Corrigendum

<table>
<tr><th colspan="6">Tenderdocuments (total 188 pages)</th></tr>
<tr><th>S. No.</th><th>Document Reference</th><th>Page</th><th>Clause</th><th>Tender statement</th><th>Shall be read as</th></tr>
<tr><td>1</td><td>SPECIAL COMMERCIAL CONDITIONS OF CONTRACT</td><td>01 of 188</td><td>-</td><td>Destination: i) To conduct combined testing with job motor, 01 no. VFD have to be dispatched to M/s. BHEL, Piplani, Bhopal, Madhya Pradesh – 462 022.

ii) All Other Items (excluding 01 no. VFD) are to be directly despatched to M/s. Bharat Heavy Electricals Limited, Heavy Power Equipment Plant (HPEP), Ramachandrapuram, BHEL Stores, Hyderabad, India-502032</td><td>Destination: All items are to be directly despatched to M/s. Bharat Heavy Electricals Limited, Heavy Power Equipment Plant (HPEP), Ramachandrapuram, BHEL Stores, Hyderabad, India-502032</td></tr>
<tr><td>2</td><td>SPECIAL COMMERCIAL CONDITIONS OF CONTRACT</td><td>01 of 188</td><td>-</td><td><u>Terms of Delivery</u>:
a) 1 no. VFD with Integrated dry-type transformer: FOR, BHEL-Bhopal (including Packing & Forwarding, Freight & Transit-Insurance charges but excluding Taxes)

b) All other items: FOR, BHEL-HPEP, Hyderabad (including Packing & Forwarding, Freight & Transit-Insurance charges but excluding Taxes)</td><td><u>Terms of Delivery</u>: FOR, BHEL-HPEP, Hyderabad (including Packing & Forwarding, Freight & Transit-Insurance charges but excluding Taxes)</td></tr>
<tr><td>3</td><td>SPECIAL COMMERCIAL CONDITIONS OF CONTRACT</td><td>04 of 188</td><td>-</td><td>If the bidder wants to avail the Purchase preference, the bidder must upload a certificate regarding the percentage of the local content and the details of locations at which the local value addition is made along with their bid, failing which no purchase preference shall be granted.</td><td>If the bidder wants to avail the Purchase preference, the bidder must upload a certificate along with their bid in company’s letter head specifying the percentage of the local content and the details of locations at which the local value addition is made, failing which no purchase preference shall be granted.</td></tr>
<tr><td>4</td><td>SPECIAL COMMERCIAL CONDITIONS OF CONTRACT</td><td>04 of 188</td><td>7</td><td>Invoice (01 original and 01 copy with original sign & seal / digitally signed invoice), Lorry Receipt (L/R), Packing List, NIL Short-Shipment Certificate, insurance intimation letter, Proof of Delivery on L/R etc.</td><td>Invoice (01 original and 01 copy with original sign & seal / digitally signed invoice), Lorry Receipt (L/R), Packing List, NIL Short-Shipment Certificate, insurance intimation letter, Proof of Delivery on L/R, copy of Performance security(BG) etc.</td></tr>
<tr><td>5</td><td>SPECIAL COMMERCIAL CONDITIONS OF CONTRACT</td><td>05 of 188</td><td>8</td><td>(8) <u>Erection Supervision & Commissioning, combined testing and training</u>:
<table><tr><th>Range of procurement value</th><th>Minimum percentage of basic material value proposed for Erection Supervision & Commissioning charges, combined testing and training:</th></tr><tr><td>Up to Rs. 2.50 crs.</td><td>05%</td></tr><tr><td>Greater than Rs. 2.50 crs. and lesser than Rs. 10 crs.</td><td>03% (or) Rs.12.50 lakhs, whichever is higher.</td></tr></table>Depending on the material quotation value, the bidder will have to quote the corresponding Erection Supervision & Commissioning, combined testing and training charges for the respective slab/range as per above table. In case the quoted total Erection Supervision & Commissioning, combined testing and training value is less than above stipulated charges, BHEL shall evaluate Bidders Price deducting differential amount from main supply price (excluding laptop, cable accessories, mandatory spares) and apportioning towards Erection Supervision & Commissioning, combined testing and training charges.</td><td>(8) <u>Erection Supervision & Commissioning and training</u>:
<table><tr><th>Range of procurement value</th><th>Minimum percentage of basic material value proposed for Erection Supervision & Commissioning and training charges:</th></tr><tr><td>Up to Rs. 2.50 crs.</td><td>05%</td></tr><tr><td>Greater than Rs. 2.50 crs. and lesser than Rs. 10 crs.</td><td>03% (or) Rs.12.50 lakhs, whichever is higher.</td></tr></table>Depending on the material quotation value, the bidder will have to quote the corresponding Erection Supervision & Commissioning and training charges for the respective slab/range as per above table. In case the quoted total Erection Supervision & Commissioning and training value is less than above stipulated charges, BHEL shall evaluate Bidders Price deducting differential amount from main supply price (excluding laptop, cable accessories, mandatory spares) and apportioning towards Erection Supervision & Commissioning and training charges.
<u>Note</u>: Combined testing is removed.</td></tr>
<tr><td>6</td><td>SPECIAL COMMERCIAL CONDITIONS OF CONTRACT</td><td>06 of 188</td><td>-</td><td>Break-up prices for E&C, Combined testing and training shall be provided in percentage of total lumpsum service charges quoted in priced offer.</td><td>Break-up prices for E&C and training shall be provided in percentage of total lumpsum service charges quoted in priced offer.
<u>Note</u>: Combined testing is removed.</td></tr>
<tr><td>7</td><td>PART-A (VFD SPECIFICATION)</td><td>58 of 188</td><td>4a</td><td><table><tr><td>a</td><td>Transformer Type</td><td>Dry type (Integrated in VFD panel)</td></tr></table></td><td><table><tr><td>a</td><td>Transformer Type</td><td>Copper wound Dry type transformer integrated within VFD enclosure. Cables between VFD & transformer shall be in VFD manufacturer’s scope.</td></tr></table></td></tr>
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<tr><td>9</td><td>PART-A (VFD SPECIFICATION)</td><td>61 of 188</td><td>h</td><td>Combined testing</td><td>Removed from specification. Not to be considered.</td></tr>
</table>

10	PART-A (VFD SPECIFICATION)	62 of 188	8	Note added (new)	**Below mentioned note is added in 8. Mandatory Spares for VFD System.** Note: *i) Wherever offered Drive is with Cell type construction wherein Diode is part of Power cell, bidder doesn't have to offer Diode separately under sl.no.i above. ii) In case it is found during detailed engineering that offered BoM is not meeting the above specified customer topology of spares, the additional spares will have to be supplied without any additional cost implication to BHEL/end-user.
11	PART-A (VFD SPECIFICATION)	64 of 188	10	iv. Service Engineer deputation charges: *Bidder to quote lumpsum charges for 25 man-days which shall be considered for bid evaluation* a. *01 no. VFD combined testing with Job Motor at BHEL/Bhopal (05 man-days)* b. Erection Supervision & Commissioning charges of 02 VFDs alongwith 02 LCS at project site *(18 man-days)* c. Training of Owner's personnel at project site for operation & maintenance of VFD system (*02 man-days)* Payment shall be made for actual man-days consumed at BHEL-Bhopal/Site with per man-day charges calculated on the basis of the quoted lumpsum charges. Lumpsum charges quoted shall include travelling, boarding and lodging expenses. — 1 Lot	iv. Service Engineer deputation charges: *Bidder to quote lumpsum charges for 22 man-days which shall be considered for bid evaluation* a. Erection Supervision & Commissioning charges of 02 VFDs alongwith 02 LCS at project site *(20 man-days)* b. Training of Owner's personnel at project site for operation & maintenance of VFD system (*02 man-days)* Payment shall be made for actual man-days consumed at Site with per man-day charges calculated on the basis of the quoted lumpsum charges. Lumpsum charges quoted shall include travelling, boarding and lodging expenses. — 1 Lot
12	JOB SPECIFICATIONS (ELECTRICAL)	71 of 188	r	Combined testing of motor and VFD shall be carried out at manufacturers works for 1 set of motor and VFD. However, final acceptance shall be based on PGTR at site.	Removed from specification. Not to be considered.
13	Prices against Item sl.no.6 of 'Price BoQ (Bid)' is to be quoted as per modified requirement mentioned as:	Price BoQ (Bid)	6	Service Engineer deputation charges: Bidder to quote lumpsum charges for 25 man-days which shall be considered for bid evaluation a) 01 no. VFD combined testing with job motor at BHEL-Bhopal (05 man-days) b) Erection supervision & commissioning charges of 02 VFDs alongwith 02 LCS at project site (18 man-days) c) Training of owner's personal at project site for operation & maintenance of VFD system (02 man-days) Payment shall be made for actual man-days consumed at BHEL-Bhopal/Site with per man-day charges calculated on the basis of the quoted lumpsum charges. (Break-up prices for sl. no. a), b), c) shall be provided in percentage w.r.t. lumpsum charges quoted in a separate sheet by bidder)	Service Engineer deputation charges: Bidder to quote lumpsum charges for 22 man-days which shall be considered for bid evaluation a) Erection supervision & commissioning charges of 02 VFDs alongwith 02 LCS at project site (20 man-days) b) Training of owner's personal at project site for operation & maintenance of VFD system (02 man-days) Payment shall be made for actual man-days consumed at Site with per man-day charges calculated on the basis of the quoted lumpsum charges. (Break-up prices for sl. no. a) & b) shall be provided in percentage w.r.t. lumpsum charges quoted in a separate sheet by bidder)

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

CE: PR: 003- Rev 02

SPECIAL COMMERCIAL CONDITIONS OF CONTRACT

Reference is brought to BHEL's Instructions to Bidders (Document Ref: CE: PR: 001- Rev 05) and General Commercial Conditions for Contract (Document Ref: CE: PR: 002- Rev 03).

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.

BHEL-EDN invites you to quote your best competitive prices as per the purchase specification. Kindly submit your quotation as a two-part bid in EPS portal: https://eprocurebhel.co.in/nicgep/app within Due-Date & Time as displayed in E-procurement website.

RFQ No. : ATLNIC0005

Project **:** RDG Additional Infill Wells Project Feed for Inlet Gas Compressor

Customer : M/s. CAIRN Oil & Gas (Vedanta) Ltd

Item Description **:** VFD for 4570 kW, 6.6 kV Motor

Type of Bid: Two-Part Bid (Pre-Qualification bid + Techno-commercial bid: Part-I; Price-bid: Part-II)

Purchase Executives: Clarifications with regard to the tender shall be addressed to purchase officers whose e-mail IDs are given below:
sathishkumars@bhel.in or atulsood@bhel.in

Destination: All items are to be directly despatched to M/s. Bharat Heavy Electricals Limited, Heavy Power Equipment Plant (HPEP), Ramachandrapuram, BHEL Stores, Hyderabad, India-502032

Reverse Auction: Not applicable for this tender.

Terms of Delivery: FOR, BHEL-HPEP, Hyderabad (including Packing & Forwarding, Freight & Transit-Insurance charges but excluding Taxes)

Bidder to indicate station of dispatch: _____

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

a. GeM Seller ID: _____

b. If bidder is MSE vendor, is supporting document enclosed: Yes /No
(If MSE, supporting document viz., Udyam certificate has to be enclosed)

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

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

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

f. GSTIN (no.) of place of supply of service: _____

I. Bidder to provide compliance for the under-mentioned terms:

SL. NO.	TERMS	BHEL ACCEPTABLE TERM	BIDDER'S CONFIRMATION	REMARKS, if any
01	**Delivery Period**	Within **23** weeks from the date of issue of Manufacturing clearance along with approved document. However, for mandatory spares, delivery period shall be 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. Note: The prescribed Delivery period is only indicative. Bidder is requested to quote the earliest and best possible Delivery period if any, under the Remarks column.	**AGREE** …… weeks (for main supply) …… weeks (for mand. spare)	
02	**Terms of Payment at the time of material supply**	With reference to Clause:F of Instructions to Bidder, following is the BHEL standard Indigenous Payment term: *"100% of basic 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*. " Note: MSME vendors may opt to get payment through Trade Receivables electronic Discounting System (TReDS)	**AGREE**	
03	**Please provide Percentage of local content** and **details of location(s) at which the local value addition is made:**	'Local content' means the amount of **value added in India** which shall, unless otherwise prescribed by the Nodal Ministry, be the total value of the item procured (excluding net domestic indirect taxes) minus the value of imported content in the item (including all customs duties) as a proportion of the total value, in percent.	**Percentage of local content: _____%** **Location(s) at which the local value addition is made:** _____ _____ _____	

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 may be liable for rejection:

(1) Freight & Transit insurance charges: Freight and transit insurance charges for complete scope of supply shall be to supplier's account.

(2) Validity: The offer will be valid for a period of 90 days from the date of Part-I bid opening and in case of Negotiation/counter offer/RA, price validity will apply afresh for a period of 30 days from the date of according final price by bidder (or) up to original validity period, whichever is later.

(3) Warranty period of the supplied products shall be applicable for a period of 15 months from the date of commissioning (or) 27 months from the date of last dispatch of goods, whichever is earlier.

(4) Evaluation criteria to determine L1 bidder: Items will not be split on item-wise lowest offer. Evaluation of the lowest bidder will be done as package basis. The Procuring Entity reserves its right to grant preferences to eligible Bidders under various Government Policies/ directives (policies relating to Make in India, MSME etc.)

a. Preference to Micro & Small Enterprises (MSEs): Purchase preference will be given to MSEs as defined in *Public Procurement Policy* for Micro and Small Enterprises (MSEs) Order, 2012 dated 23.03.2012 issued by Ministry of MSME (and its subsequent Orders/Notifications issued by concerned Ministry) & the latest *Office Memorandum* issued by Department of Expenditure dt:18.05.2023

   If the bidder wants to avail the Purchase preference, the bidder must be the manufacturer of the offered product in case of bid for supply of goods. Traders are excluded from the purview of Public Procurement Policy for Micro and Small Enterprises. Relevant documentary evidence in this regard shall be uploaded along with the bid in respect of the offered product.

b. Preference to Make in India (MII) products: Preference shall be given to Class 1 local supplier as defined in public procurement (Preference to Make in India) order 2017 as amended from time to time (and its subsequent Orders/Notifications issued by concerned Nodal Ministry for specific Goods/Products) & the latest *Office Memorandum* issued by Department of Expenditure dt:18.05.2023.

{'Class-I local supplier' means a supplier or service provider, whose goods, services or works offered for procurement, has local content equal to or more than 50%, as defined under Public procurement order no.P-45021/2/2017-PP (BE-II) dt: 16.09.2020.

'Class-II local supplier' means a supplier or service provider, whose goods, services or works offered for procurement, has local content more than 20% but less than 50%, as defined under Public procurement order no.P-45021/2/2017-PP (BE-II) dt: 16.09.2020.

In the event of any Nodal Ministry prescribing higher or lower margin of purchase preference and/or higher or lower percentage of local content in respect of this procurement, same shall be applicable.'}

If the bidder wants to avail the Purchase preference, the bidder must upload a certificate along with their bid in company's letter head specifying the percentage of the local content and the details of locations at which the local value addition is made, failing which no purchase

preference shall be granted.
Default margin of purchase preference shall be 20% to local suppliers with default minimum local content of 50%.

Operation methodology of Purchase preference clause to MSE & MII bidders is as detailed under clause:4.c.b) in the Office Memorandum issued by Department of Expenditure dt:18.05.2023 (ref. Annexure-VIII of ITB).

Note: In case of negotiations, the margin of purchase preference (20% for Class-I Non-MSE or 15% for MSE) shall be based on pre-negotiated L1 price and the eligible Class-I & MSE local bidder will have to match the negotiated L1 price.

(5) Performance security: Performance Bank Guarantee (PBG) or Security Deposit (SD), hereafter referred as performance security has to be submitted by successful bidder for 05% of the contract value.

PBG has to be furnished within 05 weeks after notification of the award and it should remain valid for a period of 60 days beyond the date of completion of all contractual obligations, including warranty obligations.

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.

The PBG shall be denominated in the currency of the Contract. The PBG shall be returned to the supplier, without payment of any interest, on successful completion of all the contractual formalities.

In case of breach of contract (failure of supplier), wherever the value of Performance security available with BHEL against the said contract is at least 10% of the contract value, the same shall be encashed.

In case the value of the security instruments available is less than 10% of the contract value, the balance amount shall be recovered from other financial remedies (i.e. available bills of the contractor, retention amount, etc. with BHEL) or legal remedies be pursued.

(6) Submission of documents post PO viz., datasheet/drawing etc. as indicated in Cl: 04 of GCC: Within 28 days from the date of receipt of PO. Delay in the submission of complete set of specified documents in NIT, will attract Penalty as per GCC Clause no.04.a).

(7) Despatch Documents: Complete set of despatch documents (original + 1 photocopy set) as per Purchase Order shall be forwarded to Purchase Executive/BHEL directly.

Despatch documents shall include but not limited to the following documents:

Invoice (01 original and 01 copy with original sign & seal / digitally signed invoice), Lorry Receipt (L/R), Packing List, NIL Short-Shipment Certificate, insurance intimation letter, Proof of Delivery on L/R, copy of Performance security(BG) etc.

One set of Invoice, L/R, Packing List & E-way bills (Part-A&B) shall be e-mailed to BHEL-EDN immediately after despatch.

Note: Detailed Packing List should indicate package-wise content details and also Net & Gross weight of each package.

(8) Erection Supervision & Commissioning and training:

Range of procurement value	Minimum percentage of basic material value proposed for Erection Supervision & Commissioning and training charges:
Up to Rs. 2.50 crs.	05%
Greater than Rs. 2.50 crs. and lesser than Rs. 10 crs.	03% (or) Rs.12.50 lakhs, whichever is higher.

Depending on the material quotation value, the bidder will have to quote the corresponding Erection Supervision & Commissioning and training charges for the respective slab/range as per above table. In case the quoted total Erection Supervision & Commissioning and training value is less than above stipulated charges, BHEL shall evaluate Bidders Price deducting differential amount from main supply price (excluding laptop, cable accessories, mandatory spares) and apportioning towards Erection Supervision & Commissioning and training charges.

Payment terms for E&C charges: 100% payment (on per-diem basis), will be paid in 15 days from the date of submission of supplementary invoice/documents against proof of completion of successful installation & commissioning duly certified by Engineer-in-charge. Contractor's payment is subject to TDS, TCS as per applicable act of Govt.

Terms of Payment for Training at site: 100% payment (on per-diem basis) 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. Contractor's payment is subject to TDS, TCS as per applicable act of Govt.

(9) Based on the under-mentioned declarations in company letterhead of Bidder as insisted under Rule 144(Xi) of General Financial Rules,2017 amendment dt 24.02.2023, eligibility of offer will be ascertained in the tender:

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

Note: Wherever applicable, evidence of valid registration by the Competent Authority shall be attached.

Additional declaration by Bidder in the cases of specified Transfer of Technology (ToT):

"I have read the clause regarding restrictions on procurement from a bidder having Transfer of Technology (ToT) arrangement. I certify that our firm does not have any ToT arrangement requiring registration with the Competent Authority."

OR

"I have read the clause regarding restrictions on procurement from a bidder having Transfer of Technology (ToT) arrangement. I certify that our firm has valid registration to participate in this procurement."

(10) Integrity Pact: Execution of Integrity Pact is applicable for this tender (Refer clause "K" of Instructions to Bidders). The IP as enclosed with the tender is to be submitted (duly signed by authorized signatory

who signs in the offer) along with Part-I 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.

(11) It is the obligation on the part of supplier to discharge his liability by payment of GST to Government of India in cash (or) utilization of input Tax credit in respect of such supply or services through GST invoice under this contract, so that BHEL will avail input tax credit on such supply. In the event that the input tax credit of the GST charged by the supplier is denied by the tax authorities to BHEL due to reasons attributable to supplier, BHEL shall be entitled to recover such amount from the supplier by way of adjustment from the next invoice or from Bank Guarantee. In addition to the amount of GST, BHEL shall also be entitled to recover interest and penalty, in case same is imposed by the tax authorities on BHEL.

If BHEL is not able to avail the credit of CGST & SGST/IGST, partially or entirely because the supplier issued a defective invoice or failed to produce the requisite documents, then the supplier shall immediately indemnify BHEL for such loss of tax credit which would be otherwise available to BHEL. BHEL, in such case, may, at its sole discretion, decide to recover such loss by way of deduction from payment due to the supplier or invoking the contract Performance Bank Guarantee.

The classification of goods as per GST should be correctly done by the supplier to ensure that ITC benefit is not lost to the BHEL on account of any error on the part of the supplier.

Any statutory increase in taxes and duties (i.e GST) or introduction of new taxes and duties within the Contractual Delivery Period shall be to BHEL's account and shall be reimbursed against documentary evidence. However, any statutory increase in taxes and duties (i.e GST) or introduction of new taxes and duties beyond the Contractual Delivery Date shall be borne by BHEL to the extent documents are passed on to BHEL and BHEL is in the position to get the claim from the authorities. Any corresponding decrease on account of above shall be passed on to BHEL.

Any variation in CGST & SGST / IGST at the time of supplies for any reason other than statutory, including variations due to turnover, shall be borne by supplier.

In case GST or any taxes or duties is not applicable at present but become applicable at the time of contractual delivery period due to any reason other than statutory, the same shall be borne by supplier.

With this, we hereby confirm that all the terms & conditions as indicated in Instructions to Bidders (Document Ref: CE: PR: 001- Rev 05) & General Commercial Conditions for Contract (Document Ref: CE: PR: 002- Rev 03) are also accepted without any deviation.

Vendor's Signature with Seal

Note: The above filled-in document shall be furnished as a part of Techno-commercial (i.e., Part-I) bid.

Break-up prices for E&C and training shall be provided in percentage of total lumpsum service charges quoted in priced offer.

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441/VFD/Vedanta/CAIRN/IGC/PQC/R0
Date: 11/01/2025

Pre-Qualification Criteria

Item: VFDs for RDG Additional Infill Wells Project (4570 kW, 6.6kV Motor)
Project: Feed for Inlet Gas Compressor
Customer: M/s.CAIRN Oil & Gas (Vedanta) Ltd.

1. The vendor shall be an Original Equipment Manufacturer (OEM) of VFD Equipment. Only the OEM can submit offers.

2. The vendor should have designed, engineered, manufactured, type tested or got type tested, supplied and commissioned or supervised commissioning of at least one (1) number of VFD system (of the type & model offered) for feeding induction motor/synchronous motor of 1500 kW, 6.6kV or higher rating, which is in successful operation for a period of atleast one (1) year as on February,2025. Necessary supporting document shall be provided.

3. The Reference List of VFD supplies made indicating the ratings, application, details of the customers, year of supply and commissioning status to be provided along with the offer.

4. The vendor or their authorized service representatives shall have trained engineers for commissioning & service of the offered equipment and shall be in a position to provide prompt after sales service and spares support for at least 15 years from the date of supply.

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.

c. PQC/Technical clearance of bid/offer will be based on customer acceptance of vendor's Credentials (does not apply to customer approved vendors for this project).

