal marking plate
 - Marshalling box
 - Lifting hooks and jacking pads, towing holes
 - Earthing terminals
 - Neutral CT (as per data sheet)
 - Off-circuit tap changer
 - Temperature monitoring system (For rating 500KVA & above)
- 9.2 Temperature monitoring system shall be supplied with temperature sensors fitted in each limb. Temperature monitoring system shall initiate alarm and trip for winding over temperature. Alarm and trip temperatures shall be site settable. The monitoring system shall also have an indicating device.

10.0 NOISE LEVEL

The average audible sound level for the transformers at a distance of 30 cm shall be as below:

KVA	AVERAGE SOUND LEVEL (DECIBEL)
0-50	50
51-150	55
151-300	58
301-500	60
501-700	62
701-1000	64
1001-1500	65
1501-2000	66
2001-3000	68
3001-4000	70
4001-5000	71

11.0 INSPECTION AND TESTING

EIL / owner's representatives shall be given free access to enter the plant and inspect the equipment at any time during fabrication. However, 4 weeks advance notice shall be given by vendor to witness the final tests.

For testing requirements, refer Inspection & Test Plan doc. no. 6-81-1044. All testing shall be carried out at manufacturer's works under his care and expense.

12.0 PACKING AND DESPATCH

All the equipment shall be divided into several sections for protection and ease of handling during transportation. The equipment shall be properly packed for the selected mode of transportation i.e. by ship/ rail or trailer. The equipment shall be wrapped in polythene sheets before being placed in the crates/ cases to prevent damage to the finish. Crates / cases shall have skid bottom for handling. Special notations such as 'Fragile', 'This side up', 'Centre of gravity', 'Weight', 'Owner's particulars', 'P.O. numbers' etc., shall be clearly marked on the package together with other tag numbers etc.

The equipment may be stored outdoors for long periods before erection. The packing shall be suitable for outdoor storage in areas with heavy rains/ high ambient temperature.



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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 01

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.

- '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.
- '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.
- '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.
- '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:

- words indicating one gender include all genders;
- 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.
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 Phytosanitary/ 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 01

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 01), General Conditions of Contract (document reference: CE: PR: 002 - Rev 01) 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.

B. GUIDELINES FOR PREPARATION OF OFFER:

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) if applicable, 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. For Physical Export projects or wherever services are rendered by foreign suppliers in India, 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. GUIDELINES FOR OFFER SUBMISSION:

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. PROCESSING OF OFFERS RECEIVED:

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. BHEL reserves the right to adopt Reverse Auction or standard Price Bid Opening procedure for price evaluation, at its discretion. This shall be decided after completion of techno-commercial evaluation of tender (Refer BHEL website http://www.bhel.com/vender_registration/vender.php for Guidelines of Reverse Auction). In case BHEL does not resort to Reverse Auction, the price bids and price impacts (if any) already submitted and available with BHEL shall be opened as per BHEL's standard practice.
6. 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.
7. 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.
8. 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.
9. 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.

10. 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.

11. Ranking (L-1, L-2 etc.) shall be done only for the techno-commercially acceptable offers.

E. INFORMATION ON PAYMENT TERMS:

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. 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.

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:

<u>PURCHASE ORDERS FOR:</u>	<u>SUPPLY WITH ERECTION & COMMISSIONING</u>	<u>SUPPLY WITH ERECTION SUPERVISION & COMMISSIONING</u>	<u>SUPPLY ONLY</u>
<u>INDIGENOUS PROCUREMENT</u>	a. 90% of basic value + 100% of taxes and freight charges 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. Balance 10% of basic value (Retention money) will be paid in 15 days from the date of submission of supplementary invoice/documents against proof of completion of E&C. <u>Note:</u> In case PBG is not furnished, only 80% payment will be released against 90% 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. 95% of the basic value + 100% of taxes and freight charges 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. Balance 5% of basic value (Retention money) will be paid in 15 days from the date of submission of supplementary invoice/documents against proof of completion of commissioning. <u>Note:</u> In case PBG is not furnished, only 85% payment will be released against 95% 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.	c. 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.

<u>PURCHASE ORDERS FOR:</u>	<u>SUPPLY WITH ERECTION & COMMISSIONING</u>	<u>SUPPLY WITH ERECTION SUPERVISION & COMMISSIONING</u>	<u>SUPPLY ONLY</u>
<u>IMPORT PROCUREMENT</u>	d. 90% of the basic value will be paid on the 45th day, against usance draft of 45 days, from the date of AWB/BOL on submission of complete set of documents. Balance 10% of basic value (Retention money) will be paid in 15 days from the date of submission of supplementary invoice/documents against proof of completion of E&C. <u>Note:</u> In case PBG is not furnished, only 80% payment will be released against 90% 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.	e. 95% of the basic value will be paid on the 45th day, against usance draft of 45 days, from the date of AWB/BOL on submission of complete set of documents. Balance 5% of basic value (Retention money) will be paid in 15 days from the date of submission of supplementary invoice/documents against proof of completion of commissioning. <u>Note:</u> In case PBG is not furnished, only 85% payment will be released against 95% 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 PO value will be paid against usance draft of 45 days from the date of AWB/BOL on submission of complete set of documents.
<u>HIGH-SEA SALES PROCUREMENT</u>	g. 90% 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. Balance 10% of basic value (Retention money) will be paid in 15 days from the date of submission of supplementary invoice/documents against proof of completion of E&C. <u>Note:</u> In case PBG is not furnished, only 80% payment will be released against 90% 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.	h. 95% of the 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. Balance 5% of basic value (Retention money) will be paid in 15 days from the date of submission of supplementary invoice/documents against proof of completion of commissioning. <u>Note:</u> In case PBG is not furnished, only 85% payment will be released against 95% 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.	i. 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.

j. 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 AMC value should not be less than 20% of the main supply value. In case the quoted total AMC value is less than 20% of the main supply value, BHEL shall evaluate Bidders Price deducting differential amount from main supply price and apportioning towards AMC charges.

Payment terms: 100% AMC 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 AMC on yearly basis.

k. 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.
- l.** 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.
- m.** Standard payment terms indicated in Clauses: F (a), (b), (c), (d), (e), (f), (g), (h), (i), (j) & (k) 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, the retention money will be 10% (where scope includes E&C) or 05% (where scope includes Erection supervision & Commissioning) of both purchase order values put together.

Note 2: If the E&C could not be completed till the end of the Warranty period due to reasons not attributable to the supplier, BHEL will release the retention money to the supplier against Bank Guarantee for equivalent value valid for an initial period of one year.

Note 3: In case of Physical Export projects or wherever services are rendered by foreign suppliers in India, E&C charges (if quoted separately/extra by bidder) will be paid in 15 days from the date of submission of supplementary invoice/ documents against proof of completion of E&C.

Note 4: In case of multiple packages/units in a power plant, payment of retention money/E&C charges will be processed on pro-rata basis.

Note 5: 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 BGs / PBGs will be returned only after expiry of the claim period or on completion of the contractual obligation with respect to Purchase Order.
10. PBG shall not be applicable for spares.

I. PROVISIONS 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 any of the following documents along with the tender documents in the Part I / Technical bid to avail the applicable benefits:

- a. Attested copy of valid NSIC certificate or
- b. Attested copy of either Entrepreneur's Memorandum part II (EM II) certificate/Udyog Aadhar certificate having deemed validity (five years from the date of issue of acknowledgement in EM II/Udyog Aadhar) or
- c. EM II/ Udyog Aadhaar certificate along with attested copy of a CA certificate (Format enclosed at Annexure VIII where deemed validity of EM II certificate/ Udyog Aadhar certificate of five years have expired) applicable for the relevant financial year (latest audited).

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:

- d. MSE vendors quoting within a price band of L1 + 15% shall be allowed to supply up to 20% 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. 20% of the 20% (i.e. 4% of the total enquired quantity) will be earmarked for SC/ST owned MSE firms provided conditions as mentioned in (1) and (2) are fulfilled.
 5. In case no vendor under SC / ST category firms are meeting the conditions mentioned in (1) and (2) or have not participated in the tender, in such cases the 4% quantity will be distributed among the other eligible MSE vendors who have participated in the tender.
 6. Serial no. 1 to 5 will not be applicable wherever it is not possible to split the tendered quantity/items on account of customer contract requirement, or the items tendered are systems. 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. Integrity Pact (IP):

- 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

Annexure I
Guidelines for Indian Agents

- **Definition of Indian Agent:** An Indian Agent of foreign principal is an individual, a partnership, an association of persons, a private or public company, that carries out 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.