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	

REVISION HISTORY SHEET

REV. NO.	DATE	NATURE OF CHANGE	REASONS	PREPARED BY	APPROVED BY
00	11-01-2025	FIRST ISSUE	------	MOUNISH G	L SUBBALAKSHMI
01	04-02-2025	SECOND ISSUE	CUSTOMER FEEDBACK	MOUNISH G	L SUBBALAKSHMI

PART-A (VFD SPECIFICATION)

Sl.	Parameter	Specification
1	**Project Data**	
a	Title	RDG Additional Infill Wells Project Feed for Inlet Gas Compressor
b	End-Customer	CAIRN Oil & Gas (Vedanta) Ltd.
c	Consultant	Nauvata Engineering Pvt. Ltd.
e	Location	Gudamalani, Rajasthan, India
2	**Environment Specifications**	
a	Maximum / Minimum Ambient Temperature	50°C / -2°C
b	Equipment Design Temperature	50°C
c	Relative Humidity	74%
d	Altitude	Less than 1000m above mean sea level
e	Seismic Zone	Zone-III as per IS-1893
3	**Input Data**	
a	System V / f / ph	6.6 kV / 50 Hz / 3-ph
b	Voltage variation	± 10%
c	Frequency variation	± 3%
d	Fault level	40kA for 1 Sec
4	**Transformer Data**	
a	Transformer Type	Copper wound Dry type transformer integrated within VFD enclosure. Cables between VFD & transformer shall be in VFD manufacturer's scope.
b	Design Margin	Transformer must be designed for 10% spare capacity of calculated VFD rating.
c	Taps	Transformer shall be provided with ±5% taps on HV side. Tap changer shall be Off-Circuit Tap Changer (OCTC) type.
d	Insulation class / Winding temperature rise for transformer	Class- H / F
5	**VFD Specification**	
a	Drive Application	RDG Additional Infill Wells Project Feed for Inlet Gas Compression
b	VFD type	Fully Assembled Units of Air Cooled VFD Panels (VSI based) with integrated Copper wound Dry Type Transformer.
c	Bypass feature required	No

d	Drive Control	Sensorless Vector Control
e	VFD Output Current	Bidder to size VFD as per Motor full load current indicated in attached Motor datasheet. VFD shall be able to provide rated current at design ambient.
f	Overload capacity	The overload capacity shall be 110% of rated current for 01 minute at rated voltage (refer attached Electrical Job Specification ref.no. R290NEL1A-RDG-E-SP-0003 & Specification for HV VFD ref.no. CAIRN-TSG-E-SP-0020-B2). Bidder to furnish detailed sizing calculations of drive alongwith transformer.
g	Cooling fan redundancy	Redundant ventilating Fans (N+1) shall be provided in both Transformer & Inverter cubicle. In case redundant cooling fan is not possible to be mounted, same shall be supplied loose.
h	Single Line Diagram	Refer attached SLD of VFD system
i	Degree of Protection	VFD : IP-31 ; LCS : IP-55
j	Paint shade	VFD : RAL 7032; LCS : RAL 7031 (Paint shade shall be finalized during detail engineering)
k	VFD + Transformer Efficiency	Efficiency of VFD System (including Transformer) shall be ≥ 95%. Vendor to mention the overall efficiency of quoted VFD system in the offer.
l	Aluminium gland plate thickness	Minimum 3 mm thickness shall be provided. It shall be suitable for Power & Control cables connected to VFD as indicated in SLD. Cable sizes shall be finalized during detailed engineering stage.
m	Motor Winding temperature measurement	Motor winding temperature shall be monitored in VFD panel and take necessary tripping action in case the Motor temperature goes higher than prescribed limits. <u>Protection</u>: 06 Nos. PT100, Simplex,3-wire RTDs will be provided for winding temperature measurement such that Motor winding temperature gets displayed on VFD HMI (or) alternatively, Temperature scanner to be provided for measurement of winding temperature.
6	**Flame proof Local Control Station (LCS)** – As per Spec. ref.no.CAIRN-TSG-E-SP-0010-B2	
a	Enclosure Type / Area Classification	Ex-d / Zone-2, IIA/B, Temp. Class T3
b	Meters/Push buttons/ Indication lamps/etc.	These are to be provided in line with VFD system SLD of BHEL attached with Specification. Meter ratings to be decided by Vendor based on Motor parameters. Push buttons shall be provided with adequate NO/NC contacts (wired upto terminals).

c	Approved make	The LCS shall be procured from following customer approved sources only: • FLEXPRO ELECTRICAL PVT. LTD. • BALAJI ELECTRICAL LTD. • FLAMEPROOF EQUIPMENTS PVT. LTD. • SUDHIR SWITCHGEAR PVT LTD.
d	Cable accessories	LCS shall be supplied with required number of lugs and flameproof glands. Cable sizes for glands shall be provided during detailed engineering stage. The same shall be supplied without any price implication. It shall be noted that all push button stations shall be provided with 2 nos. earthing lugs/studs.
7	**Other Important Data**	
a	Cables and accessories	a) Cable glands and lugs (as applicable) for equipments in Vendor scope b) Owner's scope is limited to only Power and control cables, whose exact cable sizes 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. c) Any special cable required between VFD and motor shall be in VFD vendor's scope and price of same shall be included in base price. However vendor to inform the requirement of PE conductor between VFD and Motor so as to inform customer for arranging the same.
b	Distance between various equipments (approx.)	i) Cable length between VFD and Motor: 500m (Max.) ii) Cable length between VFD and DCS : 700m (Max.)
c	Switching Frequency	to be specified by vendor
d	Area classification	Zone-2, IIA/B, Temperature Class T3
e	Testing requirements	Refer Clause no. 6.0 of attached Job Specification for HV VFD ref.no. CAIRN-TSG-E-SP-0020-B2. Inspection & Testing Plan (ITP) shall be prepared and submitted to customer for review/approval post award during detailed engg. stage.
f	Harmonics	Refer Clause no. 5.25 of attached Electrical Job Specification ref.no. R290NEL1A-RDG-E-SP-0003. Vendor to provide Harmonic Spectrum of VFD for harmonic analysis during detail engineering stage.

g	Auxiliary Supply (All feeders in Customer Scope) – Feeder requirements to be provided by Vendor	i) 02 nos. of 415V,3ph.,50Hz feeders for each VFD – Vendor has to build redundancy with necessary auto change-over arrangement in VFD panel to avoid tripping of VFD on account of failure in one of the 415V supply feeders. Feeder power rating (short-time & continuous) to be specified by vendor. ii) 110V DC control supply for each VFD. However for space heaters, separate Non-UPS supply shall be provided. Necessary power supply arrangement for Motor space heaters shall be made available in VFD panels. iii) 230V AC supply for each LCS
h	Type test	Type test certificate shall be furnished for approval prior to manufacture. Type test performed beyond 05 years are not acceptable. In case type test certificate for the equipment as required above is not available, the vendor shall perform type test free of charge to prove the design to the satisfaction of customer.
i	HV circuit breaker (by EPCC) feeding the HV VFD System	Owner shall provide one shunt trip coil, operating at 110V DC. VFD vendor to confirm suitability of the same.

8. Mandatory Spares for VFD System (02 sets of spares):
(To be supplied along with the Main equipment)

Each set comprises of:

Sl. No.	Items	Mandatory Spares
a	Transistors/IGBT/IGCT	01 no. of each rating & type (or) 01 no. of Power cell (Complete Powercell to be supplied in case of Cell type construction)
b	Control Cards	1 no. of each type
c	Power supply cards/modules	1 no. of each rating and type
d	Power Fuses	1 no. or 20% for each rating, whichever is more
e	Control Fuses / MCB	10 nos. of each rating and type
f	Contactors	Minimum 1 no. or 10% of each rating & type
g	Indication lamps	1 no. or 20% of each rating, whichever is more
h	Indication lamp covers	2 nos. of each colour
*i	Blocker Diode / Diode	2 nos. of each rating and type
j	HMI	1 set
k	CT/PT	1 set each

Note: *i) Wherever offered Drive is with Cell type construction wherein Diode is part of Power cell, bidder doesn't have to offer Diode separately under sl.no.i above.
ii) In case it is found during detailed engineering that offered BoM is not meeting the above specified customer topology of spares, the additional spares will have to be supplied without any additional cost implication to BHEL/end-user.

9. Attachments for VFD System (enclosed in same sequence):

HV VFD	CAIRN Electrical Job Specification ref.no.R290NEL1A-RDG-E-SP-0003-B1
	CAIRN Specification for HV VFD ref.no.CAIRN-TSG-E-SP-0020-B2
	CAIRN (HV VFD) Datasheet ref.no.R290NEL1A-RDG-E-DS-0003 to be filled by bidder
Electrical Requirements for Package Equipments	Specification for Electrical Requirements for Packaged Equipments Document ref.no.CAIRN-TSG-E-SDP-0002-B1
	Electrical Design Basis ref.no.R290NEL1A-RRX-E-BD-0001-B1 (Electrical Interface)
LCS (Flameproof)	CAIRN-TSG-E-SP-0010-B2-Specification for Flameproof Local Control Station
Motor	Datasheet of BHEL,Bhopal
Compressor	Torque-Speed Curve, C2421001/ST (rev.02)
SLD	Single-Line Diagram of VFD System (BHEL,EDN)
INSPECTION TEST PLAN	CAIRN guideline for Inspection Test Plan - Ref.no.CAIRN-TSG-Q-GUI-0004-B1

10. Consolidated *Scope of Supply and Services* for VFD:

Sl. No.	Items	Quantity
i.	a) Fully assembled unit of 4570kW,6.6kV Air-Cooled VFD panel (VSI based) with integral dry-type Transformer including all Power & Control cables between VFD and integrated input Dry Type Transformer; O/p choke/filter (if required) along with power cables between choke/filter and VFD, glands, lugs and termination kit for Output choke/filter as applicable	2 Nos.
	b) Flameproof (Ex-d) Local Control Station (LCS)	2 No.
	c) Cable Accessories: Cable glands for power cable termination in 02 no. each of VFD and Transformer; Double compression flameproof (Ex-d) cable glands and tinned heavy duty long barrel type Cu lugs for all cable terminations in 02 no. LCS.	1 Set
ii.	Laptop loaded with Drive Software	1 No.
iii.	Mandatory spares for VFD	2 Sets
iv.	Service Engineer deputation charges: *Bidder to quote lumpsum charges for 22 man-days which shall be considered for bid evaluation* *a.* Erection Supervision & Commissioning charges of 02 VFDs alongwith 02 LCS at project site *(20 man-days)* *b.* Training of Owner's personnel at project site for operation & maintenance of VFD system (*02 man-days)* Payment shall be made for actual man-days consumed at Site with per man-day charges calculated on the basis of the quoted lumpsum charges. Lumpsum charges quoted shall include travelling, boarding and lodging expenses.	1 Lot

Sl.	Parameter	Specification
11	Training	Training for OWNER's Engineers (02 batches of 15 personnel each) for a maximum period of 02 working days at Site. Bidder to provide all requisite training material like catalogues/ manuals/ documents, etc.
12	Inspection / TPIA	Approved TPIA along with Customer/BHEL will be present at manufacturer's works for witnessing of final testing. This is to be incorporated in the Quality Plan/ Inspection Test Plan (ITP). Charges for hiring of Third Party Inspector (TPI) shall be in Bidder's scope and same shall be built into the prices. The approved TPI for this project is as mentioned below. i) ABS ii) APPLUS INDIA iii) BUREAU VERITAS iv) CERTIFICATION ENGINEERS INTERNATIONAL LTD. v) DNV/GL vi) INTERTEK INDIA vii) IRCLASS SYSTEMS viii) LLOYDS ix) SGS x) TATA PROJECTS xi) TECHMAS TECHNICAL SERVICES PVT. LTD. xii) TUV INDIA xiii) TUV-NORD xiv) TUV-RHEINLAND xv) VCS QUALITY SERVICES PVT. LTD. Third party Inspector shall have to carry out inspection based on approved ITP referring to approved drawings/documents.
13	Packing	All items shall be braced and/or cushioned as necessary to prevent damage from shock, vibration and rough handling. The equipment shall be wrapped in polyethylene sheets before being placed in crates so as to prevent damage to the finish. Crates/cases shall have skid bottoms for handling.
14	Technical Information required along with Offer	a) Dimensional Drawing of Panels along with minimum clearance to be maintained for effective cooling, Heat loss of panel, feeder requirement, Weight of the panel/equipment.

Sl.	Parameter	Specification
14	Technical Information required along with Offer	b) Technical Catalogue of VFD being offered. c) Reference list for similar rating VFDs furnishing the following information: Model number, Application, Rating, Year of supply and status of commissioning. d) Duly filled Pre-Qualification Criteria to be furnished with authorized signatory e) Confirmation / Clarification / Deviation List to Job Specification. f) Duly filled Datasheet for HV VFD. g) Sizing Calculation for Transformer and VFD.
15	Information / Confirmations required along with offer	a) Supply of the VFD shall be by OEM only. Location of the manufacturing plant of the offered equipments 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 from the date of supply. c) Vendor shall give a notice of at least 1 year to the end user of equipment/ Cairn India Limited (CIL) and BHEL before phasing out the product / spares to enable the end user for placement of order for spares and services.
16	Information required for Customer / Consultant approval of proposed VFD system after placement 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 details for each VFD - 415V, 3ph,3 wire (02 nos.) and 110V DC supplies. e) Heat Loss for Air Conditioning System sizing. f) Technical Catalogue of VFD being offered. g) Test Protocol and Quality Plan h) Type test certificates as per ITP. i) Duly filled Datasheet of VFD. j) Sizing Calculation for Transformer and VFD. k)BoM of Mandatory Spares (shall also separately include recommended spares for 02 years of normal operation & maintenance of VFD,which will be directly ordered by end-user)
17	Information Required along with Supply, Operation & Maintenance Manuals and Documentation	Soft copies of Erection, Commissioning and Maintenance Manuals along with Final Drawings and Documentation, Test and Guarantee Certificates, complete Bill of Material for the equipment supplied.

VEDANTA LIMITED

Cairn Oil & Gas

RDG ADDITIONAL INFILL WELLS PROJECT

FEED FOR INLET GAS COMPRESSION PROJECT

JOB SPECIFICATIONS (ELECTRICAL)

Doc No: R290NEL1A-RDG-E-SP-0003

B1	10 May 2024	Issued for Design	KSK	BRB	RR	
A2	15 Feb 2024	Issued with MR	MB	BRB	RR	
Rev	**Date**	**Purpose of Issue**	**Prepared by**	**Checked by**	**Approved By**	

nauvata	**NAUVATA ENGINEERING PVT LTD**	**Contract No. 8500003118R**
		Project No. JBG22002-036

GENERAL

1.1 The specification defines the basic requirements of the electrical works in vendor's scope for the Inlet Gas Compressor Package, FEED & ITT of IGC Compression Project of M/s CAIRN-Gudamalani. This job specification shall be read in conjunction with CAIRN standard specifications, data sheets and documents attached with the Material Requisition. In case of any conflict amongst various documents enclosed with MR, the most stringent requirement shall govern and Owner/PMC decision in this regards shall be final & binding with no cost & time impact to CAIRN.

1.2 The equipment shall conform to this specification, enclosed data sheets and standard specifications.

2.0 SCOPE & EXCLUSIONS

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For vendor's scope of work and supply, refer document no. R290NEL1A-RDG-E-SOW-0002 attached elsewhere in the MR

3.0 POWER SUPPLY SYSTEM

3.1 Utilization Voltages:

Input supply voltage to VFD system, DOL motors, anti-condensation heaters based on their ratings shall be as listed below:

a)	DOL Motors rated below & up to 0.25 kW	:	240 V, 2 Phase,2 Wire AC
b)	DOL Motors rated above 0.25 KW to 160 kW	:	415 V, 3 Phase, 3 Wire AC
c)	DOL Motors rated above 160 kW	:	6600 V, 3 Phase , 3 Wire AC
d)	VD Driven Motor rated up to 315 kW	:	415 V, 3 Phase , 3 Wire AC
e)	VFD Driven Motors rated above 315 kW & up to 700kW {Motor voltage rating (i.e. 690V & above) to be suitably decided by vendor}	:	6600 V, 3 Phase, 3 Wire AC
f)	VFD Driven Motors rated above 700kW	:	6600 V, 3 Phase, 3 Wire, AC
g)	Anti-condensation heaters	:	240V, 2 Phase, 2 Wire AC

3.2 Voltage Level:

Medium voltage	:	415V ±10 %, 65kA (1 Sec), solidly earthed
High voltage	:	6.6kV±10%, 40kA (1 Sec), resistance earthed
System frequency	:	50Hz ± 3 %

4.0 SITE CONDITIONS

The equipment and the installation shall be suitable for continuous operation under the following site conditions:

Altitude above MSL : < 1000 m

Seismic Zone : As per IS-1893

Environment : Dusty, Tropical & Corrosive as found in Hydrocarbon Industry

The temperature profiles at various locations are tabulated below:

Location	Maximum/ Minimum Ambient Temperature	Equipment design temperature (IS-9676)	Humidity
Gudamalani	50 °C/ -2 °C	50 °C	74 %

5.0 SPECIAL REQUIREMENTS

5.1 VFD fed HV motors (>1100V) shall conform to CAIRN Specification CAIRN-TSG-E-SP-0003 and CAIRN-TSG-E-SP-0020 and motor data sheet no. R290NEL1A-RDG-E-DS-0001.

5.2 MV motors (<1100V) for DOL start shall conform to CAIRN Specification CAIRN-TSG-E-SP-0002 and MV Motor data sheet no. R290NEL1A-RDG-E-DS-0002. All MV motor shall be energy efficient IE3 type as minimum as per latest IS: 12615.

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

S. No.	Tag No.	Enclosure Type	Area Classification
1.	Inlet Gas Compressor	Ex-p	Zone-2, IIA/B, Temp. Class T3
2.	Auxiliaries of Off Gas compressor	Ex-d	Zone-2, IIA/B, Temp. Class T3
3.	Local Control Panel/ Local Control Stations for VFD fed motors	Ex-d	Zone-2, IIA/B, Temp. Class T3

5.4 Main compressor motor shall have minimum enclosure protection Ex–p. Motor shall meet the requirements of IS/ IEC 60079.

5.5 Auxiliary motors shall have minimum enclosure protection Ex–d and shall meet the requirements of IS/ IEC-60079-1.

5.6 The rated efficiency and the IE code shall be durably marked on the rating plate, for example “IE3– 94.0 %”. Requirement of Gazette of India for IE-3 motors shall be duly complied as applicable.

5.7 All MV motors shall be provided with spreader box for smooth termination of power cables in the motor.

5.8 Starting current of HV Motor shall be limited to 100% inclusive of positive tolerance when fed through VFD.

5.9 All motors shall have provision for double earthing.

5.10 All glands supplied with motors shall be of thread type ‘ET’.

5.11 RTD/BTD Alarm & Trip setting recommendation shall be provided by Vendor.

5.12 Space heater shall be supplied for motors rated 30 kW and above.

5.13 If HV Motor is provided with elastimold terminal box, then vendor to furnish detailed drawings of elastimold cable termination kits & ensure that cable termination kit shall be made available during FAT of Motor. Short circuit test report shall be furnished for elastimold terminations.

5.14 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.

5.15 Trolley mounted pumps shall be powered from a nearby 5 pin socket provided by client/EPCC. Vendor to provide trolley mounted flame proof motors and their flameproof starters suitable for use in Zone-2, Gas group IIA/B, Temp class T3, with 30 meters of armored copper conductor trailing cable.

5.16 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 & basic control/indications as applicable.

5.17 **VARIABLE FREQUENCY DRIVES (VFD)**

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

a.) The VFD system having converter input voltage above 1000 & upto 11000V shall conform to CAIRN specification CAIRN-TSG-E-SP-0020and VFD datasheet no. R290NEL1A-RDG-E-DS-0003.

b.) System earthing for VFD incoming supply is resistance earthed at 6.6kV.

~~c.)~~ Owner shall provide a single plant feeder 6.6KV for each of the VFD system .

d.) Compressor Main motors shall be fed from VFD system continuously. The VFD controlled system shall be complete in all respects including all connections between VFD panels and input transformers, and power electronic circuits. Input transformer, All other equipment shall be suitably rated and power electronics circuit shall be designed to reduce the voltage / frequency at the time of starting so that starting current is restricted to a value not more than 1.0 times rated full load current.

e.) All control and protections required for vendors supplied system shall be in vendor's scope.

f.) For VFD, the input voltage shall be made available by purchaser at 6.6KV level. Output voltage of VFD shall be same as motor utilization voltage (ie 6.6KV) only and no output transformer is acceptable.

g.) Motor shall be started through VFD system consisting of suitably rated input transformer (if applicable), power electronic circuits to reduce the voltage / frequency at the time of starting so that starting current is restricted to a value not more than 1 times rated full load current. The VFD system shall be complete in all respects including all connections between the breakers & other components, VFD panels and input transformer (if applicable). VFD system sizing calculation including sizing of input transformer (if applicable) shall be furnished for owner's review.

h.) VFD By-pass is not envisaged.

i.) Total operational scheme/ logic shall be developed by VFD vendor for owner's approval.

j.) Input transformer (if required) for VFD shall be dry type only. Dry type transformer shall comply with relevant clauses of CAIRN Specification for VFD system (Doc. No. CAIRN-TSG-E-SP-0020).

k.) 51G and 64R relays for input transformer of VFD to be decided by Manufacturer.

l.) VFDs shall be installed in Air-Conditioned area but it shall be suitable for operation in non-air-conditioned area also.

m.) Requirement of dedicated clean earth for VFD system (if any) shall be suitably indicated by the vendor in the offer.

n.) RS-485 serial port shall be provided for communication on MODBUS.

o.) For HV circuit breaker (by owner) feeding the HV VFD System, owner shall provide one's shunt trip coils, operating at 110VDC.VFD vendor to confirm suitability of same .

p.) Control supply to VFD shall be 110 V DC only. However, for space heaters, separate Non UPS supply shall be provided. Power supply for cooling fans shall neither be taken from UPS supply nor shall be taken from space heater supply. It shall be tapped by vendor from incoming power supply. Any converter / inverter module required by vendor shall be suitable taken care by vendor in the supplied VFD.

As numerical relays are not applicable, MODBUS RTU communication protocol may be considered. However,the same shall be finalized during detailed engineering, without any additional cost implication to BHEL/end-user.

q.) Separate 240V, 2 Phase (Phase-Phase) power supply to the motor space heater shall not be provided by owner to VFD panel. Necessary arrangement for these supplies shall be made available in VFD panels by vendor.

r.) ~~Combined testing of motor and VFD shall be carried out at manufacturers works for 1 set of motor and VFD. However, final acceptance shall be based on PGTR at site~~.

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

t.) Provision shall be provided in VFD to provide safety interlocks and permissive commands, in addition to close and trip commands to associated breakers, based on the open and close status of breakers. All control and protections required for motor and equipment fed from VFD shall be in vendor's scope.

u.) VFD shall have terminals to interface with LCS for signals as listed below in Cl. 6.2.

v.) Interposing relays for all the DI signals from DCS/ PLC in VFD shall be considered. 4-20 mA current output signal from VFD shall be provided for current and speed indication to DCS and LCS.

w.) Special Requirement:

i. All numerical relays shall be suitable for communication via IEC 61850 through dual redundant FO link for data integration with substation automation system (SAS). To meet this requirement multiple Ethernet switches (as required) shall be provided for redundant communication with SAS. The details shall be finalized during detail engineering for implementation.

ii. Supply of interconnecting FO cables/ any other special cables from each VFD panels to SAS/ Data Concentrators/ Ethernet switches including end termination accessories such as Pigtails, end connectors, patch cords, LIU and other interfacing/ end termination hardware for optical fiber cables shall be in vendor scope.

iii. Data integration with SAS from each VFD shall be over Modbus TCP/IP protocol. Provision for the same shall be included.

iv. Vendor to consider 4-20mA signal provision for current indication/ speed raise, lower in owner's DCS/ PLC for motor in each VFD. All necessary transducers shall be provided. Vendor to also consider 1 no. trip indication for each motor for interface with owner's DCS/ PLC. Necessary terminal block for these signals shall be provided for taking these signals to owner's DCS/ PLC.

v. Following signals to be considered for interfaces between owner's DCS/PLC and VFD (as minimum) :
   - From PLC panel to VFD- VFD Start Permissive, Stop Command, Emergency Stop.
   - From DCS Panel to VFD- Speed Reference (4-20mA)
   - From VFD to DCS- VFD Ready / run Permissive, VFD Run. VFD fault, VFD Alarm, VFD in remote mode
   - From VFD to DCS- Motor speed (4-20mA) feedback, Motor current (4-20mA), Motor power (4-20mA)
   - From VFD to PLC- VFD mode.

vi. Cable Interface document with interconnection diagram shall be submitted by the vendor.

5.18 Following Cables to be supplied by owner/EPCC:
- Between client's breaker feeder to VFD input breaker (HT Cable)
- Between VFD output to motor TB in field (HT Cable)
- VFD to motor space heater
- Control cables from LCS/ LCP to VFD
- Owner's DCS interface cables

All other cables (if any) are to be supplied by the vendor including but not limited to SAS interface cables.

5.19 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 below. Only power and control cables shall be supplied by Owner.

5.20 Maximum lengths for various cables to be considered for design of the VFD for Compressors, as mentioned in the VFD Data sheet shall be as listed below:

a.) Cable length between switchboard and VFD : 500m
b.) Cable length between VFD and Motor : 100m
c.) Cable length between VFD and DCS : 700m

5.21 Power cable specifications shall be 6.6 kV (unearthed), XLPE insulated, PVC outer sheath, FRLS, armored Copper conductor cable. Vendor to note that there is no PE conductor envisaged between VFD and motor. Vendor to confirm same is not required. If the same is required, vendor to inform the requirement.

5.22 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.

5.23 A joint declaration shall be provided by Compressor vendor, VFD vendor and Motor vendor confirming that VFDs and associated motors compatibility have been ensured & motor is suitable for inverter duty application. dv/ dt value & V_{peak} of VFDs along with dv/dt withstand capacity of motors shall be also mentioned in the declaration.

5.24 Necessary design in VFD shall be considered to avoid drop in the output voltage of VFD. Various parameter i.e. Harmonic content, THD, output voltage/ current etc. at the output of VFD shall be within acceptable limits as per relevant IS/IEC.

5.25 For calculation to limit harmonics within limits as per IEEE 519, system parameters shall be informed during detail engineering. Vendor to provide harmonic spectrum of VFD for harmonic analysis. Following details shall be provided as minimum.

- Current harmonics at 100% and 50% loading for each harmonic order.
- Voltage harmonics at 100% and 50% loading for each harmonic order
- Pulse modulation number
- Phase shift angle
- Rectifier firing angle
- Advance angle
- Commutation reactance in percent of the rated reactance

5.26 Vendor shall provide complete interconnection document which includes complete terminal details (of all vendor supplied equipment) for all signals as required for interface between vendor supplied equipment's (VFD, motor and LCP/LCS) and interface between vendor supplied equipment's and Owners system (VFD to Owners Power and control supply and VFD to Owners DCS system).

5.27 All wiring in equipment supplied as part of this package shall be of PVC/ XLPE insulated, FRLS, stranded copper wires of 660 V grade and size not less than 2.5 sq. mm for CT circuits and 1.5 sq. mm. for other connections.

6.0 LOCAL CONTROL STATIONS FOR MOTORS

6.1 Flameproof (Ex-d) local control panel suitable for gas group as indicated for motors and weatherproof (IP-65) for all motors, emergency stop push buttons & local control station for motors and emergency push buttons as required for plant operation and safety etc. shall be provided by the vendor.

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

a.) Start/Stop push buttons for motor/ heater.
b.) Ammeters for driver motor rated above 5.5kW.
c.) Selector switches as required.
d.) Emergency Stop Push button.
e.) Speed raise Push Button (Applicable for VFD fed motors only)
f.) Speed Lower Push Button (Applicable for VFD fed motors only)
g.) ON/OFF/READY/FAULT indication (Applicable for VFD fed motors only)
h.) RPM Meter (Applicable for VFD fed motors only)

6.4 All the analogue meters shall be taut band type with 240° deflection scale. All meters shall be highly reliable, accurate, compact. Ammeter at LCS for VFD driven motor shall be suitable for 4-20 mA signals from VFD. For DOL fed motors, Owner shall provide 1A CT signal from Owner's motor feeders for wiring ammeter in LCS. Ammeters in the each LCS to be calibrated as per current at different speed of VFD before dispatch. Calibration certificates of the same shall be submitted by vendor during drawing review stage.

6.5 All push button stations shall be provided with 2 nos. earthing lugs/studs.

7.0 GENERAL REQUIREMENT (FOR ALL EQUIPMENTS)

7.1 All equipment shall be tested and certified by an independent testing authority for use in the specified area. The following statutory approval certificates shall be submitted for all equipment to be installed in hazardous areas.

i) Type Test Certificate from independent testing authorities such as CIMFR / BASEEFA / ATEX / equivalent test house

ii) Applicable CCoE/ PESO approval certificates.

iii) Valid BIS license for all Ex-d equipment (equipment procured from India)

7.2 All equipment shall be subject to routine and acceptance tests as per applicable specifications.

7.3 All the instruments, meters, etc., used for testing shall be duly calibrated at NABL laboratory and necessary calibration certificate shall be made available during inspection.