—X—

Vendor's Signature with Seal

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/ retainerhip 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.

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
001	UK	GBP	LONDON (HEATHROW)
002	UK	GBP	NEW CASTLE
003	UK	GBP	OXFORD, CHETAM
004	UK	GBP	BRISTOL, WELLINGBOROUGH
005	UK	GBP	BIRMINGHAM
006	UK	GBP	EAST MIDLANDS
007	UK	GBP	MANCHESTER
008	UK	GBP	LEEDS
009	UK	GBP	GLASGOW
010	FRANCE	EURO	PARIS (BOISSY) & LYON
011	SWEDEN	EURO	STOCKHOLM
012	SWEDEN	EURO	GOTHENBERG & MALMO
013	ITALY	EURO	ROMA, MILAN
014	ITALY	EURO	TURIN, BOLOGNA, FLORENCE
015	NETHERLANDS	EURO	AMSTERDAM, ROTTERDAM
016	AUSTRIA	EURO	VIENNA, LINZ, GRAZ
017	BELGIUM	EURO	ANTWERP, BRUSSELS
018	DENMARK	DKK	COPENHAGEN
019	JAPAN	JPY	TOKYO, OSAKA
020	SINGAPORE	SGD	SINGAPORE
021	CANADA	CAD	TORONTO
022	CANADA	CAD	MONTREAL
023	USA	USD	NEW YORK, BOSTON
024	USA	USD	CHICAGO
025	USA	USD	SAN FRANCISCO, LOS ANGELES
026	USA	USD	ALANTA, HOUSTON
027	GERMANY	EURO	MUNICH, KOLN, DUSSELDORF, HANNOVER, HAMBURG, STUTTGART, DAMSTADT, MANIHEM, NURUMBERG
028	GERMANY	EURO	FRANKFURT
029	GERMANY	EURO	BERLIN
030	SWITZERLAND	SFR	BASLE, ZURICH, GENEVA
031	SPAIN	EURO	BARCELONA
032	AUSTRALIA	AUD	SYDNEY
033	AUSTRALIA	AUD	MELBOURNE
034	AUSTRALIA	AUD	PERTH
035	CZECH	EURO	PRAGUE
036	HONG KONG	HKD	HONG KONG
037	NEW ZELAND	NZD	AUCKLAND
038	RUSSIA	USD	MOSCOW
039	SOUTH KOREA	USD	KIMPO INTERNATIONAL, INCHEON
040	FINLAND	EURO	HELSINKI
041	ROMANIA	EURO	BUCHAREST
042	NORWAY	EURO	OSLO
043	IRELAND	EURO	DUBLIN
044	ISRAEL	USD	TEL AVIV
045	UAE	USD	DUBAI
046	OMAN	USD	MUSCAT
047	EGYPT	USD	CAIRO
048	TAIWAN	USD	TAIPEI
049	UKRAINE	USD	KIEV
050	CHINA	USD	SHANGHAI, SHENZHEN
051	PHILIPPINES	USD	MANILA
052	MALAYSIA	USD	KUALALUMPUR, PE NANG
053	CYPRUS	USD	LARNACA
054	SOUTH AFRICA	USD	JOHANNESBURG, DURBAN
055	SLOVAKIA	EURO	BARTISLOVA
056	SAUDI ARABIA	SAR	RIYADH
057	TURKEY	EURO	ISTANBUL
058	THAILAND	USD	BANGKOK
059	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 / transferring 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 Query, 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.

Annexure-VI
BHEL MEMBER BANKS (LIST OF CONSORTIUM BANKS)

BANK GUARANTEE (BG) SHALL BE ISSUED FROM THE FOLLOWING BANKS ONLY:

	Nationalised Banks		Nationalised Banks
1	Allahabad Bank	19	Vijaya Bank
2	Andhra Bank		Public Sector Banks
3	Bank of Baroda	20	IDBI
4	Canara Bank		Foreign Banks
5	Corporation Bank	21	CITI Bank N.A
6	Central Bank	22	Deutsche Bank AG
7	Indian Bank	23	The Hongkong and Shanghai Banking Corporation Ltd. (HSBC)
8	Indian Overseas Bank	24	Standard Chartered Bank
9	Oriental Bank of Commerce	25	J P Morgan
10	Punjab National Bank		
11	Punjab & Sindh Bank		Private Banks
12	State Bank of India	26	Axis Bank
13	State Bank of Hyderabad	27	The Federal Bank Limited
14	Syndicate Bank	28	HDFC Bank
15	State Bank of Travancore	29	Kotak Mahindra Bank Ltd
16	UCO Bank	30	ICICI Bank
17	Union Bank of India	31	IndusInd Bank
18	United Bank of India	32	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 to 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.