7.4 All external hardware shall be of stainless steel in view of the corrosive atmosphere.

7.5 Paint shade for indoor electrical equipment shall be RAL 7032, & for outdoor electrical equipment shall be RAL 7031.

7.6 Suitability of cable terminal boxes/ chambers for the respective cables sizes / runs as per the final cable schedule shall be ensured by the Vendor. Cable sizes for motor shall be provided by Owner, as per voltage drop calculations. In case, motor terminal box does not have provision to terminate the proposed cable size, intermediate flameproof junction box (suitable for applicable hazardous area classification and voltage grade) shall be provided by the vendor. Terminal box for VFD shall be suitable for the cable sizes, to be finalized during detail engineering.

7.7 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.

7.8 All equipment located in hazardous area and supplied by vendor shall be provided along with double compression cable glands and shall meet all the requirement of IS/IEC-60079-0 whereas single compression cable glands shall be provided along with safe area, indoor located equipment.

7.9 Cable lug material shall be Copper and lugs shall be heavy duty long barrel type only.

7.10 Lugs having sector shaped / circular barrel shall be used for making connections for cables having sector shaped / circular geometry of conductor respectively.

7.11 Vendor to note that, if there is any requirement of emergency electrical power for the auxiliary equipment supplied with the main motor/pump, same shall be highlighted at the bid stage only.

8.0 SPARES

For requirements of commissioning spares, mandatory spares and two year recommended spares for all electrical equipment, refer elsewhere in the MR.

8.1 Commissioning spares for all electrical equipment are included in Vendor's scope of supply and shall be included in the base price.

8.2 Mandatory Electrical spares as mentioned elsewhere in MR are included in vendor's scope of supply and shall be included in the base price suitably.

8.3 Bidder shall submit a list with unit prices of recommended spares for two years of normal operation & maintenance for all electrical equipment along with their bid.

8.4 Recommended list of maintenance spares for two years operation shall include the following as a minimum for motors. Vendor shall ensure & quote for the same accordingly.

a.) Bearing for DE/NDE-one set

b.) Terminal box cover with screws
c.) Fan
d.) Terminal block

8.5 Special tools and tackles required, if any, for erection, site assembly and maintenance of motors as recommended by the equipment manufacturer are included in Vendor's scope of supply and shall be included in the base price.

9.0 MAKES OF EQUIPMENT AND COMPONENTS

9.1 List of approved vendors for Electrical equipment/components is as mentioned elsewhere in the Master Vendor List, attached elsewhere in the MR. VENDOR shall restrict the make of Equipment/ Components/ Materials/ Devices supplied by him strictly in line with the approved Vendor List attached with MR.

9.1 All electrical equipment shall be brand new with state of art technology and proven track record. No prototype shall be offered. The make and type of equipment, if not specified with this bid document, shall be subject to approval of Owner/ EIL.

9.2 VENDOR may procure Equipment/ Components/ Materials/ Devices from any of the approved vendors mentioned in master vendor list. However, current validity and range of approval as per CAIRN enlistment letter, workload, stability and solvency need to be verified by the vendor before placement of order.

9.3 The Equipment /Items for which vendor is not mentioned in the approved master vendor list, the vendor will propose the makes after order placement which is subject to review and approval by owner/ PMC based on satisfactory track record and type test certificates to be furnished by the vendor. Vendor to take approval from Owner/ PMC before finalization of vendor.

9.4 Vendor shall ensure the availability of spare parts and maintenance support services for the offered equipment at least for 15 years from the date of supply. Vendor/ sub-vendor shall give a notice of at least one year to the end user of equipment before phasing out the products/spares to enable the end user for placement of order for spares and services.

9.2 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 motors must have completed 8000 hours of successful operation as on the date of bid opening.

e.) Vendor shall furnish the Experience Record for motor & VFD along with bid to prove that the offered motors & VFD meet the above requirements.

10.0 LIST OF ATTACHMENTS

Sr. No.	Document Title	Document No.
1.	Data Sheet – HV Motors - VFD	R290NEL1A-RDG-E-DS-0001
2.	Data Sheet –MV Motors - DOL	R290NEL1A-RDG-E-DS-0002
3.	Data Sheet - VFD	R290NEL1A-RDG-E-DS-0003
4.	Job Specification (Electrical)	R290NEL1A-RDG-E-SP-0003
5.	Scope of Work (Electrical)	R290NEL1A-RDG-E-SOW-0002
6.	Specification for flameproof control stations.	CAIRN-TSG-E-SP-0010
7.	Specification for high voltage induction motors	CAIRN-TSG-E-SP-0003
8.	Specification for HV variable frequency drive system	CAIRN-TSG-E-SP-0020
9.	Specification for medium and high voltage cable and accessories	CAIRN-TSG-E-SP-0007
10.	Specification for medium voltage induction motors	CAIRN-TSG-E-SP-0002

TECHNICAL SERVICES GROUP

SPECIFICATION FOR HV VARIABLE FREQUENCY DRIVE SYSTEM

CAIRN-TSG-E-SP-0020

CAIRN ENGINEERING STANDARD

Revision	Date	Description	Originator	Checker	Approver
B2	18/01/13	Issued for Technical Input Added	C.Nallakuttalam	C.Nallakuttalam	A.N
B1	29/08/12	Issued for Implementation	C.Nallakuttalam	C.Nallakuttalam	A.N
A1		Issued for Review	C.Nallakuttalam	C.Nallakuttalam	A.N

REVISION RECORD

Revision Philosophy

All revisions for review will be issued at A1, with subsequent A2, A3, etc as required.

All revisions approved for issue or implementation will be issued at B1, with subsequent B2, B3, etc as required.

All revisions approved for issue or design and construction will be issued at C1, with subsequent C2, C3, etc as required.

Narrative sections revised from previous pprove issues are to be noted in the table below and/or highlighted using the appropriate revision status thus: | A2

Previous revision highlighting to be removed at subsequent issues.

Drawings/diagrams revised from previous approved issues are highlighted by 'clouding' the affected areas and by the use of a triangle containing the revision status.

Revision History

Revision No.	Date of issue	Reason for change
A1		Issued for review
B1	29/08/12	Issued for Implementation
B2	18/01/13	Issued for Technical Input Added

CONTENTS

1.0 SCOPE

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 / Soft Starter. 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.

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 limiting harmonics level to 30% motor cable selection and motor sizing/selection.

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 requirements of latest revision of following standards issued by BIS (Bureau of Indian standards) unless otherwise specified.

CODE	DESCRIPTION
IS-5	Colours for ready mixed paints and enamels.
IS-325	Three phase induction motors
IS-2026	Specifications for Power Transformers
IS-3700	Essential ratings and characteristic of semi-conductor 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 for semi-conductor devices
IS-5469	Code of practice for the use of semi-conductor junction devices
IS-6297	Transformers and indicators for electronic equipment
IS-8789	Performance parameters for motors
IS-12729	Switchgear and control gear for voltages exceeding 1000V – General requirements
IS 13408	Code of practice for the selection, installation & maintenance of electrical apparatus for use in potentially explosive atmospheres
IEEE 519	Harmonic distortion standards

2.2 Regulations

All equipment to be used in hazardous area shall be of a type already tested by Central Mining Research Institute (CMRI), Dhanbad and approved by Chief Controller of Explosives (CCE)/Directorate General of Mines Safety (DGMS)/ Directorate General Factory Advice Service & Labour Institute (DGFASLI), as required, for use in specified gas group locations. BIS marking is mandatory.

In case electrical equipments to be used in hazardous area are type tested by other reputed agencies outside India, the vendor shall approach applicable statutory bodies specified above and get the equipment approved by them for use in the specified area of utilisation prior to bidding.

Imported equipment shall conform to the international standards such as IEC/BS/VDE/NEMA or equivalent.

The equipment shall also conform to the provisions of Indian Electricity rules and other statutory regulations currently in force in the country in case Indian standards are not available for any equipment, standards issued by IEC/BS I VDEI NEMA or equivalent agency shall be applicable.

In case of any contradiction between various referred standards I specifications I data sheet and statutory regulations the following order of priority shall govern:

- Statutory regulations
- Data sheets
- Job specification
- This specification
- Codes and standards

In addition, work shall conform to the following statutory requirements as applicable.

- Indian Electricity act and rules
- Fire insurance regulations
- Regulations laid down by Chief Controller of Explosives/DGMS as applicable.
- Regulations laid down by Electrical Inspectorate/CEA
- Indian Petroleum Rules
- OISD guidelines/standards
- Regulations laid down by local authorities from time to time.
- In subject requirement motor shall be mounted in hazardous area where as drive shall be mounted in safe area. However string test is necessary. Remote operating station which shall be mounted near to motor shall be flame proof. Hence request instead of specifying in general be specific related to particular enquiry. This avoids lot of discussion later on.

3.0 SITE CONDITIONS

3.1 The equipment shall be suitable for installation and satisfactory operation in tropical, humid and corrosive atmosphere as prevalent in Refineries/Petrochemical Plants. Unless otherwise specified, design ambient temperature of 50°C and altitude not exceeding 1000 m above MSL shall be considered.

4.0 SYSTEM DESIGN REQUIREMENT

4.1 General Requirement

1. The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.
2. The offered equipment shall be offered for FAT in India. During FAT important parameters shall be demonstrated at full load.
3. Vendor shall ensure availability of spare parts and expert maintenance support services by Indian engineers for the offered equipment for at least for 15 years from the date of supply. The expert engineers shall be stationed in India.
4. Vendor shall give a notice of at least one year to the end user of equipment and CEIL before phasing out the product/spares to enable the end user for placement of order for spares and services.
5. Vendor shall ensure proper co-ordination with the driven equipment supplier in selection / sizing of offered variable frequency drive system.

4.2 Performance Requirement

1. The system shall be energy efficient, designed as standard product and shall provide very high reliability, high power factor, low input harmonic distortion (Less than 5 % or betterTHD) 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.
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 ± 1 0% and frequency variation of ±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.

3. The Sensorless 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
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. 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 ± 1% of rated maximum speed and steady state regulation of ±0.5% of rated speed.
6. The total harmonic distortion (<3% THD) of the voltage and current at inverter output shall be as per IEC 61800-4 and it shall be considered in the design of the motor.(not applicable for soft starter with Bypass arrangement)
7. Harmonics at the supply side of the drive system at primary of the main input dry type 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 CEIL 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 etc.Necessary measurement shall be demonstrated during FAT.
8. Unless otherwise specified, the overload capacity of the controller considering 50c ambient temp. 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 shut down to prevent over heating of the motor and damage to the drive.
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 up to 60 seconds.
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.
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.
12. Maximum noise level from the drive at I-meter distance, under rated load with all normal cooling fans operating shall not exceed 85 DBA.
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.
14. Voltage at motor neutral shall be maintained at ground potential for the total operating condition.

4.3 Control requirement

1. The system shall operate on constant V/F supply with required voltage boost capability in low frequency mode of operation.

2. Short time voltage dips up to 30% 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.

3. The system shall also be equipped with a facility which will restart the system in case of voltage dip over 30% 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.

4. The system shall be suitable for number of starts as per CEIL specification for High Voltage Motors.

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.

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.

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 keypad, 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 drive panel.

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.

9. Drive system shall have provision for interface with upper level automation on profibus protocol such as Substation monitoring system or electrical control system in case specified in the data sheet/job specification.

10. since there will not be any output transformer this point is not required.

4.4 Panel Construction

1. The panel shall include suitable semi conducting power devices (Diodes/LVIGBT/IGCT/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 integrated standards.

2. Upstream breaker 'ON/OFF/TRIP' indications and remote breaker closing and trip push button shall be provided on the front door. Normally upstream breaker shall not be part of drive supplier and hence such indication on MV dive cabinet never comes.

3. Safety Interlock shall be provided so that power cabinet can't be opened unless the upstream 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.

4. The drive shall be suitably housed in sheet steel panels fabricated with 2 mm thick cold rolled sheet steel. 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. The maximum and minimum operating height shall be 1900 mm and 300 mm respectively.

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.

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. Input and output cable terminating busbar shall be housed 500mm from bottom for proper cable termination.

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, 96x96mm. Scale shall have red mark indicating maximum permissible operating rating.

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.

9. Copper earth bus of min. 30x6 sq.mm up to 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 purchaser'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 is required shall be provided.

10. All panels shall be of same height so as to form a uniform line-up, to give good aesthetic appearance.

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, copper conductor wire.l.5rnm2 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 terminal shall be provided.

12. 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.

13. All low voltage compartment and cabling shall be electrically and physically separated from the high voltage compartment.

14. DC link capacitor and pre charging and discharging circuit shall be preferably mounted in the rear of the panel. . Please mention transformer inrush current.

15. Suitable removable type hooks shall be provided for lifting the panel.

16. Perspex type transparent insulating material shall be used for covering live components.

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.

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.

4.5 Cooling

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, module 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, same shall be supplied loose.

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.

3. Necessary starters shall be provided with in the VFD panels for the Ventilation fans CW circulation pumps, any other auxiliary motor etc. The system provided shall be interfaced with drive starting and shut down such 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., shall be incorporated in the overall sequence logic.

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

5.0 EQUIPMENT / COMPONENT SPECIFICATION

5.1 Motor

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

a. The motor shall be suitable for operation with a solid-state power supply consisting of an adjustable frequency inverter for speed control. whose waveform will have less than 1kv dv/dt and less than 3% harmonics.

b. The motor shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive.

c. 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.

d. 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.

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 (RTD's).

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

The converter transformer shall be dry type or type as specified in the data sheet. In case of the dry type transformer, it shall be mounted in the drive system panel unless other specified in the in data sheet, and the offered transformer shall be as per enclosed CEIL Specifications/data sheet. 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, t In rush current of transformer shall be minimum and try to limit to its maximum current capacity.

Oil cooled transformer is not advisable with multi winding facility to take care of input harmonics distortion. When there are more winding in secondary there are more holes in oil tank. As there are mor holes on secondary side of transformer it affects the reliability.he converters and the motor windings under all operational conditions including starting and restarting. NOT REQIRE SINCE NO output transformer is required

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 whole speed range.

e. All power diodes shall be of silicon type with minimum V 80 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 in account the distance between Drive panel and motor and system shall include all material and accessories to make system suitable for a distance of 500m (to take care of eventuality) unless otherwise specified in the data sheet.

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 Output Filter

VFD output current waveform should be inherently sinusoidal at all speeds, with 3% or less 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.

5.6 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 data sheet. 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. 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.

5.7 Local Motor Control Station

a. The flame proof local motor control station to be installed in the field near the motor shall conform to the CEIL 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. Digital 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 full load and starting currents, as well as the drive current.

5.8 Protection, Control, Metering, Indication and Annunciation

The system vendor shall provide all the necessary system control, protection; alarm equipment and metering for the entire drive system and its auxiliary equipment.

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.

5.8.1 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 what is being displayed 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 for upload and download of 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 up stream 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.

f. Laptop with necessary software shall be provided to take care of fault analysis.

5.8.2 Protective Features

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

1. Incoming line surge protection
2. Under / Over voltage protection
3. Phase loss protection
4. Programmable Over current protection and under load protection.
5. Inverter Fault.
6. Over frequency/Over speed of motor
7. Ventilation loss (In case same is not provided, drive shall generate a over temperature).
8. Fault alarm and suitable sensors as required for same shall be provided).

9. Over temperature of equipment.
10. Specific motor protection, including motor winding, bearing temperatures, over current, overload, negative phase sequence and earth fault protections etc.
11. System Earth fault protection.
12. Excitation system protection for synchronous motor
13. Over and under frequency, rotor earth fault(if applicable), field failure protection for
14. synchronous motor
15. Additional protection, if any for drive system

5.8.3 Control and Monitoring

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

1. Start/Stop
2. Speed control (Raise/lower)
3. Forward/Reverse(if specified)
4. Auto/Manual test mode
5. Local/remote
6. Emergency stop
7. Start/stop for by pass starter (where specified)
8. Trip-Remote Breaker
9. Excitation control system for synchronous motors
10. Sequential switching of filters
11. The Operator console shall be communicable with DCS / SCADA via TCP/IP Modbus protocol as well as hardwire for start / stop, Speed control and ESD.

6.0 INSPECTION AND TESTING

The Switchgear, other equipment and materials to be supplied by contractor shall be subject to inspection by CEIL at manufacturer's works. Manufacturer shall furnish all necessary information concerning supply to CEIL inspectors. The inspector shall have free access to the manufacturer's works for the purpose of inspecting the process of manufacture in all its stages to assess the progress of works as well as to ascertain the quality of raw materials used. All routine tests as specified by the applicable standard codes shall be conducted. Shop tests shall be witnessed by Inspector of CEIL or of an agency authorised by owner. Test certificates shall be furnished before the despatch of equipment.

All routine tests shall be carried out as per IS / IEC at the manufacturer's works in India under his care and expense.

Type tests, if specified shall be performed. Short circuit and internal arc test shall be performed at CPRI or equivalent independent testing lab. Impulse withstands and Heat run test may be performed at manufacturer's works.

All sundry installation materials brought to site directly will be inspected and approved by Engineer-in-charge before installation.

Inspection test plan shall be furnished by the vendor for CEIL approval.

6.1 Acceptance Tests

The following acceptance tests shall be carried out at the India manufacturer's works under his care and expense.

1. A general visual check of MV drive shall be carried out. This shall cover measurement of overall dimensions, location, number and type of devices, location and connection of terminals, etc.

2. Manual and electrical operation of circuit breakers and relays shall be checked under the worst conditions of auxiliary supply voltage.
3. Dry insulation test with power-frequency voltage shall be conducted for the main and auxiliary circuits.
4. Insulation resistance of the main and auxiliary circuits shall be checked before and after power frequency voltage withstand test.
5. Operation check shall be carried out for every control function as per the approved schematic diagrams by manually simulating fault conditions and operation of control switches, relays, etc.
6. For equipment bought from other sub-suppliers, certified test reports of the tests carried out at the manufacturer's works shall be submitted. Normally, all routine tests as specified in the relevant standards shall be conducted by the sub-supplier at his works.

6.2 Reports and Certification

Provide applicable certified test reports.

7.0 VENDOR DOCUMENTATION

The VENDOR shall have to take approval of relevant drawings and data from the COMPANY in writing before starting manufacture of any equipment. The VENDOR shall at his own cost rectify defects in any manufacture done prior to the approval of drawings / data in accordance with the approved drawings/data and the equipment shall be delivered within stipulated time.

Drawings, data, information and manuals shall be submitted as indicated below:

a. Single Line Diagram showing power distribution.
b. Design calculations in support of selection of equipment rating and system design
c. Technical data sheets, characteristic curves.
d. Equipment layout
e. Dimensional general arrangement drawing along with cross section
f. Control & operation write up/block logic diagram
g. Control Schematic and wiring diagram
h. Any other drawings & data as required for satisfactory operation and maintenance.

8.0 MANDATORY SPARE PARTS

The VENDOR shall supply construction, start-up, commissioning, insurance and capital spares as required.

9.0 PACKING AND DESPATCH

All the equipment shall be divided into several shipping sections for protection and ease of handling during transportation .The equipment shall be properly packed for selected mode of transportation (i.e.by Ship/rail/ trailer). The equipment shall be wrapped in polyethylene sheets before being placed in crates in cases to prevent damage to the finish. Crates /cases shall have skid bottoms for handling. Special precaution notations such as Fragile, This side up , centre of gravity ,weight ,CEIL's particulars, Purchase number etc. shall be clearly marked on the package together with other details as per purchase order.

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

ELECTRICAL

4.14 Type test certificate for similar motors shall be provided.

4.15 Motor shall be suitable for 50 Deg C. ambient Temp.

4.16 Variable frequency drives for HV motors shall be with integral isolation transformer and harmonic filter.(if required)

4.17 Motor shall be provided with LCS as per specification requirement.

4.18 VFD Voltage dip lessons learnt shall be added for new VFD suitably as per below requirement:-

- VFD shall be suitable to overcome Voltage dip concern. All required DO consideration in the VFD, Suitability of VFD software, etc. shall be provided in the VFD.
- In Under Voltage case VFD shall be able to withstand upto 20% dip in supply voltage for 2 secs without damage to semiconductors or fuses.
- The drive shall be designed with an automatic restart facility which will restart the system in case the voltage dips or power interruption for less than 2 second with recovery of the voltage to 90%of its nominal value.
- The drive shall have the facility to block the automatic restart. Upon restart the converter shall be capable of synchronizing onto a rotating motor, so called 'Catch on Fly Start' and develop full acceleration torque within 10 seconds.

4.19 Inlet Gas Compressors shall not be unloaded during main power supply voltage dip and fluctuations. The new VFD and UCP system shall be suitable to meet the aforementioned requirement with all necessary program, VFD protection settings, software, hardware, graphics, licenses etc.

4.20 Please refer "Section C" under "List of Applicable Documents" for more detailed Electrical requirements.

INSTRUMENTATION

4.21 Speed reference shall be taken from Key phasor and not from calculated value. Accordingly, all required interface components as required shall be provided between UCP and VFD to mitigate the unloading of compressors and idle speed of VFD during main power supply voltage dip and fluctuations.

4.22 20% IO spares to be maintained as per company philosophy.

4.23 Package Control, Monitoring & safety requirements including antisurge, load sharing, Machine Monitoring System (MMS) shall be implemented entirely in the Supplier's UCP.

VEDANTA LIMITED

Cairn Oil & Gas

RDG ADDITIONAL INFILL WELLS PROJECT

FEED FOR INLET GAS COMPRESSION PROJECT

DATA SHEET – HV VFD

Doc No: R290NEL1A-RDG-E-DS-0003

B1	04 Mar 2024	Issued for Final	MB	BRB	RR	
A2	28 Feb 2024	Issued for Review	MB	BRB	RR	
Rev	**Date**	**Purpose of Issue**	**Prepared by**	**Checked by**	**Approved By**	**Client Approval**

nauvata	**NAUVATA ENGINEERING PVT LTD**	**Contract No. 8500003118R**
		Project No. JBG22002-036

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

1.	Applicable standards		:	CAIRN -TSG-E-SP-0020
2.	Rated output capacity (KW)		:	*
3.	Rated Output voltage		:	6.6 KV, 50Hz, 3phase
4.	Motor Details			
	a)	Motor tag no.	:	*
	b)	Type of motor	:	Squirrel cage induction motor
	c)	KW rating	:	*
	d)	Starting condition	:	VFD start/ VFD run
	e)	Frequency range	:	*
	f)	Voltage range	:	*
	g)	Full load current	:	*
	h)	Full load PF		
		- pf at lowest KW	:	*
		- pf at Highest KW	:	*
	i)	Starting current	:	*
	j)	Load torque details	:	*
5.	**SITE CONDITIONS:**			
	a)	Ambient temperature	:	Max. 50° C / Min. -2° C
	b)	Design temperature	:	50° C
	c)	Altitude	:	Less than 1000M
	d)	Installation	:	Indoor
	e)	Location	:	VFD Room at Roof top of Substation Provide AC room for VFD
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	:	± 5%
7.	**SYSTEM REQUIREMENTS**			
	a)	Speed range required	:	As per process requirement
	b)	Adjustment of speed	:	Auto (from DCS) & Manual (from LCS)
	c)	Speed Reference by measurement of the stator voltage frequency through voltage transformer	:	*
	d)	Reference Signal	:	4 - 20 mA (from DCS).
	e)	By pass Contactor	:	NA
	f)	Acceleration time	:	*
		Deceleration time	:	*
	i)	Fault diagnostic	:	Required

j)	Braking	:		
k)	Regeneration	:		
l)	Cable length between swbd and VFD.	:	*	
n)	Cable length between VFD and Motor	:	*	
o)	Cable length between VFD and DCS	:	*	
p)	Communication facility with data concentrator on open protocol	:	Required	
q)	Separate PE conductor between VFD and motor	:	Required / Not Required	Customer to provide PE cable

*** - 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	:		
4.1	Applicable code/standards (for VFD)	:		
4.2	Applicable code/standards (for Harmonics-I&V)	:		
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.	Output short circuit capability and duration	:		
13.	Deration of motor at			
	a) Maximum speed	:		
	b) Minimum speed	:		
14.	**Rectifier/Inverter**			
	a) Make	:		
	b) Type/Model No.	:	voltage or current source/	
	c) Mode of Operation	:	PWM with IGBT or forced/ Load commuted.	
	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	:	Open/Closed type	
	g) Speed control Range	:		
	h) Speed Control accuracy	:		
	i) Torque control accuracy	:		
	j) Ramp up/downtime range	:		
	k) Rated output current	:		
	l) Type	:	Constant/Variable Torque	
	m) Switching frequency range	:		
	n) Full Load power factor	:		
	o) Power loss ride through	:		
	p) Accessories	: i) Input choke ii) Output choke iii) Mains filter iv) Current harmonics-THD/Other prominent harmonics v) Rectifier configuration- 6/12/18/24/36 pulse vi) dv/dt filter or sine filter at vfd o/p-yes/no vii) Electromagnetic compatibility- Reqd.		
15.	**DC Reactor**			
	a) Make	:		
	b) Type	:		
	c) Rating	:		
	d) Inductance of the reactor	:		
	e) Air Core/Iron Core	:		
	f) Cooling Type	:		
	g) Overall Dimensions	:		
	h) Total weight	:		
16.	**Output Filter**			
	a) Make	:		
	b) Type / Model No.	:		

c) Rating :
d) Rated Voltage :

17. **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 :

18. **Converter Transformer Details**

a) Make :
b) KVA Rating :
c) Type : oil cooled/dry type/cast resin
d) Voltage ratio :
e) Vector group :
f) Impedance value :
g) Insulation Class :
h) Overall dimensions :
i) Total weight :
j) Trafo. Accessories :

19. **VFD PANEL DETAILS**

a) Overall Dimensions (LxWxH) mm :
b) Material :
c) Final Paint Shade :
d) Cooling fans redundancy : Yes/No
(Dimensional details of all panels shall be furnished)
e) Degree of protection for enclosure. :
f) Cooling system : Natural/Forced
g) Heat output of Panel :
h) Max. temp rise allowed :
i) Total Weight (Kg) :

20. **Auxiliary Power Requirement:**

a) KW :
b) Voltage :

21. LCS/LCP required as per spec : Yes

22. Requirement of earthing cable between :

motor & drive

23. Address of Manufacturing Location :
24. Address of Shop Testing Location :
25. Since when the proposed type of semiconducting power devices are being used in the offered drive model :
26. List of equipment / Components to be sourced from India :

27. General

27.1 Speed/Torque Characteristics furnished : Yes/No

27.2 Standard Features provided : Specify

27.3 Optional Functions :

27.3.1 Microprocessor based (digital) control system : Yes/No

27.3.2 Auto Voltage boost :

27.3.3 Auto slip compensation :

27.3.4 Extended speed range :

27.3.5 Energy saving option :

27.3.6 Breaking :

27.3.7 Four Quadrant operation :

27.3.8 Trip History Monitor :

27.3.9 Auto Torque Boost :

27.3.10 Specify other functions/features :

27.3.11 Recommended clearance from (VFD Panel (Front/Rear/Side) :

27.3.12 Bus Bar Material
a) Earth Bus size :
b) Earth Bus material :

28. **E& I Interface** (as per Annexure of Engg. Design Basis) :

29. Inlet Gas Compressors shall not get unloaded under main power supply voltage dip and fluctuations. VFD and associated UCP system shall be suitable to meet the aforementioned requirement with all necessary program, VFD protection, software/hardware, graphics, licenses, etc.

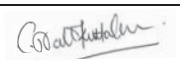
30. VFD Panel back door interlocking arrangement shall be provided.

TECHNICAL SERVICES GROUP

SPECIFICATION FOR ELECTRICAL REQUIREMENTS FOR PACKAGED EQUIPMENTS

CAIRN-TSG-E-SDP-0002

CAIRN ENGINEERING STANDARD

					
B1	31/08/12	Issued for Implementation	C.Nallakuttalam	C.Nallakuttalam	A A
A1		Issued for Review	C.Nallakuttalam	C.Nallakuttalam	A A
Revision	Date	Description	Originator	Checker	Approver

REVISION RECORD

Revision Philosophy

All revisions for review will be issued at A1, with subsequent A2, A3, etc as required.

All revisions approved for issue or implementation will be issued at B1, with subsequent B2, B3, etc as required.

All revisions approved for issue or design and construction will be issued at C1, with subsequent C2, C3, etc as required.

Narrative sections revised from previous pprove issues are to be noted in the table below and/or highlighted using the appropriate revision status thus: | A2

Previous revision highlighting to be removed at subsequent issues.

Drawings/diagrams revised from previous approved issues are highlighted by 'clouding' the affected areas and by the use of a triangle containing the revision status.

Revision History

Revision No.	Date of issue	Reason for change
A1		Issued for review
B1	31/08/12	Issued for Implementation

TABLE OF CONTENTS

1.0 SCOPE

This specification defines the requirements for design, engineering, procurement of materials, construction, wiring, testing and commissioning of electrical equipment provided with packaged units. The skid shall have pre-wired terminations to externally mounted terminal boxes for connection to the COMPANY's facilities.

2.0 CODES AND STANDARDS

2.1 Standards

2.1.1 Bureau of Indian Standards (BIS or IS)

2.1.2 International Electro-technical Commission (IEC) Standards.

Regulations

All equipment to be used in hazardous area shall be of a type already tested by Central Mining Research Institute (CMRI), Dhanbad and approved by Chief Controller of Explosives (CCE) / Directorate General of Mines Safety (DGMS)/ Directorate General Factory Advice Service & Labour Institute (DGFASLI), as required, for use in specified gas group locations. BIS marking is mandatory.

In case electrical equipments to be used in hazardous area are type tested by other reputed agencies outside India, the vendor shall approach applicable statutory bodies specified above and get the equipment approved by them for use in the specified area of utilisation prior to bidding.

Imported equipment shall conform to the international standards such as IEC/BS/VDE/NEMA or equivalent.

2.1.3 The equipment shall also conform to the provisions of Indian Electricity rules and other statutory regulations currently in force in the country.

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

2.1.5 In case of any contradiction between various referred standards I specifications I data sheet and statutory regulations the following order of priority shall govern:

- Statutory regulations
- Data sheets
- Job specification
- This specification
- Codes and standards

2.2 Specifications

2.2.1 This specification gives a brief outline of requirement of component parts. For details refer the latest version of respective COMPANY specifications. Requirement specified under these specifications forms part of this specification. Some of the applicable specifications are enlisted as follows:

CAIRN-TSG-E-SP-0001	Specification for Oil Type Transformers
CAIRN-TSG-E-SP-0002	Specification for Medium Voltage Induction Motors
CAIRN-TSG-E-SP-0003	Specification For High Voltage Induction Motors
CAIRN-TSG-E-SP-0004	Specification for Dry Type Lighting Transformers
CAIRN-TSG-E-SP-0005	Specification for Medium Voltage Switch Gears
CAIRN-TSG-E-SP-0006	Specification for High Voltage Switch Gears
CAIRN-TSG-E-SP-0007	Specification for Power and Control cables
CAIRN-TSG-E-SP-0008	Specification for Electrical Heat Tracing
CAIRN-TSG-E-SP-0009	Specification for Lighting Systems
CAIRN-TSG-E-SP-0010	Spec for FLP control stations

CAIRN-TSG-E-SP-0011	Spec for FLP Light fittings and JB's
CAIRN-TSG-E-SP-0012	Spec for hazardous Area Plugs , sockets and hand lamps
CAIRN-TSG-E-SP-0013	Spec for safe area industrial type control stations
CAIRN-TSG-E-SP-0014	Synchronous Motors and Generators
CAIRN-TSG-E-SP-0015	Spec for Uninterruptable Power Supply (AC)
CAIRN-TSG-E-SP-0016	Specification for DC Power supply system
CAIRN-TSG-E-SP-0017	Project General - AC-DC Distribution Boards
CAIRN-TSG-E-SP-0018	Electrical Cable Tray System
CAIRN-TSG-E-SP-0019	Cathodic Protection
CAIRN-TSG-E-SP-0020	Project General - Variable Frequency Drives - VFD / Soft Starters
CAIRN-TSG-E-SP-0021	Project General - Neutral Grounding Resistor
CAIRN-TSG-E-SP-0022	Motor Operated Valve (MOVs)
CAIRN-TSG-E-SP-0023	Specification for Packaged Substation
CAIRN-TSG-E-SP-0024	Electrical Specification For Construction Power Supply System
CAIRN-TSG-E-SP-0025	Electrical Specification for High Mast Lighting
CAIRN-TSG-E-SDP-0002	Electrical design Philosophy for Package Equipments

3.0 GENERAL REQUIREMENTS

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

4.0 SITE CONDITIONS

The equipment shall be suitable for installation and satisfactory operation in tropical, humid and corrosive atmosphere as prevalent in Refineries/Petrochemical Plants. Unless otherwise specified, design ambient temperature of 50°C and altitude not exceeding 1000 m above MSL shall be considered.

Equipment and accessories shall be designed to deliver rated performance at extreme site conditions as specified in Project General Information Sheets.

4.1 Area Classification

4.1.1 Hazardous area classification shall be done as per IS 5572. Selection of enclosures for hazardous area equipment shall be as per Oil Industry Safety Directorate (OISD) Recommended Practices 149 and IS 5571. The hazardous area equipment shall also be designed for operation in temperature class T3 and gas group II A / B.

4.2 Electrical System Voltages and Variations

4.2.1 Site Voltages

a.	6600V± 6%	3 Ph 3W 50 Hz ± 3%	Motors/Heaters rated above 160kW
b.	415V± 6%	3 Ph 4W 50 Hz ± 3%	250W<=Motors/Heaters rated <=160kW
c.	240V±6%	2Ph 2W 50 Hz ± 3%	Motors, Space Heaters, Lighting<250W
d.	230V ±1 % ac(UPS)	1 Ph 2W 50Hz ±1%	Process control & instrumentation supply
e.	110V ±10% dc	2W	Protection, Control and indication for HV & LV Switchgears*

* 415V switchgear control power can be 240V 2 Ph AC, where 11OV DC is unavailable.

4.2.2 Equipment is to run through a 20% voltage drop for a specified duration.

4.2.3 Package shall be designed based on project specific voltage requirement either 6.6 KV / 415 V. Further voltage level shall be derived internally by suitable means unless otherwise specified.

5.0 CONSTRUCTION

5.1 Interchangeability

5.1.1 Identical electrical components shall be of one type and with draw able sub-assemblies containing one or more components with identical functions and capacities shall be mechanically interchangeable.

5.2 Instrument Transformers

a. Current: Cast resin insulation type, relaying accuracy in compliance with IS 2705.

b. Potential: Cast resin type, air insulated with HRC fuses on both primary and secondary sides, to IS 3156.Accuracy Class 0.3.

5.3 Motor Starters

5.3.1 HV Switchboard

a. Indoor use, metal clad, vertical self-standing, dead front, front access, single tier cubicle type within. IP 4X enclosure. The switchboard shall be located in an unclassified area.

b. Draw-out type Vacuum Circuit Breakers (VCBs) for incomers

c. Draw-out type Vacuum Contactor with Fuse for motor feeders

d. DOL starter for motors rated up to 1000 kW and VFD's / Soft starters for motors rated above 1000kW (unless otherwise specified / agreed upon)

e. Bottom entry cables for incomers and feeders

f. 20 % spare feeders for future

g. Incomer and outgoing breakers shall have CBCT based earth fault relay in addition to the standard numerical protection relays.

h. Refer High Voltage switch board specification for detailed requirements

5.3.2 LV Switchboard

a. Indoor use, metal clad, vertical self-standing, with min. IP 4X enclosure and for outdoor use min.IPW 55. The switchboard shall be located in an unclassified area.

b. Air Circuit Breaker for incomers rated 630A & above. Otherwise MCCB will be used.

c. Double front, draw-out type construction

d. Motors rated up to 100 kW will be controlled by MCCB, Intelligent motor protection relay, Contactor. Motors rated 100 kW &above will be controlled by Air Circuit Breaker and intelligent motor protection relay identical breaker/contactor will be interchangeable.

e. Bottom entry cables for incomers and feeders

f. All motors feeders will have additional earth fault protection with CBCT in the range of 30mA to 300mA

g. Space heater for motors rated 30kW and above

h. 20% spare feeders for future

5.4 Control Equipment

5.4.1 Motors will be provided with a local control station in the field. Motors installed at elevated platforms will be provided with stop push button at ground level in addition to control station near motor.

5.4.2 The local control stations will have suitable protection for site conditions. The control stations will have the following equipments as per individual requirements:

a. Three position Hand-Off-Auto, momentary, encapsulated contacts, constructed of thermoplastic Material, protection type IP 67 per IEC 60529 or eq.

b. "Start" and "Stop" spring return type, push buttons red for stop and green for start per IEC 60073or eq., equipped with M20 sized brass glands and blanking plates. "Stop" push button shall be lockable in "Stop" position.

c. Ammeter

5.4.3 All the control voltage shall be derived internal unless otherwise specified in the data sheet.

5.4.4 All Package equipments shall have communicable interface with SCADA / DCS for control and monitoring of electrical parameters. The communication protocol shall be Modbus TCP/IP, Modbus RS485.

5.4.5 All the Electrical equipments (LV switch gear, HV switch gears, Drives etc) shall be designed in such a way their electrical parameters shall be wired so that the complete package parameters can be communicable as said in 5.4.4 by means of single interface system.

5.5 Motors

5.5.1 TEFC, preferably with enclosure protection IP 44 for indoor and IPW 55 for outdoor, severe duty, high efficiency, form wound squirrel cage induction type, stator

5.5.2 Motor sizing guidelines shall be as per Electrical Design Philosophy

5.5.3 Motor re-acceleration, where required by process conditions

5.5.4 Refer to the motor specifications and datasheet for further details.

5.6 Degree of Ingress Protection for Panels

a. Indoors : IP42

b. Outdoors (protected, e.g. rain canopy) : IPW 55

c. Outdoors (unprotected) : IP 66

d. Terminal boxes : IP 66

5.7 Terminal Boxes

5.7.1 Made of copper free cast aluminium for Zone-1 areas and copper free cast aluminium or reinforced polyester type for Zone-2 areas, temperature class T3 and gas group II A / B.

5.7.2 For motors separate terminal boxes shall be provided for space heaters, bearing temperature detectors and winding temperature detectors as required.

5.8 Lighting

5.8.1 Lighting and controls wired in rigid aluminium / galvanised steel conduit or armoured cable and to skid terminal box for power connection.

a. Indoor type:

Fluorescent, 2 x 36W lamp, 230V(ph-ph) 50Hz input, low loss, electronic ballast, mounted to ceiling or chain suspended, 300 lux illumination level. The control switch shall be located at the accessible location at the entrance to the skid.

b. Outdoor type:

Metal Halide, 70W 230V(ph-ph) 50Hz, Zone 2, Gas Group II A/B T3, low loss, electronic ballast, aluminium ballast housing, impact resistant fluted glass globe, wall mount with cast aluminium feed through box, controlled by photocell and contactor with manual override. The illumination shall be as given below:

Area Description	Illumination Level in Lux
a. Pump Houses, Sheds	100
b. Main Operation Platforms and Access Stairs	60
c. Ordinary Platforms	20

d.	Process Areas, Piperacks, Heat Exchanger, Heaters, Separators, Cooling Tower Columns Pig Launching/Receiving Areas, Loading Area, Flares etc	60
e.	Cooling Tower	60
f.	Stairs	50

c. Photocell:

230V (ph-ph) ac Zone 2 Gr II A/B, T3 with manual override

d. d. Emergency Lighting: Non-metallic, gasketed enclosure, self-contained sealed lead calcium battery,6 or 12Vdc output, two integral heads 8W tungsten halogen, suitable for area of applications. Emergency Lighting shall provide a minimum illumination level of 5 lux when normal supply fails.

5.9 Cable tray

5.9.1 Galvanized steel or aluminium cable tray rated for 149 kg/m, 225 mm rung spacing, 150mm depth, and 6m length. Cable trays will be provided with inverted 'V' type cover. Standard width of trays shall be 900mm, 600mm, 450mm or 300mm.

5.9.2 Installed to form a continuous system by the use of standard fittings where tray changes direction, elevation or branches.

5.9.3 The cable tray will be supported at 1.5 m intervals both vertically and horizontally.

5.9.4 Support cables leaving tray by channel to termination. Process piping and handrails shall not be used to support cable trays.

5.9.5 Multi Cable transit (MCT) for cable entry into containerized equipment shall be used.

5.9.6 Separate perforated tray shall be used for instrument cables. Separate ladder type trays shall be used for HV cables, LV cables and Control cables.

5.9.7 Cable trays shall have 20% spare capacity for laying future cables.

5.10 Cables

5.10.1 Steel Wire Armoured (SWA), XLPE (power) or PVC (lighting & control) insulated, flame retardant low smoke (FRLS), ultra-violet (UV) resistant, non fire propagating halogen free, moisture resistant outer sheath, stranded copper conductors sized on current carrying capacity, 2.5 mm2 stranded for control and lighting wiring, 4 mm2 minimum for power circuits. The cable shall be manufactured as per IS / IEC.

5.10.2 Maximum cross section area for multi core cables is 300mm2 and 630mm2 for single core.

5.10.3 Cables terminated with gas and watertight double compression type for brass cable glands DGMS approved for classified areas and industrial type for unclassified areas.

6.0 CABLING, TERMINATIONS AND EARTHING

6.1 Internal Wiring & Termination

6.1.1 Cables shall be laid and dressed neatly along the cable trays and tied with non-magnetic and noncorrosive cable ties at intervals not exceeding 750mm to the cable tray.

6.1.2 Non-corrosive and non-magnetic cable identification tags shall be provided at cable ends, where cable changes direction, on either side of wall/floor.

6.1.3 Wire identification by the use of permanently embossed slip-on markers at each end to IEC 60391 or eq. Wrap-around, adhesive type markers shall not be used.

6.1.4 Provide crimp-on wire-end lugs of suitable size and sleeves for stranded wire.

6.1.5 Provide individual numbered terminals for each conductor Provide partition terminals of different Voltages.

6.1.6 Cables coming up from floors shall be protected against mechanical damages by means of PVC/Galvanized Iron pipes

6.1.7 20% spare terminals in each panel.

6.1.8 Segregate intrinsically safe wiring.

6.2 Earthing

6.2.1 Minimum size of copper earth conductors shall be 4 mm2 (internal) and 35 mm2 (external).

6.2.2 Two earth bars to which equipment earthing is connected shall be provided at opposite ends of the skid.

6.2.3 Earth connections shall be treated with insulation coating.

7.0 NAMEPLATES AND WARNING PLATES

7.1.1 Corrosion resistant weatherproof material, 3mm black letters on a white background, identifying equipment number as indicated on the drawings

7.1.2 The shop order number, the year of manufacture, the name of the manufacturer, the type and serial number of the equipment etc, shall be clearly marked on the name plate installed outside of switchgear and control gear enclosures.

7.1.3 Warning labels shall have red letters on a white background

8.0 INSPECTION AND TESTING

8.1 Testing

8.1.1 Type test certificate shall be furnished for each type & rating of equipment for approval prior to manufacture. Type test performed beyond 5 years are not acceptable. In case type test certificate for the equipment as required above is not available, the VENDOR shall perform type test free of charge to prove the design to the satisfaction of COMPANY.

8.1.2 Upon completion, the distribution boards shall be subject to standard routine tests as per relevant Standards. In addition any special test called for in this specification shall be performed. The test report in agreed format shall be furnished by the VENDOR.

8.2 Inspection Requirements

8.2.1 The COMPANY's authorized representative shall be afforded the opportunity to witness the testing of the equipment at the supplier's work. The VENDOR shall give 14 days' advance notice of the date when the tests are to be carried out.

8.2.2 The inspection does not relieve the supplier from meeting the requirements of this Specification.

8.2.3 Equipment found not to comply with this Specification may be rejected by the COMPANY's authorized inspector.

a. Fabrication and physical check.

b. Enclosure degree of protection.

c. Degree of protection within compartments regarding safety

d. Reliability of shutters, partitioning, operating mechanism, locks and interlocks, bus bar insulation, creepage distances and clearances

e. Compliance with drawings regarding labelling, grounding and wiring

8.3 Reports and Certification

Provide applicable certified test reports.

9.0 VENDOR DOCUMENTATION

9.1.1 The VENDOR shall have to take approval of relevant drawings and data from the COMPANY in writing before starting manufacture of any equipment. The VENDOR shall at his own cost rectify defects in any manufacture done prior to the approval of drawings / data in accordance with the approved drawings/data and the equipment shall be delivered within stipulated time.

9.1.2 Drawings, data, information and manuals shall be submitted as indicated below:

a. Single Line Diagram showing power distribution.

b. Design calculations in support of selection of equipment rating and system design

c. Technical data sheets, characteristic curves.

d. Equipment layout

e. Dimensional general arrangement drawing along with cross section

f. Control & operation write up/block logic diagram

g. Control Schematic and wiring diagram

h. Any other drawings & data as required for satisfactory operation and maintenance.

10.0 MANDATORY SPARE PARTS

10.1.1 The VENDOR shall supply construction, start-up, commissioning, insurance and capital spares as required.

11.0 PACKING AND DESPATCH

All the equipment shall be divided into several shipping sections for protection and ease of handling during transportation .The equipment shall be properly packed for selected mode of transportation (i.e.by ship/rail/ trailer). The equipment shall be wrapped in polyethylene sheets before being placed in crates to prevent damage to the finish. Crates /cases shall have skid bottoms for handling. Special precaution notations such as Fragile, This side up, centre of gravity, weight, Owner's particulars, Purchase number etc. shall be clearly marked on the package together with other details as per purchase order.

The equipment may be stored in a covered shed for long periods before installation. The packing should be suitable for such storage.

		Comments Resolution Sheet (CRS)
	NAUVATA ENGINEERING PVT LTD	**Project Name : FEED & ITT Preparation for Inlet Gas Compression Project**
DWG/ DOC Number: **R290NEL1A-RRX-E-BD-0001**	**Revision Number: A3**	**Date:04.03.2024**
From, **Nauvata Engineering Pvt. Ltd** 192 &193, Primeco Towers, 5th Floor, Arekere Gate Junction, Bannerghatta Main Road, Bangalore-560076	To, Attn.Ms. Pratyusha Patnaik **CAIRN INDIA LTD.** DLF Atria Building, DLF Phase-2, GURGAON-122002, HARYANA, INDIA	

We are in receipt of your comments on our deliverable(s) which are tabulated in the following table. Clarifications / resolutions to each comment are furnished below. Based on this resolution sheet we shall revise our deliverable(s) and resubmit.

Sl. No.	Clause/ Ref. No.	Comment	Clarifications / Resolution	Status Open/Closed
1.	Page No. 17	Cl. 6.3- Please confirm with Process 5. 2MW or 6MW.	Noted. 5.2MW deleted. 6 MW retained	Closed
2.	Page No. 39	Cl. 7.17, Add following at end of Para. "Inlet Gas Compressor shall not get unloaded under main power supply voltage dip or fluctuations. VFD & associated UCP system shall be suitable to meet the aforementioned requirements with all necessary programs, VFD Protections, software/hardware graphics, license etc. "	Noted & incorporated	Closed

VEDANTA LIMITED

Cairn Oil & Gas

RDG ADDITIONAL INFILL WELLS PROJECT

FEED FOR INLET GAS COMPRESSION PROJECT

ELECTRICAL DESIGN BASIS

Doc No: R290NEL1A- RRX-E-BD-0001

B1	04.03.2024	Issued For Final	MB	BRB	RR	
A3	27.02.2024	Issued For Review	MB	BRB	RR	
A2	14.02.2024	Issued for review	MB	BRB	RR	
Rev	**Date**	**Purpose of Issue**	**Prepared by**	**Checked by**	**Approved by**	**Client Approval**

nauvata	**NAUVATA ENGINEERING PVT LTD**	**Contract No. 8500003118R**
		Project No. JBG22002-036

TABLE OF CONTENT

1. INTRODUCTION

Vedanta (erstwhile Cairn India Limited merged with Vedanta Limited w.e.f. April 11, 2017, pursuant to NCLT order dated March 23, 2017) is a globally diversified natural resources company with interest in Zinc, Iron Ore, Aluminium, Copper, Power and Oil & Gas. Through Cairn, its upstream Oil and Gas division, Vedanta is the operator of the Onshore RJ-ON-90/1 block along with its Joint Venture (JV) partners Cairn Energy Hydrocarbons Limited (CEHL) and Oil and Natural Gas Corporation Limited (ONGC).

Cairn Oil & Gas, in Joint venture with ONGC, is the Operator of Contract Area RJ-ON-90/1 in the State of Rajasthan, North West India as indicated figure 1 below. Cairn discovered various oil and gas fields in RJ-ON-90/1 block. Mangala, Bhagyam and Aishwariya are the major oil fields located in northern part of RJ block and Raageshwari Deep Gas field is the gas field located in southern part of the RJ block. Presently RJ Block has two processing terminals, one is located in northern part (i.e. MPT) and other is in southern part (i.e. RGT).

The RDG Gas Processing Terminal presently processes gas from the Raageshwari Deep Gas (RDG) field. Raageshwari Deep Gas (RDG) field is a low permeability gas condensate reservoir consisting of sandstone (Fatehgarh) and volcanic (Basalt and Felsic) lithology.

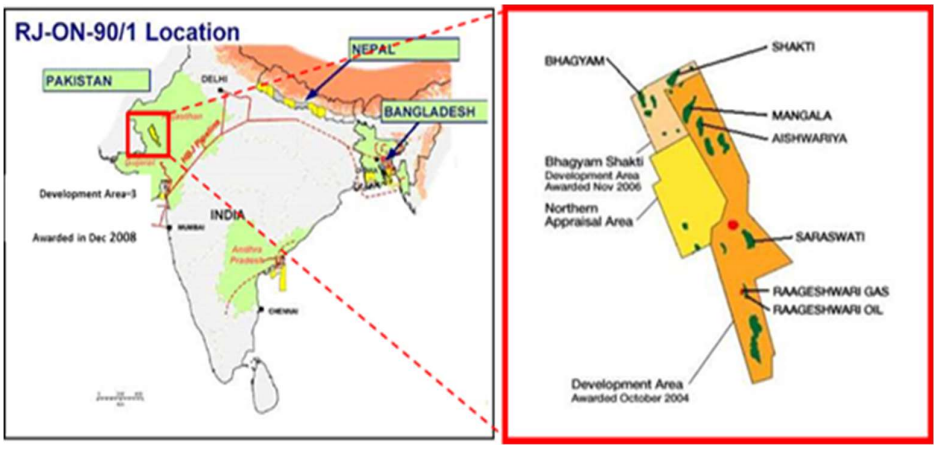


Figure 1 : Block RJ-ON-90/1 Location

The Raageshwari Gas Fields consists of the following facilities:

- Processing Terminals- RGT, RDG and Early Gas Processing Plant (Bridge Facility)
- Wellpads and associated facilities.
- Intrafield Pipelines and Evacuation Pipelines

Now as part of the RDG Additional Infill Wells Project, Company intends to pursue the following activities:

- Inlet Gas Compression at Terminal for reducing backpressure at wellpad.
- Develop and hook-up new eight infill wells from existing well pads.
- Debottlenecking of the existing Fire water network of the terminal for meeting the requirements of OISD-116 and for addition of new equipment.