WeBANK 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 including⁷ 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 the⁸ 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 to⁷
- c) Unless the Bank is served a written claim or demand on or before⁸ 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

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

_____. 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 IPC/ PC 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 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.

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 Bidder(s)/ Contractor(s) undertake(s) to obtain from all subcontractors a commitment consistent with this Integrity Pact and report Compliance to the Principal. This commitment shall be taken only from those sub-contractors whose contract value is more than 20 % of Bidder's/ Contractor's contract value with the Principal. The Bidder(s)/ Contractor(s) shall continue to remain responsible for any default by his Sub-contractor(s).
- 6.2 The Principal will enter into agreements with identical conditions as this one with all Bidders and Contractors.
- 6.3 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 /Sub-contractors

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.
- 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 As soon as the Monitor notices, or believes to notice, a violation of this agreement, he will so inform the Management of the Principal and request the Management to discontinue or take corrective action, or heal the situation, or to take other relevant action. The Monitor can in this regard submit non-binding recommendations. Beyond this, the Monitor has no right to demand from the parties that they act in a specific manner, refrain from action or tolerate action.
- 8.6 The Monitor will submit a written report to the CMD, BHEL within 8 to 10 weeks from the date of reference or intimation to him by the Principal and, should the occasion arise, submit proposals for correcting problematic situations.
- 8.7 The CMD, BHEL shall decide the compensation to be paid to the Monitor and its terms and conditions.
- 8.8 If the Monitor has reported to the CMD, BHEL, a substantiated suspicion of an offence under relevant IPC / PC 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.

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

8.10 The word 'Monitor' would include both singular and plural.

Section 9 – Pact Duration

9.1 This Pact begins and shall be binding on and from the submission of bid(s) by bidder(s). It expires for the Contractor 12 months after the last payment under the respective contract and for all other Bidders 6 months after the contract has been awarded.

9.2 If any claim is made / lodged during this time, the same shall be binding and continue to be valid despite the lapse of this pact as specified as 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)

For & On behalf of the Bidder/ Contractor

(Office Seal)

Place:_____

Date:_____

Witness: _____

(Name & Address) _____

Witness: _____

(Name & Address) _____



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Page 1 of 3

Bharat Heavy Electricals Ltd.,
(A Government of India undertaking)
Electronics Division

CE: PR: 003- Rev 01

PB 2606 , Mysore Road Bangalore , 560026 INDIA

SPECIAL COMMERCIAL CONDITIONS OF CONTRACT

Reference is brought to BHEL's Instructions to Bidders (Document Ref: CE: PR: 001- Rev 01) and General Commercial Conditions for Contract (Document Ref: CE: PR: 002- Rev 01). These documents along with required annexures are available in our website: [www.bhel.in](#). 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: NKR0000235

RFQ Date: 31.05.2018

Due Date: 22.06.2018

Customer/Project: BPCL Kochi and APCL Assam

Item Description: VFD System

E-tendering – ~~Applicable~~/Not applicable

TYPE OF BID: ~~SINGLE PART BID / TWO PART BID~~ / **THREE PART BID**

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 isaac@bhel.in or savitha@bhel.in

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.

Splitting of tendered quantity to MSE vendors: The tendered quantity ~~will~~ /will not be split to MSE vendor/s subject to submission of relevant documents by vendors. Refer clause I of Instructions to Bidders for conditions applicable and for information on documents to be submitted.

Destination: a) For Indigenous scope of supply, items are to be directly despatched to respective project BHEL's Site Office or Stores located at/near BPCL Kochi , Ernakulam Dist, Kerala State, India and APCL Assam, Namrup, Parbatpur, Assam State , India Consignee other details required for dispatch will be issued by BHEL along with Despatch Clearance.

b) For Imported scope of supply, destination is **Bangalore**. In case of shipment by sea, port of discharge will be any port in India seaport and port of delivery shall be ICD-Bangalore.