2. DEFINITIONS / ABBREVIATIONS

2.1 DEFINITION OF TERMS

COMPANY	Vedanta Limited or its authorized representative
DEC/EC	Design / Engineering Consultant appointed by COMPANY
CONTRACTOR/ LSTK/EPC	
SUPPLIER / SUB-CONTRACTOR	The entity / party who supplies equipment and services for the Plant and Facility
OEM	Original Equipment Manufacturer (OEM)

2.2 ABBREVIATIONS

Code	Description
ABT	Availability Based Tariff
AC	Alternating Current
ACB	Air Circuit Breaker
AN	Air Natural
ASB	Auxiliary Service Board
BFAP	Building Fire Alarm panel
CBCT	Core Balance Current Transformer
CEA	Central Electricity Authority
CMRI	Central Institute of Mining & Fuel Research
CT	Current Transformer
CPRI	Central Power Research Institute
DC	Direct Current
DCP	Data Concentrator Panel
DCS	Distributed control system
DG	Diesel Generator
DGMS	Director General Mines Safety
DOL	Direct Online
EHV	Extra High Voltage (132 KV)
ELCB	Earth Leakage Circuit Breaker
ELR	Earth Leakage Relay
EPMCC	Emergency Power cum Motor Control Center
ESD	Emergency Shutdown System
ERTL	Electronics Regional Test laboratory
FEED	Front End Engineering Design
FGS	Fire & Gas System
FRLS	Flame Retardant Low Smoke

GI	Galvanized Iron
GIS	Gas Insulated Switchgear
GTG	Gas Turbine Generator
HMI	Human Machine Interface
HV	High Voltage (6.6 KV ,11 KV ,33 KV)
ICSS	Integrated Control & Safety System
IEC	International Electro-Technical Commission
ITT	Invitation To Tender
LDB	Lighting Distribution Board
LV	Low Voltage (Less than equal to 240V)
MCCB	Molded Case Circuit Breaker
MLDB	Main Lighting Distribution Board
MOV	Motor Operated Valve
MV	Medium Voltage (415 V)
MVA	Mega Volt Ampere
NGR	Neutral Grounding Resistor
ONAN	Oil Natural Air Natural
ONAF	Oil Natural Air Force
OCTC	Off Circuit Tap Changer
OISD	Oil Industry Safety Directorate
OLTC	On Load Tap Changer
PMCC	Power Cum Motor Control Centre
PMS	Power Management System
PESO	Petroleum & Explosive Safety Organization
PT	Potential Transformer
PVC	Polyvinyl Chloride
RCC	Reinforce Cement Concrete
JDVVNL	Jodhpur Vidyut Vitran Nigam Ltd.
RTCC	Remote tap change control
RTU	Remote Terminal Unit
SPLDB	Small Power & Lighting Distribution Board
SP	Single Phase
TP	Three Phase
TPE	Three Phase & Earth
UPS	Uninterrupted Power Supply
VFD	Variable Frequency Drive
XLPE	Cross Link Poly Ethylene

3. SCOPE

The purpose of this document is to describe the requirements of the design and construction of the electrical power, lighting, earthing and auxiliary systems equipment to be installed as part of FEED & ITT preparation for inlet gas compression project to be constructed in Raageshwari Gas Field, as part of this project.

The requirements of this document are to be considered as minimum requirements and CONTRACTOR may submit to the COMPANY, for agreement, any possible solutions, with supporting calculation notes that could give technical and / or economic value addition.

Any omission in this requirement shall not relieve the CONTRACTOR of his responsibility to deliver the equipment along with other associated items, which are complete, of proven design, and conforms to the Performance Requirements.

4. ENVIRONMENTAL CONDITIONS

4.1 CLIMATIC CONDITIONS

Unless specified otherwise, the equipment shall be designed for out-door location, suited to corrosive, desert / salt laden and marine offshore environment. Climatic conditions under which equipment designed / operated shall be as per Equipment Datasheet.

4.2 DESIGN LIFE

Equipment shall be designed and constructed for continuous operation, outdoor and for a minimum service life of 25 years.

5. CODES, STANDARDS AND REFERENCE DOCUMENTS

5.1 INTERNATIONAL CODES AND STANDARDS

The design, materials, fabrication, inspection and testing of equipment shall be in accordance with this document and the latest edition (including addenda / errata) of applicable codes and standards as listed below:

a) BIS - Bureau of Indian Standards
b) IEC - International Electro technical Commission CEA Regulations
c) IEEE - Institution of Electrical and Electronics Engineers
d) ASTM - American Society for Testing of Materials
e) BS - British Standard
f) API - American Petroleum Institute
g) DGMS - Directorate General of Mines Safety
h) PESO - Petroleum & Explosives Safety Organization
i) OISD - Oil Industry Safety Directorate (Elect. Std.)

j) OMR - Oil Mines Regulations (DGMS Guidelines)

k) CEA - Central Electricity Authority (Regulations 2023)

l) Petroleum Rules and any other regulations laid down by Chief Controller of Explosives

m) IEA: Indian Electricity Act.

n) Applicable State Electricity Board Regulation.

In the event of conflict between codes and standards being used, the most stringent one will be followed and decision of company/PMC shall be final & binding on contractor without any cost & time impact to company. . Where Indian standards do not exist for an item or an equipment, or equipment is supplied by foreign manufacturer, relevant international standards shall be applicable. However, certification from National agency as required for the installation of equipment at Feed & ITT preparation for inlet gas compression project shall be complied with.

IS-1646	Code of practice for the fire safety of buildings - Electrical Installations.
IS/IEC-62305	Code of practice for the protection against lightning.
IS-3043	Code of practice for Earthing.
IS-3646	Code of practice for Interior Illumination.
IS-5216	Guide for safety procedures and practices in electrical work
IS-16724	Explosive Atmosphere-Electrical installation Design, Selection and Erection
IS-5572	Classification of hazardous areas (other than mines) having Flammable gases and vapors for electrical installations.
IS-6665	Code of practice for Industrial Lighting.
IS-7689	Guide for Control of undesirable static electricity.
IS-8478	Application guide for on load tap changers.
IS-9676	Reference ambient temperature for electrical equipment
IS-10028	Code of practice for selection, installation, and maintenance of transformer.
IS10118	Code of practice for selection, installation and maintenance for switchgear and control gear.
IS-10561	Application guide for Power Transformer.

IS-12360	Voltage bands for electrical installations including preferred voltages and frequencies.
IS-13234	Guide for short circuit calculations in three phase AC systems.
IS-61241(Part-10)	Electrical Apparatus for use in the presence of combustible dust: Classification of area where combustible dust may be present
IS-61241(Part-14)	Electrical Apparatus for use in the presence of combustible dust: Selection & Installation
IS- 15142	Guide to the use of electrical apparatus for potentially explosive atmospheres in the presence of combustible dusts.
SP-30	National Electrical Code (NEC) - BIS Publication.
IS/IEC 60079-0	Electrical apparatus for explosive gas atmospheres - General requirements.
IS/IEC 60079-1	Equipment protection flameproof enclosures "d".
IS/IEC 60079-15	Electrical apparatus for explosive gas atmospheres:Part15 construction, test and marking of type of protection “n” electrical apparatus.
IS/IEC 60079-7	Explosive atmospheres: Part 7 Equipment protection by increased safety "e".
IS/IEC 60079-2	Explosive protection by pressurized enclosure "p".
OISD-RP-110	Recommended Practices on Static Electricity.
OISD-STD-113	Classification of Areas for Electrical Installations at Hydrocarbon Processing and Handling Facilities.
OISD-STD-118	Layouts for Oil & Gas Installations.
OISD-RP-149	Design Aspects for safety in Electrical System.
OISD -STD-173	Fire prevention and protection system for Electrical Installation.
OISD-GDN-180	Lightning Protection.
OISD-RP-147	Inspection and safe practices during Electrical Installations.
OISD-STD-234	Electrical Safety in Onshore Production Installation in E&P Sector
OISD-STD-116	Fire Protection Facilities for Oil / Gas Processing Plants
IS-325	Three (3) phase Induction Motor.

IS-732	Code of practice for electrical wiring installation system voltage not exceeding 650V.
IS-2309	Code of practice for the protection of buildings and allied structures against lightning.
IS-3034	Code of practice for fire safety of Industrial Buildings-Electrical Generating and Distributing Stations.
IS-3716	Application Guide for Insulation Coordination.
IEEE-519	Requirement for harmonic Control in Electrical Power system

5.2 COMPANY STANDARD SPECIFICATIONS

DOCUMENT NO	REV	DESCRIPTION
CAIRN-TSG-E-SP-0002	B2	Specification for Medium Voltage Induction Motors
CAIRN-TSG-E-SP-0003	B1	Specification for High Voltage Induction Motors
CAIRN-TSG-E-SP-0004	B3	Specification for Dry Type Lighting Transformers
CAIRN-TSG-E-SP-0005	B4	Specification for Medium Voltage Switchgear
CAIRN-TSG-E-SP-0006	B4	Specification for High Voltage Switchgear
CAIRN-TSG-E-SP-0007	B5	Specification for HV & LV P&C Cables
CAIRN-TSG-E-SP-0008	B5	Specification for Electrical Heat Tracing (EHT)
CAIRN-TSG-E-SP-0009	B2	Specification for Lighting Systems (Including High Mast Aircraft warning Lighting)
CAIRN-TSG-E-SP-0010	B2	Specification for Flameproof Control Stations
CAIRN-TSG-E-SP-0011	B1	Specification for Flameproof Lighting Fixtures and Junction Boxes
CAIRN-TSG-E-SP-0012	B2	Specification for Flameproof Plugs, Sockets and Hand Lamps for Flameproof and Safe Area
CAIRN-TSG-E-SP-0013	B2	Specification for Industrial Type Control Stations

CAIRN-TSG-E-SP-0015	B1	Specification for Uninterrupted Power Supply (AC)
CAIRN-TSG-E-SP-0016	B1	Specification for DC Power System
CAIRN-TSG-E-SP-0017	B1	Specification for AC DC Distribution Boards
CAIRN-TSG-E-SP-0018	B2	Specification for Electrical Cable Tray System
CAIRN-TSG-E-SP-0019	B1	Specification for Cathodic Protection System
CAIRN-TSG-E-SP-0020	B2	Specification for HV Variable Frequency Drive System
CAIRN-TSG-E-SP-0022	B1	Specification for Motor Operated Valve (MOVs)
CAIRN-TSG-E-SP-0023	B2	Specification for Electrical House (Packaged Substation)
CAIRN-TSG-E-SP-0024	B1	Electrical Specification for Construction Power Supply System
CAIRN-TSG-E-SP-0025	B1	Specification for High Mast Lighting System
CAIRN-TSG-E-SP-0028	B3	Specification for MV Variable Frequency Drive System
CAIRN-TSG-E-SP-0031	A1	Specification for Field Inspection, Testing and Commissioning of Electrical Installations
CAIRN-TSG-E-SDP-0002	B1	Electrical Requirements for Packaged Equipment

NOTE- Contractor shall refer latest revision of specifications provided along with Tender documents, in case of any discrepancy on revision nos. mentioned elsewhere in the documents.

5.3 STATUARY REQUIREMENT AND APPROVALS

The designed electrical system shall conform to latest version of all statutory and Government regulations. As a minimum, contractor need to meet and fulfill the requirements of following statutory Acts/ regulations, necessary for obtaining all statutory approvals/ certificates, as required, from concerned authorities:

- Indian Electricity Act.

- Central Electricity Authority Regulations latest version.
- The Factory Act
- The Mines Act (DGMS)/ Oil Mines Regulations, OISD etc.
- Fire Insurance Regulations.
- The Petroleum Rules.
- State Electricity Rules/ Regulations laid down by Chief Electrical Inspector of State.
- Any other applicable rules/ regulations of central/ state/ local statutory body.

NOTE:
Special attention is to be paid to chapter IX of CEA Regulations latest version which includes requirements for design of electrical system as applicable to Mines and oil fields Installations.

The CONTRACTOR shall obtain all statutory approvals from DGMS/ Chief Electrical Inspectorate etc. on behalf of VL wherever required. All statutory requirements/ formalities shall be met & fulfilled by the CONTRACTOR, irrespective of level of priority defined elsewhere. VL shall only sign the relevant application forms (as owner) on a request from the contractor after due verification of pre-requisites. Any modification, replacement etc. arising due to requirements of DGMS/Chief Electrical Inspector or any other authority is included in the scope of work and shall be carried out at no extra cost and/or time implication All liaison works between various agencies like Electrical Inspectorate, DGMS, Factory Inspectorate etc. for obtaining necessary statutory approvals/ clearances/ permissions shall be in CONTRACTOR's scope.

<u>DGMS Statutory Approval</u>

Facility of DGMS application, Obtaining Approval, notification / intimation, etc. for overall facility shall be in CONTRACTOR scope including submission of documentation, drawing update, any queries from DGMS the same shall be addressed and completed by CONTRACTOR.

CONTRACTOR shall obtain DGMS approval for all HV installation.
CONTRACTOR shall carryout DGMS notification / intimation for all LV installations.
CONTRACTOR shall comply the submission of below drawing and documents for HV & LV installations according to DGMS Approval & Notification Procedure but not limited to the following.

- All Electrical Equipment's test reports, SLD, Hazardous Area Classification Drawing,

- Electrical Layouts, etc.
- Work Completion Certificate for all Electrical Equipment's.
- EPC Contractor supervisor license copy.
- Electrical EPC Contractor class "A" mines license copy.

Necessary coordination and liaison work in this respect with DGMS shall be responsibility of the EPC CONTRACTOR.

5.4 PRECEDENCE

In case of any conflict between applicable code (s), specification (s) and standards, the most stringent requirements shall govern and Company/PMC decision in this regard will be final & binding on EPC Contractor without any cost &time implication to company.

6. ELECTRICAL SYSTEM DESIGN PHILOSOPHY

The Electrical system shall be designed to provide

Safety to plant, personnel and equipment during operation and maintenance
Reliability of service
Flexibility of operation and maintenance
Minimal fire risk
Reliable Protection system through selective relaying system.
Adequate provision for future extension and modification
Effective power management and load shedding
Low harmonics in the system as per standards (IEEE 519)

6.1 AREA CLASSIFICATION AND EQUIPMENT SELECTION

Hazardous classification of areas and installations shall be in accordance with IS 5572, IS 61241-10, OISD standards and Oil mines regulations act. All the area within the battery limits shall be classified for the degree and the extent of hazard from flammable materials.

All the electrical Equipment installed in hazardous areas shall be selected as per IS-16724 and IS-61241-14 and shall meet the requirements of relevant IS and statutory regulations. However, electrical equipment's for Zone 2 areas as a minimum shall be Ex(d) type as per IS/ IEC codes.

Pressurized electrical equipment's can be used in Zone-1 / Zone-2 as per OISD. Up on failure of pressurization system, the following minimum actions shall be provided.

For Zone 1, the equipment needs to switch off and alarm needs to be initiated.

For Zone 2, Alarm needs to be initiated.

The electrical equipment for hazardous areas shall be selected as per IS-16724 and petroleum rules & Gas group shall be selected based on the hazardous area classification. The minimum requirement is summarized below:

SR NO.	Equipment	Zone-1	Zone-2
1	HV Motors	Ex-de */Ex-p	Ex-de */Ex-p
2	MV/LV Motors	Ex-de*	Ex-de*
3	Push Button Station	Ex-de*	Ex-de
4	Motor Starters	Ex-de*	Ex-de
5	Plug & Socket	Ex-de*	Ex-de
6	Welding Receptacle	Ex-de*	Ex-de
7	Lighting		
7.1	Lighting fitting	Ex-d	Ex-d (Note-1)
7.2	Control Gear Box	Ex-d	Ex-d
8	Junction Boxes	Ex-d	Ex-d
9	Hand Lamps		
9.1	Transformer Unit	Ex-d	Ex-d
9.2	Plug & Socket	Ex-d	Ex-d
9.3	Light fitting	Ex-d	Ex-d
10	Lighting Panel/Power Panel	Ex-d	Ex-d

Note -1 - Emergency light fittings shall be Ex-d as per Cl 5.8 (iv) of OISD-234.
2 – All Ex rated equipment shall be PESO approved.
3 – Any equipment originating from outside India shall be ATEX certified, based on which the PESO certification shall be obtained.

* _ Ex-de equipment shall be subject to availability of PESO Approval.

All electrical equipment to be used in classified areas shall be certified by CMRI /CPRI/ERTL or equivalent recognized independent test house such as BASEEFA/LCIE/PTB/UL/FM. All equivalent (Indigenous and imported) shall also have valid statutory approvals as applicable for use in the specified hazardous area. The indigenous equipment shall confirm to Indian standards and shall comply with requirements of DGMS and CEA 2023.

6.2 SITE CONDITION FOR ELECTRICAL EQUIPMENT

All equipment shall be entirely suitable for the site service conditions and shall be protected against dust, humidity, atmosphere and designed to obviate the entry of vermin and insects.

Description	Values
Black body temperature	80°C
Temperature for thermal design of air cooler	50°C
Site Rated Temperature for GTG sizing	45°C
Design minimum ambient temperature	(-) 2°C
Coldest month normal minimum temperature	10.6°C
Hottest month normal maximum temperature	42°C
Electrical Equipment Design temperature	
Outdoor	50°C
Indoor	50°C
Altitude above mean sea level Less than	1000 m
Seismic Zone (For Seismic Design refer to IS 1893 Part 1 & 4)	Zone-III
Relative humidity Post monsoon Winter Summer	31.5% to 74% 27% to 53% 23% to 67%
Solar radiation level	1.04 kW/m2/hr (5.15 kW/m2/day)

For Soil resistivity, temperature, and Electrical resistivity, please refer the Geotechnical report, for the respective areas.

It shall be ensured that all Electrical equipment selected are suitable for the environmental conditions as specified in this design basis.

6.3 POWER SOURCE

The existing RDG Terminal receives electric power from 132 kV grid of Rajasthan State Electricity Board (JDVVNL) through GIS substation via 2 nos. 40/50 MVA, 132/11.5 kV (ONAN/ONAF) transformers. The received power is stepped down and distributed to various

loads at 6.6kV and 415V levels. 2 nos. GTG Sets each rated 18.3 MW, 11 kV, provide alternate power.

The existing RGT Terminal is presently powered by 3 nos. GEG Sets each rated 1250 kVA, 415 V. An alternate source through double 11 kV feeders from RDG Terminal, that terminates in a 11 kV RMU, and a step-down transformer rated 2500 kVA, 11 / 0.433 kV has already been installed.

2 Nos. VFD fed IGC Compressor motors of rating approx. 6 MW (each) are envisaged under present project which constitute to be the major Electrical load. As per preliminary site information , loading of existing 2 Nos. 11/6.9KV, 40MVA transformers (RDG-RD-901-2-TR-01A & RDG-RD-901-2-TR-01B) through which 6.6KV switchboard (RDG-RD-901-3-SB-01) is getting feed , is 18.4 MW (max) i.e. approx. 23MVA (max) i.e. approx.57.5 %. In view of above, with addition of 2x 5.2/6MW additional load for IGC Compressor motors, max. Loading of 11/6.6KV transformer will be approx. 28.8MW i.e. 36MVA which is approx. 90% which is well within the permissible loading of transformers as per normal/standard practices followed in Industry for brown field projects.

Regarding availability of 2 no's of 6.6kV feeders in above mentioned 6.6kV switchboard, 2 no's 6.6kV extension panels of OEM (SCHNEIDER) make will be provided i.e. one on left side and other on right side of the end panels of existing 6.6kV switchboard. The required vacant space is available for installation of extension panel on LHS and RHS of 6.6kV switchboard.

6.6kV IGC motors will fed through VFD. Required space in RDG substation is not available in switchgear hall for accommodating VFD panels. For housing VFD panels, the substation building will be extended vertically by having new VFD room (air-conditioned) at terrace/roof of RDG substation building.

a) 415V SYSTEM (NORMAL)

Existing two number hot oil pumps (1W+1S), are getting upgraded under this project with the rating of new pump motor as approx.75KW each. These are proposed to be fed from existing 415V, 4000A, 65kA switchboard (RDG-RD-901-4-SB-01, ABB Make). Rather making use of existing spare feeders which are meant for O&M purposes, it is envisaged to extend this switchboard on left hand side by installing 1 no double front extension panel having 2 no's 75KW DOL motor starter feeders. The space for installing extension panel on the left and right side of the switchboard exists in the substation. The associated 11/0.433kV 2.5MVA transformers (RDG-RD-901-2-TR-02A & RDG-RD-901-2-TR-02B) are loaded as 70kW and 170kW respectively summing up to 240KW (load on one transformer with the second transformer not available, a worst case scenario) which is around 300KVA.

HVAC(1W+1S) load for VFD Room is being added under this project. This is proposed to be fed from existing 415V, 4000A, 65kA switchboard (RDG-RD-901-4-SB-01, ABB Make). Rather making use of existing spare feeders which are meant for O&M purposes, it is envisaged to extend this switchboard on right hand side by installing 1 no single front extension panel having 2 no's 630A ACB feeders, in two tier arrangement, to feed 200KW HVAC DB/Panel. The space for installing

extension panel on the right hand side of the switchboard exists in the substation.

b) 415V SYSTEM (IN RGT SUBSTATION)

Existing two fire water jockey pumps (1W+1S), are getting upgraded under the present project with the rating of new pump motor as approx. 150KW each. These are proposed to be fed from existing 415V, 4000A, 65kA switchboard (RGF-RD-901-4-SB-01-NEW EXT, L&T make) which is located in existing RGT substation. This switchboard will be extended on left hand side by installing 1 no two tier extension panel which will have 2 no's 150KW ACB fed motor feeders.

The existing BRIDGE Facility is presently powered by 3 nos. GEG Sets each rated 1250 kVA, 415V. Now the BRIDGE Facility is power up from RGT existing 415VAC, L&T make PMCC (by utilizing feeders which will become spare after dismantling of existing 0.415/34kV Transformer's feeders) to feed the existing as well as new loads. With this modification, the BRIDGE Facility receives permanent power from RGT and the existing GEG set will serve as alternate source.

6.4 SYSTEM VOLTAGE

Utilization Voltage and Frequency shall be considered as below:

Sr. No.	Description	Selected Option
1.	Grid Power	132KV ± 6%, 3ph, 3W, 50 Hz ± 3%, solidly grounded
2.	Power Generation (Normal) (at RDG)	11KV ± 6%, 3ph, 3W, 50 Hz ± 3%, High resistance grounded
3.	Power generation (Emergency) (at RDG)	6.6 KV ± 6 %, 3ph, 3W, 50Hz, ± 3%, High resistance grounded
4.	Utilization voltage (Motors > 160KW)	6.6 KV ± 6 %, 3ph, 3W, 50Hz, ± 3%, High resistance grounded
5.	Utilization voltage (250W<=Motors <=160KW, MOVs, Welding socket outlet)	415V ± 10 %, 3ph, 3W, 50Hz, ± 5%, resistance grounded
6.	Motors < 250W, Lighting, Space Heaters, Convenience socket outlet	240V ± 6 %, 2ph, 2W, 50Hz, ± 3%, solidly grounded

7.	Protection, Control & Indication Supply for 132KV/11KV/6.6KV Switchboard and 415V Breakers*	110V± 10%, DC, 2W, Ungrounded
8.	Circuit Breaker Spring Charging of HV Switchgears and 415V switchgears*	110V± 10%, DC, 2W, Ungrounded
9.	415V contactor feeder control and indication supply	240V± 6%, 2ph, 2W, 50 Hz ±3%, solidly grounded
10.	AC UPS system	230 V± 1%, 1ph, 50 Hz± 1%
11.	DC Charger system	110 V±10%, DC and 24V DC. 24V DC Supply is generated internally within Panel.
12.	Process Control & Instrumentation system	UPS: 230V AC ±1%, 1ph, 50 Hz ± 1% Non-UPS: 240V ± 6%, 2ph, 2 W, 50 Hz ± 3% 3 Phase: 415V ± 6%, 3ph, 3W, 50Hz ±
13.	Communication System	230V±1%, 1ph, 50 Hz + 1%, (from UPS System)

* 415V switchgear control power supply can be 240V, 2ph, 50Hz, where 110V DC is unavailable. 240V, 2ph, 50Hz supply shall be derived from the Switchboard's Control Transformer.

6.5 ALLOWABLE VOLTAGE DROPS

The maximum allowable voltage drops, as a percentage of the system during Normal Operating and Startup.

SR NO	DESCRIPTION	OPERATING CONDITION	ALLOWABLE VOLTAGE DROP LIMIT
1.	Bus duct or cable between transformer secondary and HV switch board	Stabilized	0.5 %
2.	Cable between PCC / MCC and MCC or auxiliary switch board	Stabilized	0.5 %

2.1	Remotely located MCC / Auxiliary switch board to PCC / PMCC	Stabilized	2 to 2.5 % (Note 3)
3.	Cable between HV switch Board and HV Motor	Stabilized	3 %
4.	Cable between PMCC and MV motor	Stabilized	5%
5.	Cable between auxiliary switch board / LDB and lighting Panel	Stabilized	1.5 % (Note 2)
6.	Circuits between lighting panel and Lighting points	Stabilized	4 %
7.	DC supply circuits for electrical systems	Stabilized	5 %
8.	From Main DCDB to DC Sub DB	Stabilized	2 %
9.	From DC Sub DB to farthest consumer	Stabilized	3 %
10.	From Main UPS DB to UPS Sub DB	Stabilized	2 % (Note 1)
11.	From UPS Sub DB to farthest consumer	Stabilized	3 % (Note 1)
12.	At the bus bar of the worst affected HV switch board (Startup of the large HV motors with other loads on the bus (Simultaneous startup of HV motors is not envisaged)	Startup	15 %
13.	At the bus bar of the worst affected MV switch board (PCC / PMCC / MCC) (Startup of the large MV motors with other loads on the bus (Simultaneous startup of MV motors is not envisaged)	Startup	10 %
14.	Cables between HV switch board and HV Motors	Motor startup	5% (Note 7)
15.	Cables between MV switch board and MV Motors	Motor startup	15 % (Note 7)
16.	33 KV / 132 KV OH line	Stabilized	3 %

Note 1: Minimum voltage available across any instrument in the field shall be as per instrumentation design basis. Distribution system for instrumentation supplies shall be designed accordingly. in case of any conflict between electrical design basis and instrumentation design basis, the later shall govern regarding instrumentation power supplies.

Note 2: In case of difficulty in achieving specified voltage drops in cables up to lighting panel, 5 % drop from auxiliary switch board up to lighting points may be permitted.

Note 3: Higher voltage drop may be permitted between PMCC and remote mounted Distribution board; if overall voltage drops up to motor (PMCC to motor) is limited within 5.5 %.

Note 4: For medium voltage motors, the voltage available at the motor terminals must not be less than 75 % of the rated value during startup & must be sufficient to ensure positive starting without causing any damage to the motor.

Note 5: For high voltage motors, the voltage available at the motor terminals must not be less than 80 % of the rated value during startup & must be sufficient to ensure positive starting without causing any damage to the motor.

Note 6: Based on the sizing criteria as defined, including voltage drop criteria, cables for 415 V motors shall be selected.

Note 7: Higher voltage drop in motor cables may be permitted, in case the condition given in note 4, 5 are complied.

7. EQUIPMENT DESIGN PHILOSOPHY

The equipment shall in general confirm to standard specification. Equipment shall be selected and sized as per philosophy given below.

The degree of protection for enclosures shall be according to IEC 60529 and IEC 60144 as follows:

- Indoor equipment : IP 4X for HV Switchgear
  IP 42 (Min) for MV and LV Switchboards & Other Panels
- Outdoor Equipment: IP 55 with canopy for all equipment

7.1 TRANSFORMERS

7.1.1 All transformers except lighting transformers/ VFD transformer shall be three phase, oil immersed, double wound type suitable for outdoor use. Lighting transformers & Heat tracing transformers shall be dry type.

7.1.2 KVA rating and percentage impedance of each transformer shall be selected to limit the rated current and short circuit current values which are within the current rating and interrupting capacity of switch gear available.

7.1.3 The KVA rating shall be decided on the following basis and should be as far as possible a standard value. Sizing shall include 10 Percent margin for future growth.

- Transformers without any forced cooling, each transformer shall be rated to or equal to or greater than the 8 hr maximum demand of the load plus 10 % margin for future growth.
- Transformers with forced cooling, each transformer shall be rated equal to 8 hrs

maximum demand of the load plus 10 % margin for future growth within 110 % of its self-cooled ONAN rating and shall be fitted with automatic forced air-cooling fans.

7.1.4 Heat tracing transformers shall be rated for 30 % spare capacity considering the unequal loading.

7.1.5 Heat tracing transformers secondary side shall be protected with ELR and CBCT with CBCT installed on the secondary side in the transformer itself.

7.1.6 All power and distribution transformers shall be of low loss type. Usually no-load and load losses shall be optimized for operation around 40-50% of their ONAN rating.

7.1.7 Transformer rating shall be sized considering diversity factor for continuous, intermittent loads and standby loads as 1, 0.3 & 0.1 respectively.

7.1.8 Peak Total Load = Continuous Load x 1 + Intermittent Load x 0.3 + Standby Load x 0.1.
7.1.9 (Standby Loads shall be considered, largest Motor Load or 10% of total standby Loads whichever is higher)

7.1.10 132 /11.5 kV Power transformers shall be with OLTC, and microprocessor based RTCC. All other Transformer shall be with OCTC requirement. Temp. Scanner shall be provided for Dry type Transformers.

7.1.11 All Transformer except 132 /11.5 kV Grid transformer shall be ONAN type and 132/11.5 kV Transformer shall be ONAN/ONAF type.

Sr. No.	Transformer	Voltage Ratio	Vector Group	Tap Changer	Cooling
1.	HV Transformer	11/35 kV	YNd 11	Off-circuit	ONAN
2.	Distribution Transformer (<= 2500KVA)	33/0.433kV	Dyn 11	Off-circuit	ONAN
3.	Dedicated (e.g., for VFD, EHT)	As Reqd.	As Reqd.	Off-circuit	AN
4.	Lighting and Small Power Transformer	0.433 / 0.25 KV	Dyn 11	Off-circuit	AN

Forced Air cooled for VFD Transformer

NOTE:
1) Provision of Oil Soak Pit & Oil Collection Pit for transformers shall be as per OISD-173 & OISD-149 as follows:

- Oil quantity <= 2000L: Not Required
- 2000L < Oil Quantity <= 9000L: Soak Pit
- Oil Quantity > 9000L: Soak Pit + Collection Pit

2)Firefighting system for transformers with oil capacity greater than 2000 Liters.

3)All individual electrical system shall be complied with Company TSG Specification, OISD Guideline, IS & IEC, CEA Latest Version.

7.2 SWITCHGEAR

7.2.1 All switchgear and associated equipment fed from generators and transformers shall have rating at least equal to the rating of respective generator and transformers feeding it, under any circuit configuration. Generator incomer shall be rated to the maximum power output of the generator set over entire operating temperature range. Transformer incomer shall be rated equal to forced cooled rating of transformer or 110 % of ONAN rating as applicable.

7.2.2 Bus tie circuit breakers shall have the same rating as the Incomer circuit breaker, as a minimum.

7.2.3 All other switchgears not directly fed from generator and transformers shall have rating at least to the maximum demand under any circuit configuration plus a provision for 10 %future load growth. Incomers of these switch gears shall be designed to cater to the complete load including 10 % margin for future load growth.

7.2.4 20% spare feeders shall be considered for new Switchgears, PDBs, LDBs.

7.3 HV SWITCHGEAR

7.3.1 The below clauses are applicable for a new switchboard. In case of extension of existing switchboards, only the specifications and OEM standards of the existing switchboard shall be applicable.

7.3.2 The High Voltage Switchboard shall be metal-enclosed (metal Clad) and shall comprise of standard prefabricated, cold-rolled, sheet steel units assembled to form a rigid, freestanding, and dead-front structure.

7.3.3 Switch board shall be designed for Indoor application shall be IP 4X as minimum.

7.3.4 In case of HV vacuum circuit breaker, metal oxide surge suppressors shall be provided for all outgoing feeders.

7.3.5 All power cables shall enter the switchgear from the bottom.

7.3.6 All High voltage feeders and incomers shall have Numerical protection relays according to their service like transformers, generators, motors.

7.3.7 All the switch boards shall be Suitable for future expansion on both sides.

7.3.8 For HV switch boards 20% spare shall be provided for each type of Outgoing feeder except Capacitor Outgoing feeder.

7.3.9 Auto-change over between incomers and bus coupler shall be provided. Additionally, manual change over through synchro-check relay with momentary paralleling shall also be provided. All necessary hardware shall be included to achieve auto, independent and manual operation of incomers and bus coupler.

Power to unlock the door interlock with voltage detecting insulator, door limit switch etc. shall be provided. Door will not open in POWER ON & TRIP both conditions. However, door may be opened by pressing push button in breaker trip condition.

7.3.10 Auto changeover philosophy Normal Switchgear shall be as per below:

i. Auto changeover between the two incomers and one bus coupler shall be in such a way that two incomer breakers are 'ON' at a time and bus coupler breaker is normally open.

ii. Bus coupler breaker is made 'ON' automatically in case the incoming supply at incomer breaker no. 1 or 2 fails and the respective breaker trips on under voltage.

iii. Blocking of auto transfer (i.e., closing of bus coupler) if any incomer breaker trips due to a fault.

iv. Tripping of incomer on under voltage shall be blocked if both the incomers simultaneously experience an under voltage.

v. PT MCB trip under voltage blocking must be configured. Tripping on under voltage shall be blocked if PT MCB trips.

7.3.11 Dual supply source for DC and AC control supply scheme for switchboards shall be considered and changeover arrangement shall be considered.

7.3.12 Circuit breakers for capacitors shall have a current rating of at least 135 % of the capacitor rated current. Circuit breakers capability to interrupt applicable capacitive current shall be specifically verified.

7.3.13 HV switchgear shall have provision of View glasses / IR Windows / Polycarbonate covered windows in the cable chamber to take thermographic reading.

7.3.14 HV Switchgear (11 kV & 6.6 kV) design shall be as per below configuration

SR NO	DESCRIPTION	CONFIGURATION
1	Execution	Draw out
2	Type of Switchgear	Air Insulated
3	Bus bar	Single Bus
4	Circuit Breaker Type	VCB
5	Outgoing Motor Feeder	VCB
6	Outgoing Feeder / Capacitor Feeder	VCB

7.4 MV SWITCHGEAR (415 V)

7.4.1 The below clauses are applicable for a new switchboard. In case of modifications/vacant module conversion in an existing switchboard, only the specifications and OEM standards of the existing switchboard shall be applicable.

7.4.2 The Medium voltage switchboard shall be metal enclosed fully draw out, free standing, floor mounting, compartmentalized, modular type suitable for indoor installation.

7.4.3 Switch board designed for Indoor application shall be IP 42 as minimum.

7.4.4 Form of separation shall be Form-4b for MV switchgear.

7.4.5 Separate feeders shall be provided in the switch board for each load / motor. However, as an exception maximum two numbers of welding receptacles may be connected to one power feeders looped from the first to second receptacle.

7.4.6 Auto-change over between incomers and bus coupler for 415V system shall be provided. Additionally, manual change over through synchro-check relay with momentary paralleling shall also be provided. All necessary hardware shall be included to achieve auto, independent, and manual operation of incomers and bus coupler.

7.4.7 Auto changeover philosophy for 415V Normal Switchgear shall be as per below:

i. Auto changeover between the two incomers and one bus coupler shall be in such a way that two incomer breakers are 'ON' at a time and bus coupler breaker is normally open.

ii. Bus coupler breaker is made 'ON' automatically in case the incoming supply at incomer breaker no. 1 or 2 fails and the respective breaker trips on under voltage.

iii. Blocking of auto transfer (i.e., closing of bus coupler) if any incomer breaker trips due to a fault.

iv. Tripping of incomer on under voltage shall be blocked if both the incomers simultaneously experience an under voltage.

v. PT MCB trip under voltage blocking must be configured. Tripping on under voltage shall be blocked if PT MCB trips.

7.4.8 Dual supply source for DC and AC control supply scheme for switchboards shall be considered and changeover arrangement shall be considered.

7.4.9 Control supply of 415V switchboards shall be tapped from bus bar side

7.4.10 All the switch boards shall be Suitable for future expansion on both sides.

7.4.11 For motors rated above 5.5 KW, CT shall be provided in the switch gear for ammeter on the local push button station.

7.4.12 Instrument Air Compressor motors shall be supplied from Emergency switchboard.

7.4.13 For MV switch boards 20 % of each type of outgoing feeder shall be provided as spares.

7.4.14 MV Switchgear (415 V) design shall be as per below configuration:

SR NO	DESCRIPTION	CONFIGURATION
1	PMCC	Draw out Double front (Incomer & Bus coupler Feeder shall be Draw out Single Front)
2	Motor Feeder (Above 55 KW up to 160 KW)	Air Circuit Breaker with Motor protection relay, CBCT with ELR for earth fault protection.
3	Motor Feeder (Up to 55 KW)	MCCB, Contactor, Overload Relay, CBCT with ELR for earth fault protection.
4	Outgoing Feeder	MCCB, CBCT with ELR for earth fault protection

7.4.15 The switch board components like circuit breakers, Main horizontal bus bars, bus bar joints, bus bar supports etc. shall be designed to withstand the maximum specified short circuit current for

a minimum of 1 second.

7.4.16 Top entry bus duct shall be applicable for PMCC incomer fed from Transformers rated 750kVA and above.

7.4.17 All feeders shall include as a minimum on /off indicating lights and trip indication.

7.4.18 All outgoing feeders shall have CBCT with ELR for earth fault protection. ELR shall be microprocessor based with range from 30mA to 3 A.

7.4.19 The protective relays of switchgear shall have a dedicated control MCB.

7.4.20 The short circuit capacity of current transformers shall be in accordance with the short circuit capacity of the switchgear.

7.4.21 All switchgear, modules shall be with LOTO provision for applying Lockout procedure and shall be designed to have all safety features not to have access to opening of door, live terminals, and interlocks to ensure to protect accidental closing while racking in and door opening while in service.

7.4.22 The transformer incomer feeders shall have alarm from NGR monitoring relay as well apart from other protective relays as appropriate.

7.4.23 Breaker handling trolley, safety equipment's, SLD, shock treatment chart, insulation mart, fire extinguishers, sand buckets etc. shall be provided as required.

7.4.24 E & I Interface for 415V PMCC, 6.6KV SWGR, VFD, Soft Starter, etc. shall be as per Clause.No.8 of CAIRN-TSG-E-SP-0005-B4-Specification for Medium Voltage Switchgear. Refer enclosed E & I Interface annexure-1 of this document.

7.5 UPSTREAM & DOWNSTREAM INTERLOCKS

All necessary interlocks, communications shall be provided among upstream & downstream breakers. The following minimum Upstream & downstream interlock shall be provided through hard wiring:

(i) Upstream Breaker shall close only when Downstream breaker is OFF.

(ii) Downstream breaker shall close only when Upstream breaker is ON in SERVICE.

(iii) Upstream breaker shall trip if Downstream breaker trips through '86'

(iv) Downstream breaker shall trip if Upstream breaker trips

7.6 SHORT CIRCUIT CAPACITIES

Each short circuit interrupting device shall be designed to have rated service short circuit breaking capacity (Ics) equal to or higher than the maximum value of short circuit current calculated, at its location. The related switchgear and bus ducts shall withstand the above maximum available fault current for a maximum period as mentioned in datasheet. The sizing of high voltage cables also be based on the short circuit withstand capacity for a minimum time period as dictated by the protection system as defined in design data, in addition to the maximum anticipated load current.

7.7 INSULATION SYSTEM

The insulation of electrical facilities shall be designed considered the system voltage, the system neutral earthing and the over voltages due to system fault, switching or lightning surges. Lightning/Surge arrestors shall be provided wherever necessary.

7.8 PROTECTION DEVICES FOR POWER DISTRIBUTION SYSTEM

Relay number	HV Transformer Feeder		Motor feeder	Outgoing Breaker feeder		Incomer	
	(Sec. Wdg ≥ 3.3kV)	(Sec. Wdg ≤ 0.433kV)	HV	HV	MV PMCC	HV	MV PMCC
51 IDMTL over-current relay	Y	Y	Y	Y	Y	Y (1)	Y
51N IDMTL earth- fault relay	Y (2)	Y	Y	Y	Y	Y (1)	Y
51G backup earth-fault relay (secondary neutral)						Y (24)	Y (24)

Relay number	HV Transformer Feeder		Motor feeder	Outgoing Breaker feeder		Incomer	
	(Sec. Wdg ≥ 3.3kV)	(Sec. Wdg ≤ 0.433kV)	HV	HV	MV PMCC	HV	MV PMCC
Motor protection relay with locked rotor feature (50, 50N,46, 49, 50L/R)			Y (3)				
64R instantaneous restricted earth- fault relay (Earthed Side)						Y (11)	Y (11)
50 instantaneous over-current relays	Y	Y	Y	Y			
50N instantaneous earth-fault relay	Y (4)	Y	Y	Y	Y		
87 differential protection relays	Y (5)		Y (6)	Y (7)			
86 tripping relays	Y (20)	Y (20)	Y (20)	Y (20)	Y (20)	Y (20)	Y (20)
95 trip circuit supervision relays	Y	Y	Y	Y	Y	Y	Y
63 transformer auxiliary relay	Y	Y					
27,2 under-voltage relays with timer			Y			Y (9)	Y (9)
25 check synchronization relays						Y (10)	Y (10)
87B Bus bar Differential	Y (16)	Y (16)				Y (16)	

NOTES:

(1) In case of HV switchboards with continuous parallel operation of incomers following relays shall be provided:

- 87B (Bus Differential) and 95B (Bus Wire Supervision) for each bus section

- 67 and 67N (Directional IDMTL over current and earth fault) relays for the incomers

(2) Instantaneous earth fault (50N) shall be provided only for transformer with delta primary

(3) For breaker fed motor feeders, Relay 50 shall not be provided for contactor-controlled feeders.

(4) Directional IDMTL earth fault (67N) shall be provided for transformer with star primary.

(5) For transformers rated 5 MVA and above.

(6) For motors rated 1500 kW and above. Not applicable for VFD fed Motors.

(7) For critical/long feeders and plant feeders connected to main power generation and distribution bus. A plant feeder implies outgoing feeders from one switchboard to another switchboard of same voltage level.

(8) Trip circuit supervision relay 95 shall be provided as part of the numerical relay for HV/ MV feeders wherever numerical relays are provided.

(9) Wherever auto-transfer feature is provided

(10) For switchgears where continuous or momentary paralleling of Incomers is envisaged, check synchronizing relay shall be provided.

(11) 51G and 64R relays shall not be provided for input transformer of VFD.

(12) The bus tie feeders in HV switchboards shall be provided with 51, 51N, 86 and 95 relays.

(13) HV capacitor bank feeders shall be provided with 51, 51N, 59 (over voltage), 60 (Neutral displacement), 86 and 95 relays.

(14) The following feeders shall be provided with timers for delayed tripping on bus under voltage while the under-voltage relay shall be common for the bus

- HV and MV breaker-controlled motor feeders
- HV and MV Capacitor Feeders.

(15) HV and MV breaker-controlled motor feeders
(16) HV and MV Capacitor Feeders.
(17) One no. DC supply supervision relay (80) shall be provided for each incoming DC supply to

the switchboard.

(18) Bus differential relays (87B) and bus wire supervision relay (95 B) for each HV switchboards

(19) In case of numerical relays, all relays shall be comprehensive units including all protection, metering and control.

(20) Under voltage and over voltage function along with associated timer shall be part of the numerical relays.

(21) Auto changeover logic between Incomers and bus coupler shall be built in the numerical relay.

(22) Master Trip relay (86) shall be part of Numerical Relay. For GIS Switchboard separate '86' master trip relay shall be provided.

(23) Breaker control switch shall be hardwired type.

(24) Stand by earth fault relay 51G shall be provided in the incomer of switchboard fed from transformers where transformer & switchboard both are located remotely from HV substation.

(25) Restricted earth fault relay 64R shall be provided for transformer rating >= 2.5 MVA in the incomer of switchboard fed from transformers.

(26) Protection for large transformer shall be as per manufacturer's standard.

(27) Relay 87 and 64R shall be separate numerical relay. Hence shall not be part of main comprehensive numerical relay. CT for 87 and 64R can be clubbed, as two core of single CT.

(28) Provision of monitoring of motor RTD shall be provided in Numerical relays provided for HV Motor feeders rated above 1000 kw.

(29) Emergency Generator Differential(87G) & Restricted Earth Fault (64R) relay shall be provided for Emergency Generator having rating equal to and above 1 MVA.

(30) EHV Bus coupler shall be provided with Busbar Differential (87B) Relay.

7.9 METERING

The metering devices in HV and MV switchboards shall be as below:

Feeder Type	A	V	Hz	PF	MW	MWH	Hour Run	MVAR	MVAH	MVA
Grid Incomers	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Grid Bus Tie	Y									
Grid Transformer	Y				Y	Y				
Grid Bus PT		Y								
GTG	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
EDG	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
HV Bus P.T.		Y								
HV Incomer	Y	Y	Y	Y	Y	Y		Y	Y	Y
HV	Y				Y	Y				
HV Plant Feeder	Y					Y				
HV Motor	Y					Y(kwh)	Y			
PMCC	Y	Y		Y		Y(kwh)				
PMCC Bus P.T		Y								
PMCC	Y									
ACB	Y					Y(kwh)				
MV Motor (>90 kW)	Y									
MCC / ASB	Y	Y								
MCCB / SFU O/G (250A)	Y					Y(kwh)				
MLDB	Y	Y				Y(kwh)				

NOTES:

(1) Field Ammeters are to be provided for all motors rated above 5.5kW.

(2) Metering shall be part of numerical relays (Applicable for breaker feeder & Motor feeder greater than 55 KW

(3) Digital multi-function meters shall be provided in Incomers, Bus coupler, Outgoing plant feeders & outgoing transformer feeders of HV switchboard and Incomer, bus coupler and all outgoing feeders (except motor feeder) of PMCC. This shall be in addition to metering as part of numerical relay.

7.10 BUS DUCTS

7.10.1 Bus ducts shall be provided between the secondary (415V) of transformers (rated 2500kVA) and the 415V PMCC. Same shall be non-phase segregated, self-cooled type, 3 phase, 3 wire sandwiched type.

7.10.2 Copper bus bars with heat shrinkable PVC Sleeves.

7.10.3 Enclosure will be fabricated from 3mm thick (min) aluminum sheets for ratings above 3000A and 2mm thick (min) sheet steel otherwise.

7.10.4 Seal-off bushings with wall frame assembly wherever the bus duct crosses wall from outdoor to indoor

7.10.5 All bus ducts shall have temperature monitoring system and connected to nearest data concentrator or switch board HMI or DCS. If there is no provision to hookup to the nearest system, then standalone temperature indicator with alarm shall be provided

7.10.6 The Rating of the bus bar ducts connected to breakers shall have same continuous and short circuit rating as that of breakers. Similarly, bus ducts connecting to two bus sections shall have same continuous and short circuit rating as that of main bus bars

7.10.7 Neoprene rubber bellows for enclosure wherever expansion joints are provided.

7.10.8 The outdoor portion of the bus bar shall be minimum IP 55.

7.10.9 The adopter box on both ends of the bus duct shall be designed as part of the bus duct.

7.11 NEUTRAL GROUNDING RESISTOR (NGR)

7.11.1 The Neutral Grounding Resistor (NGR) along with resistor monitoring system shall be suitable for outdoor installation for satisfactory operation under conditions of restricted natural ventilation in a tropical humid and corrosive atmosphere. The resistor elements shall be housed in a naturally ventilated sheet steel enclosure with minimum degree of protection - IP-43 for NGR and IP-55 for Terminal box.

7.11.2 The NGR shall be rated to withstand the fault current for 10 seconds. The NGR element shall be stainless steel / Nichrome.

7.11.3 NGR monitoring relay shall be supplied with UPS power.

Sr No.	Voltage level	Type & Rating
1.	132KV,33KV,240V	Solid Earthing
2.	11KV & 6.6 KV	High Resistance (50A for 10 sec.)
3.	415V	High Resistance (750mA for 10 sec.)

7.12 ELECTRIC MOTORS

7.12.1 In general, three phase squirrel cage motors designed for direct online starting shall be used. Motors shall be totally enclosed, fan cooled type and suitable for continuous outdoor use.

7.12.2 All motors shall be continuous maximum rated with possible exception of crane and hoist motors, soot blowers, turbine starting motors etc. which may be rated for the envisaged duty cycle.

7.12.3 High voltage motors shall be suitable for starting under specified load condition with 80 % of the rated voltage at the terminals and medium voltage motors shall be suitable for starting under specified load condition with 75 % of the rated voltage at the terminals.

7.12.4 For heavy duty equipments such us reciprocating compressor /agitator/crusher etc. high starting torque motors shall be provided and starting time shall be limited to ensure adequate protection by motor protection relays.

7.12.5 Variable frequency drive shall be considered if required as per process design. Bypass feeders are not considered for HV & MV VFD System. Motor data sheet shall be reviewed & stamped by VFD manufacturer & vice versa.

7.12.6 For outdoor Motors (Not Located in Shelter) suitable site fabricated MS Canopy shall be provided.

7.12.7 Motor design shall be considered as below

S.No.	Motors	High voltage (6.6kV)	415 Volts
1	Motor Enclosure		
1.1	Indoor	IP44	IP44
1.2	Outdoor	IP55	IP55
1.3	Terminal Boxes	IP55	IP55
2	Motor Insulation class	F (Temp. Rise to B)	F (Temp. Rise to B)
3	Anti-condensation heater	Yes	30 kW and above

7.12.8 All motors shall be provided with Local Control Station.

7.12.9 All motor cable termination shall be from bottom with adequate space and access for termination.

7.12.10 All MV motors (415V) shall be energy efficient & class IE3 as per IS 12615.

7.13 EMERGENCY GENERATOR

7.13.1 The Black Start and Emergency System shall consist of packaged diesel generators each housed in a self-container shipping enclosure complete with intake air louvers, exhaust, silencer, controls, air start compressor, battery chargers and battery banks, etc.

7.13.2 The Emergency generator set shall be designed to start automatically on power failure and feed the selected loads. It shall be capable of taking care of the load variations like starting of largest motor with specified base loads. On restoration of supply automatic change over and EDG stoppage shall be ensured. Generator shall be designed to take care of harmonics as per IEEE 519.

7.13.3 The Emergency generator set shall have at least 10 % spare capacity for meeting future requirements.

7.13.4 The Package shall be installed with fire suppression and F&G systems which are compatible with the plant F&G system.

7.13.5 All emergency / backup generators shall have 1 + 1 redundant battery system with dedicated battery charger and shall have provision for both trickle and boost charging.

7.14 DC SYSTEM

7.14.1 The below clauses are applicable only for new DC UPS. In case, the existing DC UPS is to be utilized, the spare feeders are to be utilized / modified.

7.14.2 DC Power supply system comprises the converters, battery banks and the Main DC Distribution Boards (Main DCDBs).

7.14.3 System shall supply continuous 110V DC power to HV and MV switchgear, relays and critical lighting.

7.14.4 The DC power supply system shall be a fully redundant system consisting of two units operating in parallel.

7.14.5 DC System shall consist of two 100% Float-cum- boost charger with 100% loading capability but operating at 50% load. Batteries shall be placed in a separate well-ventilated room on racks.

7.14.6 In case of normal power failure to the float-cum-boost chargers, each battery unit shall have sufficient capacity to supply the total 110V DC system loads for 1 hour. Each battery unit shall cater to 50% of the loads (ie. connected only to the respective Main DCDB).

7.14.7 Under normal condition the Float-cum-boost charger will take care of all DC load connected to its Main DCDB and keep the battery under charged condition. In case of failure of normal supply, battery will feed the DC load requirement. Retransfer of load on resumption of normal supply will be done without interruption of supply to loads.

7.14.8 AC input to the DC system shall be 415V± 6%, 3 phase, 50Hz ± 3% from the plant 415V Emergency Power PMCC.

7.14.9 Ingress protection of panels shall be minimum IP41.

7.14.10 A relay shall be connected to the DC busbars in the DC Power System to detect the presence of earth leakage current flowing due to a fault somewhere in the outgoing sub-circuits. This relay shall be sensitive to a low level of current (in the order of milli-amps) and shall raise an alarm when the current exceeds a pre-set level.

7.14.11 The battery charger / rectifier shall feed the load and keep the batteries under fully charged condition. Provision shall also be made for necessary boost charging / initial charging of battery

7.14.12 Each battery charger and DCDB shall be sized to cater to selected battery capacity

7.14.13 Each DCDB shall have at least 20 % spare for future loads and the charger shall be designed to cater additional 10 % for future loads.

7.14.14 All the DB's shall have cable entry at the bottom.

7.14.15 The battery chargers shall have monitoring / metering system and shall display the capacity of the battery, battery voltage, rectifier voltage and current and events and alarms and communicable for remote monitoring.