Project Benefits:

Imported scope of supply:

- ~~DEEC / SEZ/EPCG/DFIA/ Physical Export contract: Eligible for "NIL" Basic Customs Duty.~~
- ~~Project Imports: Eligible for Concessional Basic Custom Duty.~~
- ~~Basic Custom duty and Cess on Basic Custom duty are reimbursable by customer.~~
- 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	Will be intimated separately to qualified bidders after finalization of techno-commercial evaluation. Non-acceptance to participate in RA may result in non-consideration of the bid, in case BHEL decides to go for RA. In case BHEL does not resort to Reverse Auction, the price bids and price impacts (if any) shall be opened as per BHEL's standard practice.	AGREE	
02	Delivery Period	Within 16 weeks from the date of issue of Manufacturing clearance along with approved document. Delay in contractual delivery will attract Penalty as per GCC Clause no.:04.b.	AGREE weeks	
03	Terms of Payment at the time of material supply	Refer Clause "F" of Instructions to Bidder for BHEL standard Payment terms and loading factors applicable for non-compliance against payment terms: Indigenous Scope: a) Supply with Erection & Commissioning b) Supply with Erection Supervision & Commissioning (For Main supply) c) Supply only (For spares) Imported Scope: d) Supply with Erection & Commissioning e) Supply with Erection Supervision & Commissioning (For Main supply) f) Supply only (For spares) High-Sea sales: g) Supply with Erection & Commissioning h) Supply with Erection Supervision & Commissioning (For Main supply) i) Supply only (For spares) Spares: c) and/or f)/i) depending upon the scope	AGREE	

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) **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 **60** days from the date of according final price by bidder (or) upto original validity period, whichever is later.
- (2) **Guarantee/ Warranty:** i) For BPCL Kochi – **18** months from the date of dispatch of goods or **12** months from the date of commissioning of goods, whichever is earlier.

ii) For APCL Assam – **36** months from the date of dispatch of goods or **12** months from the date of commissioning of goods, whichever is earlier.
- (3) **Performance Bank Guarantee (PBG):** i) For BPCL Kochi PBG will be applicable for a period of **18** 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.

ii) For APCL Assam PBG will be applicable for a period of _36_ 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.

- (4) **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.

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.

- (5) **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.
- (6) Any additional commercial term or deviation in commercial term, if sought by any vendor, should be clearly brought out in this document (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.
- (7) **Evaluation criteria for tendered item/s:**
- (a) Evaluation, ranking and ordering will be done on projectwise package basis, i.e. BPCL Kochi – Package-1 and APCL Assam – Pkg-2
(or)
(b) ~~Items will not be split on item-wise lowest offer. Items shall be evaluated and procured as a combined package.~~

- ~~(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:~~

Name: _____ Address: _____ Email: _____

With this, we hereby confirm that all the terms & conditions as indicated in Instructions to Bidders (Document Ref: CE: PR: 001- Rev 01) & General Commercial Conditions for Contract (Document Ref: CE: PR: 002- Rev 01) are accepted without any deviation.

Vendor's Signature with Seal

Note B:

The above filled-in and signed-sealed document (in original) shall be furnished as part of Techno-commercial Bid without fail.

- Any technical or commercial clarification for this tender can be raised on or before **12.06.2018**. No clarification will be entertained by BHEL after given cutoff date.
- Wherever Indigenous suppliers are rendering E&C services at project site, no separate/extra Erection supervision and commissioning charges shall be quoted. In case Foreign suppliers are rendering E&C services at project site, separate E&C charge may be quoted
- Vendor has to mandatorily give break-up price of each item as per BOM of specification for each project in price bid
- Packing standard - 1. For non-hazardous items, wooden packing shall be strong and efficient enough to ensure safe preservice upto the final point of destination
2. For hazardous/dangerous items, packing as specified in the applicable international regulations/standards
Mandatory Spares' boxes should be marked with
 - "BHEL EDN- Mandatory Spares for VFD for ASSAM PETROCHEMICALS LIMITED, NAMRUP(CE/1426)" – For APCL Assam
 - "BHEL EDN- Mandatory Spares for VFD for BPCL Kochi, NGC (CE/1434)" – For BPCL Kochi
 - "S" with red colour on all sides proportionate to the size of the box.
- Any tender document does not prohibit any vendor to submit their offer along with clause wise deviation from the technical specification, commercial terms and any other tender condition. Changes in technical specification / Scope or any other tender condition etc. shall be informed to Participating bidders only.