7.14.16 DC Battery system configuration shall be as below:

SR NO.	DESCRIPTION	CONFIGURATION
1	BATTERY TYPE	
1.1	Switchgear Protection control and critical lighting	Ni-Cd Vented type
2	Battery Configuration	2 x 100%

7.15 AC UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEM

7.15.1 The below clauses are applicable only for new AC UPS. In case, the existing AC UPS is to be utilized, the spare feeders are to be utilized / modified.

7.15.2 Uninterruptible Power Supply system comprises the converters, inverters, static automatic transfer switch, battery banks, constant voltage by-pass transformer with maintenance bypass switch and Main UPS Distribution Board.

7.15.3 One complete Uninterruptible Power Supply (UPS) system consisting of two parallel units (for redundancy) shall be provided for powering the instrument, PMS & Telecom loads.

7.15.4 The system input shall be 3 phase, 415V± 6%, 50Hz± 3%, Output shall be 230V± 1%, 1ph, 50Hz ± 1 %.

7.15.5 UPS system shall consist of two parallel units (each including a 100% converter, a 100% solid state inverter, nickel cadmium battery bank, static automatic transfer switch), and a constant voltage by-pass transformer with maintenance bypass switch. Batteries to be placed in a separate well-ventilated room on racks.

7.15.6 Both units shall operate in parallel, each shall provide 50% load, but each shall have 100% loading capability. Battery backup time shall be at least 1 Hour for each battery unit with total of 2 hours for complete system.

7.15.7 Under normal condition, the converter will feed the inverter load requirement through static switch and keep the battery under charged condition. On failure of supply to converter, the battery will start feeding the inverter load requirements automatically without interruption. Reverse transfer on resumption of normal power will also be automatic. The inverter will be operating in synchronization with the bypass mains within specified voltage and frequency limits.

7.15.8 Usually, the two UPS units will operate in parallel and share total load requirement equally. On failure of inverter of one of the UPS the other UPS will start feeding 100% of the load

automatically without any interruption. In case of failure of both the inverters, the bypass mains will take care of 100% of the load through static bypass switch automatically without interruption. Forward and reverse transfer of load will be done automatically and without any interruption of supply to loads.

7.15.9 Incoming Power to the UPS shall be fed from 415V Emergency PMCC for all feeders (UPS-1,UPS-2 & Bypass) .

7.15.10 Each branch circuit of the UPS distribution system shall have a fast-acting MCB in each circuit of distribution. The MCB shall be fast clearing type and the MCB rating shall be coordinated with the rating of the UPS system. Normally the largest branch circuit shall not exceed 25 % of the UPS system rating.

7.15.11 Each UPS shall have at least 20 % spare feeders and the UPS shall be designed to cater additional 10 % for future loads.

7.15.12 Isolation transformer shall be provided for all feeders feeding loads pertaining to field.

7.15.13 UPS system configuration shall be as per below

SR NO.	DESCRIPTION	CONFIGURATION
1	Redundancy	100%
2	Type of Redundancy	Parallel Redundant
3	Back up Time for Instrument, PMS & Telecom Equipment	60 Minutes
4	Bypass Transfer Control	Auto
5	Battery Type	Ni-Cd Vented type (2 x100%)
6	UPS Output Supply	Single Phase
6.1	UPS Output Voltage/frequency	230V ± 1%, 1ph, 50Hz ± 3%.

7.16 HARMONICS ELIMINATION

Design consideration and equipment selection needs to carry out to reduce the overall harmonics within 5 % in the system by following ways.

Harmonics needs to be reduced at the source of generation like VFD, UPS etc. and all these equipment need to meet IEEE 519 compliance and within 5 % THD.

7.17 VARIABLE FREQUENCY DRIVE

Variable Frequency Drive (VFD) shall meet the requirements in Cairn's TSG Specification for MV Variable Frequency Drive System (CAIRN-TSG-E-SP-0028-B3) and Specification for HV Variable Frequency Drive System (CAIRN-TSG-E-SP-0020-B2)

The VFDs should be considered for the following applications where they will benefit the operation, maintenance, and efficiency of the plant:

- Variable torque/speed loads as required by Process such as blowers / cooling fans, conveyors, pumps, Inlet Gas Compressor etc.
- Energy saving for the loads where power varied by cube of the speed, such as centrifugal fans and pumps.

VFD heat load calculation shall be performed and suitable heat dissipation arrangement and HVAC shall be provided to ensure proper and safe operation of VFD.

Inlet Gas Compressor shall not get unloaded under main power supply voltage dip & fluctuations. VFD & associated UCP system shall be suitable to meet the aforementioned requirements with all necessary programs, VFD protections, Software /Hardware graphics, licenses etc.

7.18 ACTUATORS FOR MOTOR OPERATED VALUE

MOVs shall be provided with integral starters. the necessary local / remote selector switch, start / stop control switches or push-buttons, torque limit switches etc. shall be provided on actuator for local / remote control depending on the mode of selection. In case of failure of torque limit switches, the mechanical design shall be adequate to stall and trip the motor without any damage. The control circuit may AC operated for short distance and DC operated for extended distances where required. MOVs with 2 wire control shall comply to job specification and control supply shall be supplied therein.

7.19 CABLES

7.19.1 HV cables shall be dry cured XLPE insulated, extruded PVC sheathed, armored type with copper conductors.

7.19.2 MV power cables shall be XLPE insulated, extruded PVC sheathed, armored type with copper conductors.

7.19.3 The control cables shall be PVC insulated, extruded PVC sheathed, armored type with copper conductors.

7.19.4 The cables shall be sized based on the rated current of connected equipment rating / for distribution type switchboards cables are sized based on peak load, voltage drop, system voltage, system earthing, and short circuit withstand criteria as applicable. The de rating due to ambient air temperature, ground temperature, grouping and proximity of cables with each other, thermal resistivity of soil etc. shall be considered.

7.19.5 As an exception within substation areas, un-armored cables or Wires can be used in conduits / cable trays.

7.19.6 All power and control cables shall be in continuous lengths (unless otherwise agreed upon) without any splices or intermediate joints. The cables used for lighting and wires in conduits shall have appropriate junction boxes with adequately sized terminals. Cable joints in hazardous area shall not be permitted at all.

7.19.7 Outer PVC sheath of all power & control cables used shall be flame retardant type conforming to category AF as per IS: 10810.

7.19.8 The cable shall have a low smoke property. The minimum Oxygen Index shall be 29.

7.19.9 All control cables shall have minimum 10 % spare cores, except that control cable up to seven cores may have one core as spare.

7.19.10 Cables shall be designed to Bureau of Indian Standards (BIS).

7.19.11 The armor for single core cables shall be of nonmagnetic material.

7.19.12 Conductors of all sizes of cables shall be stranded and shall not be solid copper.

7.19.13 6.6KV and 11KV cables shall be Unearthed UE grade whereas the 33KV and 415 V cable shall be Earthed (E) grade.

7.19.14 Short circuit withstand rating of insulation screen for cable used for 33KV solidly grounded system shall be 1.25 kA for 1 sec.

7.19.15 The Power & Control cable Sizes cross sectional details shall be as per below:

SR NO.	DESCRIPTION	Sizes
1	Medium Voltage Power Cables	4 sqmm to 300 sqmm for Multi core & 630 sqmm for Single core
2	Control Cables	2.5 sqmm (Minimum Size)
3	Lighting (Note-1)	2.5 sqmm (Minimum Size)

Note: - For Lighting inside building (Routed inside conduit) minimum 1.5 Sqmm copper conductor, PVC insulated wire.

7.20 EARTHING AND LIGHTING PROTECTION

7.20.1 Earthing type employs following methods:

i. Solid earthing for 132KV, 33kV system & 240V system.

ii. High resistance earthing for 11kV system and 6.6 KV system.

iii. High resistance earthing system for 415V system.

7.20.2 Plant earthing design will generally be carried out in accordance with the requirements of CEA guidelines and Code of Practice for Earthing IS 3043.

7.20.3 Earth fault protection relays shall be provided for HV/MV distribution systems to limit the fault current to a maximum of 750 milliamps for 415V systems and 50 Amps for 11kV / 6.6KV systems.

7.20.4 For individual pit resistance value of up to 5 ohms will be considered as per Cl No-7 (II-b) of OISD-RP-137. For plant earth grid, new earth grid provided shall be connected to nearby existing earth grid. Accordingly, Overall plant earth system resistance value shall not be more than 1 ohm.

7.20.5 Main earth grid of Min.70mm2 bare copper conductor will be used below ground. Above ground green / yellow PVC insulated copper conductors shall be used.

7.20.6 Earth rod of 20 mm diameter 3m copper clad steel rods shall be used.

7.20.7 Earthing of HV motors will be provided by connection to the main earth grid with 70mm2 PVC insulated copper conductors. LV motors, cable trays, metallic equipment, enclosures will be connected to the main earth grid with 35mm2 PVC insulated copper conductors.

7.20.8 Lightning protection will be provided to equipment, structure and buildings which are higher than 20 meters or as per the risk index analysis worked as per IS 2309 / BS 6651. For lightning protection, the value of 5 Ohms as earth resistance will be desirable, however in no case it shall be more than 10 ohms.

7.20.9 All earth pits shall be chemically treated type.

7.20.10 “Earthing & Bonding”

- All joints in pipelines, valves, plants, storage tank and associated facilities and equipment's for petroleum shall be made electrically continuous by bonding or otherwise the resistance value between each joint shall not exceed 1 ohm in compliance with Petroleum Rule 2008 OISD
- All utility, process pipeline and flanges shall be earthed on entering or leaving the hazardous areas, except where conflicting with the requirements of cathodic protection. In addition, steel pipe racks in the process units and offsite area shall be earthed at every 25 meters.

7.21 POWER MANAGEMENT SYSTEM

7.21.1 The below clauses are applicable only for new PMS. For the extension panels to be added in this project, the existing spare IOs in PMS are to be utilized along with necessary modification in Hardware and software. The equipment in Well pads will not be connected to PMS in line with the philosophy of existing system.

7.21.2 The generation and distribution network shall be monitored by Power Management System which consists of RTU servers and HMI / workstation for monitoring and control of substation. All information of substation shall be brought into central substation HMI / workstation. All the Electrical system parameters shall be hooked into the PMS for effective control, monitoring and data logging.

7.21.3 All new extension panels of existing 6.6kV HV switchgear outgoing feeders & New MV switchgear incomer / bus coupler shall be communicable to the existing power management system appropriately in line with existing Power Management System architecture.

7.21.4 The power management system shall have 100% redundant RTU, power supply and server as applicable and shall be designed to have 20% spare DI / DO unless otherwise specified.

7.21.5 Load shedding application shall be provided in PMS. Both power based and frequency-based load shedding shall be provided.

7.21.6 The communication protocol from electrical PMS to DCS shall be TCP/IP Modbus protocol. If standalone switchgear is used in the substation the data concentrator and the HMI shall be inbuilt with the switchgear.

7.21.7 PMS and all associated panel, package HMI/ operation console shall be placed in same room for easy access.

7.21.8 PMS system configuration shall be as per below

SR NO.	DESCRIPTION	CONFIGURATION
1	Substation Automation System	Required
2	Communication protocol for relay network	TCP/IP Modbus
3	Protocol for Communication with UPS & VFD	Modbus RTU
4	Laptop	Common for HV & MV for each substation.
5	Relay parameterization	Through Laptop & HMI

7.22 CABLING SYSTEM

7.22.1 Cable laying arrangement shall be considered in cable tray & direct buried cable trench as applicable.

7.22.2 Ladders, perforated trays, and relevant fixing materials shall be made of prefabricated hot-dipped galvanized (HDG) iron as per IS 2629. All hardware which will be used to fix the cable trays or ladder racks (nuts, bolts, etc.) shall be stainless steel SS304.

7.22.3 Standard length of both Ladder and perforated trays shall be 3 mtr. Thickness of cable trays shall be as per tray width and vendor's recommendations. Standard tray sections and components shall be used, and radius shall be compatible with the minimum bending radius of the supported cable.

7.22.4 The trays shall be supported at appropriate intervals both vertically and horizontally, as required by the cable tray manufacturer's design criteria.

7.22.5 At outdoor location, covers shall be provided on the top layers including vertical cable trays. Tray cover material shall be hot dip galvanized iron.

7.22.6 Trays shall be connected by expansion splice plates between their sections and fitted with expansion guide clamps at every 36 to 40m intervals. Tray will be connected at other junctions by standard splice plate and fitted with hold-on clamps. 2 No. of splice plates considered for connecting 2 No. of trays.

7.22.7 Cable arrangement in Tray -

- Multi core HV cables will be arranged in a single layer touching formation. Single core HV cables shall be arranged in trefoil formation, with one trefoil cable diameter spacing between them. 150mm spacing shall be considered between HV Cable & control cable.
- MV & LV power cables will be arranged in single layer with no spacing between them.150mm spacing shall be considered between MV/LV power Cable & control cable.

7.22.8 Cable arrangement in Direct buried Trench -

- Multi core HV cables will be arranged in a single layer with spacing considered based on the grouping derating factor of cable sizing calculation. Single core HV cables shall be arranged in trefoil formation with spacing considered based on the grouping derating factor of cable sizing calculation. 150mm spacing shall be considered between HV power cable & control cable.

- MV/LV power cables will be arranged in single layer with spacing considered based on the grouping derating factor of cable sizing calculation. 150mm spacing shall be considered between MV/LV power Cable & control cable.

7.23 CONTROL STATION

7.23.1 Each motor shall be provided with LCS.

7.23.2 LCS shall have ammeter for motor rated above 5.5kW along with HOA Switch.

7.23.3 The enclosure of the control stations shall be made of cast light metal alloy.

7.23.4 The control stations shall be suitable for use in outdoor open locations and shall have IP-55 degree of protection with suitable canopy. The canopy shall be made of galvanized sheet steel. The canopy shall be suitable for providing protection against rain from top and two sides.

7.23.5 Motors shall be controlled in the field at the motor location. Local control station shall have Start / Stop pushbuttons and HOA selector switch. In "H" position start control transfers to only local, in "A" position control transfers to DCS, while in "O" position, the motor start is disabled.

7.23.6 Push button for Start & Stop shall be of Green & Red color respectively. Unless otherwise specified each push button shall have two normally open and two normally closed contact.

7.23.7 Motors installed at elevated platforms shall be provided with stop push button at grade level in addition to control station near motor. Emergency stop push button shall be provided at

transformer bay.

7.23.8 Stop push button shall generally have stay put feature and lockable in pressed position.

7.24 CATHODIC PROTECTION

7.24.1 A cathodic protection system for the protection of underground pipelines and underground steel structures shall be provided utilizing impressed current with manual control and designed in accordance with the National Association of Corrosion Engineers (NACE) and BS 736, and CAIRN"S TSG Specification; "Specification for Cathodic Protection System" DocNo.CAIRN-TSG-E-SP-0019 Rev B1.

7.24.2 Transformers shall be oil immersed, and rectifiers shall be SCR type. They shall be operated on 415V, 3 phases, 50Hz and installed in non-hazardous areas preferably.

7.24.3 The anode(s) shall be high silicon cast iron with coke breeze backfill, suitable for burial and with sufficient quantity and size to have a minimum life expectancy of 20 years. Anodes shall be buried to a depth sufficient to provide adequate protection.

7.24.4 Necessary test posts shall be installed along the protected underground pipelines for periodic measurements of the metal to soil potential.

7.24.5 The protective potential along the underground pipelines / structures shall not be less than 1.0 volt negative with respect to copper / copper sulphate electrode cell, neither shall be more than 1.5 volt negative.

7.25 ELECTRICAL HEAT TRACING SYSTEM

7.25.1 Individual EHT circuit design calculation shall be performed utilizing an industry accepted software program.

7.25.2 Self-regulating (SLSR) type cables may be utilized for field applications as deemed necessary.

7.25.3 Heat tracing system is project specific and based on process parameters/requirements.

7.25.4 EHT shall be designed with EHT control panel with OEM Controller, RTD, Tracer, JB & accessories. Each outgoing feeder shall be provided with ELCB, which needs to be wired for annunciation.

7.25.5 EHT and all individual electrical system shall be complied with Company TSG Specification,

OISD Guideline, IS & IEC, CEA Latest Version, etc.

7.26 AC / DC DISTRIBUTION BOARDS

7.26.1 This section covers main and sub distribution boards required for distribution of 415V / 240V for non-motor loads, 240V (Non-UPS) / 230V (UPS)/110V DC power for loads and lighting.

i. 240V, 3 phase for lighting and small power Board.

ii. 240V, 2 phase for non-motor loads such as space heaters, socket outlets.

iii. 230V (AC UPS) 1 phase for control, instrumentation, and communication loads

iv. 110V DC power for HV & MV Switchgear controls and critical lighting loads.

7.26.2 Indoor DB shall be CRCA (Indoor) / Cast Aluminum (Outdoor), vertical self-standing or wall mounting type, with min. IP4X enclosure in Substation Equipment room and for outdoor min. IP 55 with canopy.

7.26.3 MCCBs will be used for incomers and outgoing for main distribution boards. For Sub distribution boards, MCCB will be used for incomers and MCCB/ MCBs will be used for feeders as per the respective Single Line Diagram. MCB+ELCB shall be provided for outgoing feeder from Lighting & small power distribution boards.

7.26.4 Distribution boards shall be single front and of fixed type construction. MLDB & SPLDB also shall be single front and fixed type construction. All Outdoor Distribution Boards shall be provided with Canopy.

7.26.5 20% spare feeders shall be considered for Distribution board.

7.26.6 Maximum rating of bus bar for 240V AC Distribution boards should preferably be limited to 800 amps.

7.26.7 Copper bus bars with heat shrinkable PVC Sleeves shall be used.

7.26.8 All the distribution boards shall have cable entry from Bottom.

7.26.9 Form of separation shall be Form-2b type for Distribution board.

8. ELECTRICAL SUBSTATION BUILDINGS

8.1 The sub-stations shall be in a safe area close to the load center. Proper access shall be provided/ ensured for operation/ maintenance of indoor and outdoor equipment.

8.2 The substation layout will be in conformance with the Indian Electricity Rules, 1956 / Central electrical authority (CEA) regulations with latest amendments, Regulations of Statutory Authorities such as Chief Electrical Inspector to Govt. and Oil Industry Safety Directorate Recommended Practices 116,118 and 149.However, the below guidelines shall be followed as minimum.

8.3 In addition to the entry to substation for operating personnel, a separate entry of minimum 3 m x 3 m with rolling shutter shall be provided for drawing in all equipment for installation. The Sub-station shall also have an emergency door opening outwards.

8.4 Sub-station wall adjacent to the transformer bays and walls separating transformers shall be 355 mm thick (inclusive of plastering) in case of brick construction or 230 mm thick in case of RCC construction. Proper access shall be provided for Transformer bays for checking the Transformers parameters.

8.5 Sub-station building shall be without any columns within the switchgear room to ensure optimum space utilization, unless otherwise specified.

8.6 Battery banks shall be located in a separate adequately ventilated room in the sub-station Buildings, along with the necessary exhaust system and water provision with sink arrangement. Floor of the battery room and walls up to 1 m height shall have acid/alkaline resistant protective epoxy coating or resistant tiles. Light fittings in this room shall be chemical resistant and flame proof type. The battery rooms shall be provided with minimum two exhaust fans and louvered Opening in opposite wall / door. The exhaust fans shall switch on when hydrogen gas is detected. All electrical switches shall be kept outside so that there is no possibility of arc or spark in battery room. Battery room shall be provided with adequate corrosion resistant drainage facility.

8.7 Sub-station shall have fire extinguishers, first aid boxes and other safety equipment as per statutory requirements. Insulating mats shall be of synthetic rubber and required voltage rating shall be provided in front of switchboards.

8.8 Separation walls between transformers in all substations and safe inter transformer distances for switchyard transformers shall be as per clause 5.3.11 & 5.3.12 of OISD Std- 173.

8.9 Equipment like transformers, neutral grounding resistors shall be located in bays adjacent to the sub-station building. All bays shall have well drained floor, surfaced with gravel or other suitable material.

8.10 In order to prevent oil, whether from a small leakage or outflow from transformer tank, from reaching and polluting the water bearing stratum, transformers shall have the following provisions, depending

on the oil capacity of the transformer.

8.11 Oil Capacity up to 2,000 liters:
Transformers installed adjacent to sub-station/buildings or in Switchyards shall be provided with a layer of 100 mm deep stones of about 40 mm granulation, all around the Transformer, for a width of 20 % of the transformer height or with a minimum width of about 800 mm.

8.12 Oil Capacity exceeding 2,000 liters:
Transformers installed adjacent to sub-station/building or in Switchyards shall be provided with oil containing pits.

8.13 The oil containing pit may be shaped as per OISD standard 173. The pit shall extend all around the transformer for a width of 20 % of the transformer height, with a minimum width of about 800 mm. In case oil capacity exceeds 9,000 liters, in any chamber, provision shall be made for draining away of any oil, which may escape or leak from the tanks to a waste oil tank.

8.14 The following clearances will be maintained around equipment as minimum, as per Cl No 6 (ix) of OISD-RP-149:

SR NO	LOCATION	CLEARANCE
1	Front clearance for HV Switchboard	2000mm
2	Front clearance for MV switchboard	1000mm (As per manufacturer's Recommendation & CEA 2023 Guidelines)
3	Rear Clearance for HV switchboard	1500 mm
4	Rear clearance for MV switchboard which requires Maintenance	1000 mm
5	Rear clearance for other panels which requires no Maintenance on the rear side and the panels rear is not having any openings	Less than 200 mm or 1000mm.
6	Side clearance between switch boards or from nearest obstruction	1000 mm after considering space for future panels as specified.
7	Clear height of bus-duct from finished floor level	2000mm

8	Battery rack to wall for clearance for 1. Single row / double tier 2. Double row, single tier 3. Double row, double tier 4. Two Step, Double row, double tier 5. Battery Rack to Rack	 100mm 100mm 750mm 750mm 750mm
9	Front clearance for wall mounted equipment	1000mm
10	Front clearance for operation station annunciation / control panel	1500mm
11	Front-Front of 2 switchboards facing each other	2000 mm
12	All around clearance for Transformer	1000 mm
13	Clear space between Switchboard top and beam sofit	1000 mm

8.15 In all Substations/ Switchgear rooms, space for future extension of switchboards shall be Provided. One panel extension space on each side (for each Bus section) or two panel extension space on one side (in exceptional cases) shall be provided for all HV Switchboards, PMCC & EPCC.

8.16 Batteries of UPS and DC Power Supply System shall be located separately in well ventilated room provided with an exhaust fan and gas detectors. UPS panel shall have sufficient access from side.

8.17 Electrical equipment installed in battery room such as exhaust fan & lighting shall be of flameproof and corrosion proof construction and certified for ZONE-1, Gas Group II-C, T3 classified locations.

8.18 Outdoor units of building air condition system, for easy maintenance, shall be installed at lower level instead of fixing at higher level.

8.19 Large substation with length greater than 60 meters shall have three entries, one for equipment entry, second for normal entry and the third for emergency exit.

8.20 Fire protection for transformers and switchgear room shall be provided to comply to requirements of OISD-STD-173.

8.21 Equipment location in substation shall be as per below:

SR NO.	DESCRIPTION	Type
1	Batteries (Lead Acid / Nickel Cadmium) in substation, Fire station building and Control room	Separate Room with Ventilation
2	Battery charger in Substation and Control room	Air-Conditioned Room
3	UPS System	Air-Conditioned Room
4	Switchgear, VFD's, Thyristor control panel, Control Relay Panel (GIS Switchgear)	Air-Conditioned Room

9. LIGHTING SYSTEM

9.1 GENERAL

9.1.1 Plant lighting will be broadly classified into 3 categories

- Normal lighting
- Emergency lighting
- Critical lighting

9.1.2 Normal and emergency lighting will be on 240V AC (phase-phase) Supply whereas critical lighting will be on 110V DC. Under normal conditions, both emergency and normal lighting will be fed by normal power source. On failure of normal supply, emergency lighting loads will be fed from emergency generator supply. Critical lighting shall be "off" in normal condition and automatically kept "on" by 110V DC Charger System during emergency power failure.

9.1.3 In the event of normal power failure, emergency lighting may be provided to facilitate safe shutdown of the plant, access to firefighting facilities and escape route for safe evacuation of plant operating personnel. Emergency lighting will be 20-25% of normal lighting load. Probable areas for critical lighting are Control Rooms, Substations, Central Fire Station, Emergency Escape Routes etc.

9.1.4 In most cases, well pads and remote area terminals will not have emergency lighting due to absence of emergency power source. Instead, critical lighting with self-contained battery (With 90 min. Power backup) will perform the functions of emergency lighting.

9.1.5 Main Lighting Distribution Boards (MLDBs), Small Power and Lighting Distribution Boards

(SPLDBs) shall receive 240V, 3ph, 50Hz supply from 415V/250V lighting transformers which are fed from PMCC/EPMCC. SPLDBs further distribute power to field or building lighting panels.

9.1.6 Enclosure of indoor panel boards will have min IP 4X protection and outdoor panel boards will be housed in an IP 55 enclosure.

9.1.7 Lighting circuits will be R-Y, Y-B, B-R and emergency repeated in series.

9.1.8 Branch circuit protection shall be provided by miniature circuit breakers (MCBs +ELCB). The total estimated load of each circuit shall not exceed 80% of the branch circuit rating.

9.1.9 Lighting methods and material shall be suitable for the area classification in which they are to be installed.

9.1.10 The lighting system shall be designed to have the following normal average level of illumination. However, Illumination levels shall be as per IFC (International Finance Corporation) standard in addition to OISD Guidelines.

SR NO.	Area	Illumination in lux
1	Control Room	500
2	Offices / instrument Equipment Room (Rack Room) / VFD Room	300
3	Compressor area	200
4	Pump House/Boiler House/Shelter for other skids	150
5	Process areas, pipe racks, heat exchanger, heater, Separators, cooling tower, columns, pig launching /receiving / loading area etc.	60
6	Operational Platforms walkway and access stairs Walkway and access stairs	60
7	Ordinary platforms	20
8	Main Roads (along process areas)	20
9	General Outdoor Area & Secondary Roads (along storage tanks, ponds etc.)	10
10	Substation/Switchgear Room/UPS Room	200
11	Transformer bay	100
12	Battery room	150

13	Switchyard - Operating areas / other areas	100 / 50
14	Kitchen/Mess/Guard House	300
15	Toilet / Cylinder Room	100
16	IE / PMS Room	300
17	Building periphery	10

9.1.11 These are in-service values after applying a maintenance factor of 0.7 (Outdoor) & 0.8(Indoor). These figures are the component values for the locations described on a horizontal plane being 0.75m from the floor levels in buildings and the ground or platform levels in other areas.

9.2 INDOOR LIGHTING

9.2.1 Each lighting circuit load shall not exceed 2000VA (Applicable for Only Lighting Circuit).

9.2.2 Polycarbonate housing LED Luminaire, with Low loss, high power factor electronic driver for installation in Substations, VFD Room and other buildings. Fittings shall come with Polycarbonate diffuser and inbuilt driver.

9.2.3 Control Rooms, Administration Buildings and Office Rooms: LED luminaire with low loss, high power factor, electronic driver, 240V (Ph-Ph), 50Hz input. Luminaire shall Comprise electronic driver, Luminaire shall have Powder Coated CRCA steel sheet housing comprising of White LED's, suitable for recess mounting in modular false ceiling system with (600x600 mm Ceiling). In case of absence of false ceiling, suspension type/wall mounted light fittings shall be used.

9.2.4 Toilets, corridor, and general areas: Polycarbonate housing LED Luminaire or LED Down lighter material made of white powder coated aluminium housing body with polycarbonate diffuser and integrated driver.

9.2.5 Switching will be local double pole switches.

9.2.6 Substation/ control/fire station building shall be provided with critical lighting fed from DC UPS supply.

9.3 OUTDOOR LIGHTING

9.3.1 Each lighting circuit load shall not exceed 6000VA.

9.3.2 Control is timer switching with manual override of 3pole contactors.

9.3.3 Aircraft warning LED lights shall be provided for structures of height 30 meters and above such

as communication tower and flare stack as per Directorate General of Civil Aviation (DGCA) regulations.

9.3.4 Staircase and exterior lighting will be wall/bracket / handrail mounted compact, die cast aluminum housing, epoxy finish, low loss, high power factor type suitable for LED fixtures.

9.3.5 Flood lighting fixture will be diecast aluminum, low loss, high power factor type LED fixtures mounted on 12m galvanized steel poles / structures.

9.3.6 Flood lighting using adequate number of die-cast aluminum LED fixtures mounted on 30m, galvanized steel pole may also be used. It will be possible to lower / raise the fixtures manually or electrically for fixture replacement.

9.3.7 Street lighting shall be low loss, high power factor LED fixtures mounted on a 9m galvanized steel pole.

9.4 SOCKET OUTLET

9.4.1 Socket outlets shall be fed at 240(ph-ph) from small power panels. Three phase socket outlets / welding receptacles shall be fed from 415V PMCC located in Substation.

9.4.2 Receptacles will have necessary mechanical interlocks, suitable protections for site conditions and earthing facilities. All receptacles will have looping facility.

9.4.3 Substation, Control Room and Office Rooms will have decorative type receptacles, with ELCB (30mA sensitivity) controlled socket, 240V, 2 phase 16 A, 3 pin at 10-meter interval. Not more than four socket outlets shall be fed by one circuit.

9.4.4 In plant area 240 V, 2 phase, 16 A, 3 pin ELCB (30mA sensitivity) controlled industrial type receptacles will be provided at 15m radius zone.

9.4.5 In outdoor area, 415 V, 3 Phase, 63 A, ELR (30mA-3A) controlled TPE welding socket spaced 50m radius zone.

9.4.6 A maximum of two welding receptacles will be connected in one circuit.

9.4.7 All outdoor socket outlet/ receptacles will be of flameproof (Ex ‘d’) construction and rated for temperature class T3, gas group IIA/B.

9.4.8 One outdoor 415V, 3 Phase of suitable rating socket outlet shall be installed for each group (every 2) of power transformers, for oil treatment purposes.

9.4.9 All receptacles specified above shall have interlocked type and provided with one matching plug.

9.4.10 All receptacles shall have looping facility.

9.4.11 All the sockets shall have cable entry at the bottom.

9.4.12 Each branch circuit shall be protected with ELCB (30 mA) +MCBs.

9.4.13 Each branch circuit shall be double pole unless otherwise specified.

10. CABLING SYSTEM AND ACCESSORIES

10.1 CABLE INSTALLATION

10.1.1 Cable laying arrangement shall be considered in cable tray & direct buried cable trench as applicable.

10.1.2 Cable tray will be manufactured as galvanized iron ladder type, H style, with 157mm (6") side rails and 129mm (5") loading depth, using standard widths of 900 mm (36"), 600mm (24"), 300 mm (12"), or 150mm (6"). Ladder rung spacing shall be 225mm (9") on centers.

10.1.3 Cable tray shall have 1.5 safety factor and be capable of bearing149kg/m (100lb/ft) load for 900mm width, be supported at 3 m span intervals, and same equivalent for other sizes. Actual cable tray length must be equal to or exceed the supporting span interval.

10.1.4 Cable trays shall be routed on dedicated tiers of the pipe racks and on sleepers to equipment. When required, inverted "V" type cable tray covers shall be used.

10.1.5 Above ground cables trays shall be supported at appropriate intervals both vertically and horizontally, as required by the cable tray manufacturer's design criteria.

10.1.6 The cabling shall include the following:

i. Complete cable trays, supports, rack-risers, ducts, trenches, and area cabling for all the equipment/ loads, termination kits, glands, lugs, markers, tag plates & etc.

ii. Cable trays, racks & trenches shall be sized to allow for 20% future cables.

iii. Cable trays installed on elevated pipe racks, especially if carrying hydrocarbons shall be provided with GI sheet of adequate thickness to protect the cables in case of fire in the pipe rack/ equipment located below the cable trays.

iv. Cable tray cover shall be considered for outside topmost cable tray. Cable Tray cover shall be provided for the outermost trays of vertical droppers.

10.1.7 Cable arrangement in Tray -

- Multi core HV cables will be arranged in a single layer touching formation. Single core HV cables shall be arranged in trefoil formation, with one trefoil cable diameter spacing between them. 150mm spacing shall be considered between HV Cable & control cable.
- MV & LV power cables will be arranged in single layer with no spacing between them.150mm spacing shall be considered between MV/LV power Cable & control cable.
- A separate tray system shall be provided for each voltage level and for all cable trays stacked vertically, there shall be a minimum vertical working clearance of 300mm from the top of the lower tray to the bottom of the tray above

10.1.8 Cable arrangement in direct buried Trench -

- Multi core HV cables will be arranged in a single layer with spacing considered based on the grouping derating factor of cable sizing calculation. Single core HV cables shall be arranged in trefoil formation with spacing considered based on the grouping derating factor of cable sizing calculation. 150mm spacing shall be considered between HV power cable & control cable.
- MV/LV power cables will be arranged in single layer with spacing considered based on the grouping derating factor of cable sizing calculation. 150mm spacing shall be considered between MV/LV power Cable & control cable.

10.2 CABLE GLANDS

10.2.1 Double Compression glands shall be used for all outdoor area cables. For entries into Ex (d) enclosures, barrier type (or compound filled) glands shall be provided. All cable glands and adaptors are made up of nickel-plated brass and are fitted with soft sealing nylon washer. Fiber washers are not to be used. Lock nuts are used for entry into sheet steel boxes enclosures.

10.2.2 Double Compression glands for hazardous area shall be Ex certified based on the equipment certifications and number shall be punched on the glands.

10.3 HV TERMINATION KITS

The termination kits used on high voltage system shall be suitable for the type of cables to be installed. Termination kit shall be suitable to be installed in indoor switchboard or to a weatherproof cable box of an outdoor mounted transformer / motor. Type of termination kits shall be „Heat shrinkable" type.

11. MISCELLANEOUS REQUIREMENTS

11.1 Documents / drawings pertaining to expansion projects of existing plant shall update all the existing plant drawings / documents.

11.2 Individual feeder supply shall be provided for WHCP LP and auxiliary pump instead of common power.

11.3 Earthing arrangement shall be provided for WHCP LP pump / motors.

ANNEXURE-1

PMCC, HV SWGR, VFD & PLC/DCS INTERFACE

Signal Detail	Contact Type	Remarks
Start Command from DCS/PLC to VFD/MCC (Always hardwired for all motor feeders)	24V DC pulse shall be extended to MCC from DCS/PLC to start the motor. 24V DC Interposing relay shall be considered at VFD/MCC.	For all types of Motor Feeders
Stop Command from DCS/PLC to VFD/MCC (Always hardwired for all motor feeders)	24V DC shall be continuously extended to MCC from DCS/PLC, which is de-energized (negative pulse) to trip the motor. 24V DC Interposing relay shall be considered at VFD/MCC.	For all types of Motor Feeders
Start permissive Command from DCS/PLC to VFD/MCC (Always hardwired for all motor feeders) Without this contact, motor feeder shall not start either from local or from remote.	24V DC pulse shall be continuously extended to MCC from DCS/PLC to give the start permission. 24V DC Interposing relay shall be considered at VFD/MCC.	For all types of Motor Feeders, however instr. Shall decide for wiring this as per requirement
Emergency Trip Command from ESD to VFD (Always hardwired for all motor feeders)	24V DC continuous (maintained) shall be normally continuously extended to MCC from DCS/PLC, which is de-energized to trip the motor. SIL-3 certified 24V DC Interposing relay shall be considered at VFD/MCC.	For all types of Motor Feeders
Running status Indication – Feedback from VFD/MCC to DCS/PLC (Always hardwired for all motor feeders)	Normally Open Dry Contact at VFD/MCC, which closes (Continuous) to issue a running Feedback to DCS/PLC	For all types of Motor Feeders

Signal Detail	Contact Type	Remarks
Motor Available/ Ready to start (Always hardwired for all motor feeders) - Feedback from VFD/MCC to DCS/PLC This signal qualifies that the motor feeder is electrically ready to start from DCS/PLC.	Normally Open Dry Contact at VFD/MCC, which closes (Continuous) to issue Motor Available Feedback to DCS/PLC	For all types of Motor Feeders, however, instr. shall decide for wiring this as per requirement
Motor Electrical Fault (Always hardwired for all motor feeders) - Feedback from VFD/MCC to DCS/PLC	Normally Open Dry Contact at VFD/MCC., which closes (Continuous) to issue Motor Electrical fault Feedback to DCS/PLC	For all types of Motor Feeders
Local / Remote (LCS) Indication - Feedback from VFD/MCC to DCS/PLC (Always hardwired for all motor feeders)	Dry Close Contact (Continuous) from VFD/MCC for Remote Mode to DCS/PLC	For all types of Motor Feeders
Speed Feedback from VFD to DCS/PLC for VFD feeders	4-20mA signal from VFD to DCS/PLC	Only for VFD fed motor feeders
Speed Reference from DCS/PLC to VFD for VFD Feeders	4-20mA signal from DCS/PLC to VFD	Only for VFD fed motor feeders

Note:

a) When motor Trips through ESD command motor and motor anti-condensation heater shall also be switched off.

b) All the electrical drive (Motor/ Heater) signals shall be Hardwired with DCS.

c) Hardwired Electrical Interface b/w DCS and MCC of different type of signals shall be as follows: -

   I. Command Signals (DO) from DCS through interposing relays located in the DCS marshalling cabinet and supplied by DCS Supplier. Relay as well relay contact shall be suitable for 24 VDC at DCS end.

   II. Feedback Signals (DI) to DCS shall be potential free suitable for 24 VDC. Accordingly, relay shall be considered at MCC end. (No additional relays at DCS Marshalling end).

d) Interposing relays for ESD functions shall be considered as per SIL study, however Minimum rating shall be SIL3.

e) Winding Temperature Elements shall be connected directly to Switchgear as required and indicated in the P&ID.

f) Digital Output from MCC shall be considered as redundant.

TECHNICAL SERVICES GROUP

SPECIFICATION FOR FLAMEPROOF CONTROL STATIONS

CAIRN-TSG-E-SP-0010

CAIRN ENGINEERING STANDARD

Revision	Date	Description	Originator	Checker	Approver
B2	07/10/2014	Incorporated comments and issued for Implementation	Mahamuni Raja R	RKS	A Ananthanarayanan
B1	06/08/2012	Incorporated comments and issued for Implementation	C.Nallakuttalam	C.Nallakuttalam	A Ananthanarayanan
A1	27/06/2012	Issued for Review	C.Nallakuttalam	C.Nallakuttalam	A Ananthanarayanan

REVISION RECORD

Revision Philosophy

All revisions for review will be issued at A1, with subsequent A2, A3, etc as required.

All revisions approved for issue or implementation will be issued at B1, with subsequent B2, B3, etc as required.

All revisions approved for issue or design and construction will be issued at C1, with subsequent C2, C3, etc as required.

Narrative sections revised from previous pprove issues are to be noted in the table below and/or highlighted using the appropriate revision status thus: | A2

Previous revision highlighting to be removed at subsequent issues.

Drawings/diagrams revised from previous approved issues are highlighted by 'clouding' the affected areas and by the use of a triangle containing the revision status.

Revision History

Revision No.	Date of issue	Reason for change
A1	27/06/2012	Issued for review
B1	06/08/2012	Incorporated comments and issued for Implementation
B2	07/10/2014	Incorporated comments and issued for Implementation (L/R Switch)

CONTENTS

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 following standards issued by HIS (Bureau of Indian standards) unless otherwise specified.

CODE	DESCRIPTION
IS-5	Colors for ready mixed paints and enamels.
IS-1248 (Parts 1 & 2)	Direct acting indicating analogue measuring instruments and their accessories.
IS-2148	Flameproof enclosures for electrical apparatus.
IS-5571	Guide for selection of electrical equipment for hazardous areas.
IS-5572	Classification of hazardous area (other than mines) having flammable gases and vapours for electrical installation.
IS-13346	General requirements for electrical apparatus for explosive gas atmosphere.
IS-13408 (Part-1)	Code of practice for the selection, installation and n1aintenance of electrical apparatus for use in potentially explosive atmospheres (other than mining applications or explosives processing and manufacture).
IS-13947 Part 1 and 2	L. V. Switchgear and Control gear.

2.2 Imported equipment shall conform to the international standards such as IEC/BS/VDE/NEMA or equivalent.

2.3 The equipment shall also conform to the provisions of Indian Electricity rules 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 I VDEI NEMA or equivalent agency shall be applicable

2.5 In case of any contradiction between various referred standards I specifications I data sheet and statutory regulations the following order of priority shall govern:

- Statutory regulations
- Data sheets
- Job specification
- This specification
- Codes and standards

3.0 GENERAL REQUIREMENTS

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

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 Plants.

Unless otherwise specified, design ambient temperature of 50 C and altitude not exceeding 1000 m above MSL shall be considered.

5.0 CERTIFICATION

The equipment shall have test certificates issued by recognized independent test house (CMRIIBASEEFA/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 and shall be free from frictional sparking hazard. The magnesium content in the alloy shall be as per IS-13346. The temperature rise of external surfaces shall be limited to 200oe, unless otherwise specified.

6.1.2 The control stations shall be suitable for use in outdoor open locations and shall have IP-55 degree of protection as minimum. 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) galvanized sheet steel or FRP. The canopy shall be suitable for providing protection against rain from top and two sides.

6.1.3 Unless otherwise specified all control stations shall be suitable for 240 V AC as well as for 110V/220V DC control supply. LCS shall be provided for all motors.

6.1.4 The control stations shall be provided with gaskets made of non-inflammable and self-extinguishing plastic material.

6.1.5 The enclosures shall be treated and prepared for painting with two coats of epoxy paint with final colour shade (Both internal and external) as below:

Flame proof (Gas group IIA/IIB)

Flame proof (Gas group IIC)

: Dark admiralty grey shade 632 of IS-5

: Light yellow shade 355 of IS-5

6.1.6 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.

6.1.7 All accessories like nuts, bolts, washers etc. shall be made of stainless steel SS-304.

6.1.8 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.

6.1.9 Each control station shall be provided with 2 nos. bottom cable entries,1 no. flame proof double

6.1.10 Compression nickel plated brass cable gland and 1 no. flameproof nickel plated brass sealing plug. The glands shall be CMRI tested DGMS approved make for Mines application

6.1.11 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.

6.1.12 A nameplate indicating TAG NO shall be provided on each control station. Separate nameplate shall also be provided to indicate the details of testing agency (CMRI or equivalent), test certificate no. with date, statutory approval no. with date and agency (CCE/DGFASLIIDGMS), BIS license number and date, applicable gas group etc. The nameplates shall be engraved on 3 ply black white black lamicold sheets using square cutters. Black engraved Perspex sheet nameplate shall also be acceptable. Nameplates shall be fixed by screws and shall not be pasted. 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 having GREEN and RED colour respectively. Unless otherwise specified each push button shall have one normally open and one normally closed contact. The STOP push button shall be mushroom type with stay put feature and lockable in pressed position.

6.2.2 1No of 3-Position “HAND-OFF-AUTO” Selector switch (Stay put Type) shall be provided. Scheme of operation shall be as follows:

a) When selected local- Motor shall be able to start from LCS only.

b) When selected Remote- Motor shall be able to start from DCS / PLC only.

c) Stop Command – Shall be irrespective of L/R switch position.

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 positions and stay put in STOP position. Unless otherwise specified all selector switches shall have minimum two poles for each position. Each positions 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 1.5 and suitable for 1 ampere CT secondary. Unless otherwise specified, min. size of ammeter shall either be 72 mm x 72 mm or min. 65 mm dia. 80% of the scale length shall cover 100% of the CT primary current uniformly and the balance 20 % of the scale shall cover 100-600 % 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 (Type 'A' glass).

6.2.4 All push button and control switch contacts shall be rated for min. 5 Amps at 240 V AC and 1 Amp at 110 V DC-duty.

6.2.5 Indicating lamp(s) wherever provided shall be clustered LED type mounted inside a lens of minimum diameter of 151nm.

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 mm solid copper conductor. In case lugs are required for cable termination, tinned copper type lugs shall be provided.

6.3.2 All internal wiring shall employ 2.5 mm2 660V grades, PVC insulated copper conductor wires.

7.0 INSPECTION, TESTING AND ACCEPTANCE

7.1 During fabrication, the equipment shall be subjected to inspection by CEIL or by an agency authorized by the Owner. Manufacturer shall furnish all necessary information concerning the supply to CEIL. All routine/acceptance tests shall be carried out at manufacturer's works under his care and expense. Two weeks prior notice shall be given before date of commencement of test for witnessing by CEIL authorized representative.

7.2 Type test certificates from CMRI or equivalent test house, applicable CCE/DGF ASLIIDGMS 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 dispatch

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 acceptance tests as per standards but not limited to the Following:

a) General visual inspection.

b) Dimensional inspection.

c) Verification of mechanical and electrical operations.

d) Dielectric tests.

e) Routine pressure test as per IS-2148.

f) Any other routine and acceptance test as per applicable standards.

7.5 Type tests shall be carried out if specified in data sheet/job specification.

8.0 PACKING AND DESPATCH

All the equipment shall be divided into several shipping sections for protection and ease of handling during transportation .The equipment shall be properly packed for selected mode of transportation (i.e.by ship/rail/ trailer). The equipment shall be wrapped in polyethylene sheets before being placed in crates

Incases to prevent damage to the finish. Crates /cases shall have skid bottoms for handling. Special precaution notations such as Fragile, This side up, centre of gravity, weight, Owner's particulars, Purchase number etc. shall be clearly marked on the package together with other details as per purchase order.

The equipment may be stored in a covered shed for long periods before installation. The packing should be suitable for such storage.

9.0 VENDOR DOCUMENTATION

9.1 The VENDOR shall have to take approval of relevant drawings and data from the COMPANY in writing before starting manufacture of any equipment. The VENDOR shall at his own cost rectify defects in any manufacture done prior to the approval of drawings / data in accordance with the approved drawings/data and the equipment shall be delivered within stipulated time.

9.2 Drawings, data, information and manuals shall be submitted as indicated below:

- Type Test Report
- Dimensional general arrangement drawing
- Cable end box details
- Test reports in VENDOR's format

AME / 2001

A.C. Machine Engineering Division
Bhopal

Induction Machine Technical Data

Enq. Ref: AME/O2024-1293AL **Rev.** **Customer: M/s. CAIRN ENERGY thru IPM**

Note: Data furnished below is subject to 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	4570 / 1495
4	(a) RATED VOLTAGE & VARIATION (b) RATED FREQUENCY & VARIATION (c) COMBINED VARIATION	6600 / ±6% 50 / ±3% 10%
5	Frame Size / 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)	50/70
9	FULL LOAD / NO LOAD CURRENT(AMPS)	460 / 98
10	EFFICIENCY(%) AT 100% / 75% / 50% FL	96.5 / 96.3 / 95.3
11	POWER FACTOR AT 100% / 75% / 50% FL	0.90 / 0.90 / 0.85
12	LOCKED ROTOR CURRENT (%FLC) AT RV	Depends On VFD
13	FULL LOAD TORQUE (kg-m)	2977
14	LOCKED ROTOR TORQUE (%FLT) AT RV	Depends on VFD
15	PULL OUT TORQUE (%FLT) AT RV	175
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.)	20.0 / 25.0
19	MOTOR GD2 (KGM2) / WEIGHT (KG) (Approx.)	1400 / 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	Flexible
25	BRG. VIBRATION LEVEL(um) / NOISE(dB)	37 / 85 at 1 (Mtr)
	NOTE: [1] Quoted efficiency as per IS4889. [2] Motor suitable for Zone 2 IIA/IIB T3	

Name	Sign	Date
USR		21-May-2024
AKS		21-May-2024

AME / 2001

A.C. Machine Engineering Division
Bhopal

List of Accessories/ Instrument

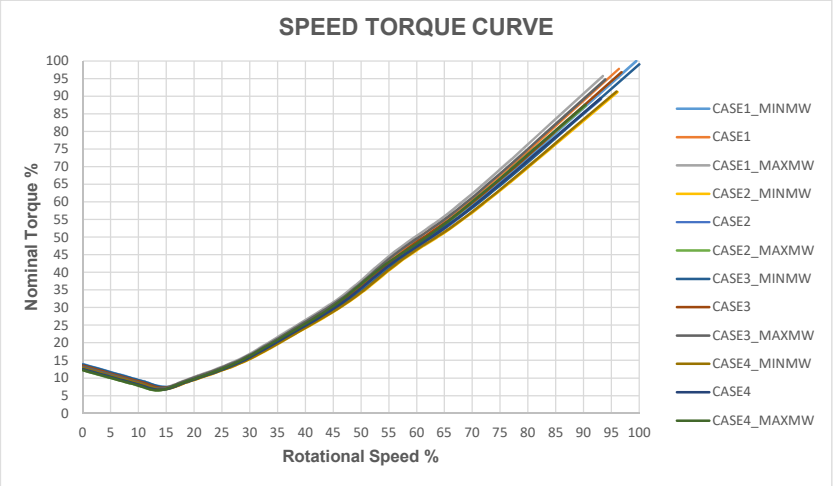
Enq. Ref: AME/O2024-1293AL **Rev.** **Customer: M/s. CAIRN ENERGY thru IPM**

No.	Description	Qty.
1	WINDING RTDs - PT100, Simplex, 3 WIRE	12
2	BEARING RTDs - PT100, Duplex, 4 WIRE	2
3	DTTs for bearings- GAS FILLED 'Without Contacts'	2
4	Hot + Cold Air RTDs PT100, Duplex, 3 WIRE	-
5	DTTs for Hot/Cold Air - GAS FILLED 'Without Contacts'	1/1
6	Stator Terminal Box: PSTB (Fault withstand current: 50kA for 0.25s) (RHS From DE)	1
7	Rotor Terminal Box (RHS From DE)	NA
8	Neutral Terminal Box - Pressurised	1
9	Current transformer: (As per customer specification)	NA
10	CT Secondary Terminal Box	NA
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	1
14	Coolers (CACA Without Blower)	YES
15	Water leakage detector with 2 contacts: Contact rating 5A, 240 V AC (2 Probes + 1 Control)	NA
16	Water Flow Indicators with 2 contacts: Contact rating 5A,240 V AC	NA
17	Bearing - Sleeve Lubrication:FOLS	2
18	Force oil lubrication system (Not in BHEL scope of supply)	NO
19	HP Jacking	NO
20	Oil level Gauge (Without any switch)	YES
21	Insulation of Bearing (NDE Only)	YES
22	Earthing Brush	NO
23	Holding down bolts	YES
24	Grounding pad with 2 tapped holes for earthing conductor (In Motor body/Terminal Box)	2/2
25	Drain holes at bottom of machine frame	NO
26	NDE shaft extention	NA
27	Tacho Generator	NA
28	Speed Switch (240V,1ph AC)	NO
29	Cable Glands: Main terminal/RTDs/Space heater (Ex'd' Type)	YES
30	Vibration Pads (80 mm3) for mounting bearing vibration probes/sensors	YES
31	Mounting arrangement for shaft vibration probes	NA
32	Vibration Probes/Sensors (Not in BHEL scope of supply)	NO
33	Paint Shade	632 OF IS5
34	Piping arragement for pressurization	YES
35	pressurization control system	YES

Name	Sign	Date
USR		21-May-2024
AKS		21-May-2024

BHEL Maharatna Company	**STARTING TORQUE CURVE FOR CENTRIFUGAL COMPRESSOR**	**Sheet 1 of 1**

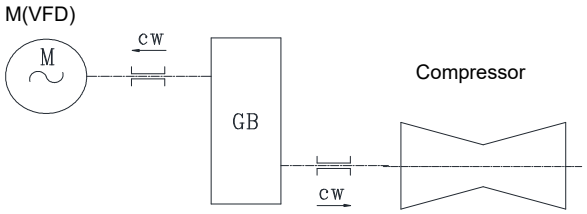
PROJECT : RDG Additional Infill Wells Project
SERVICE : Inlet Gas Compressor (Natural Gas)
CUSTOMER : Cairn Oil & Gas (Vedanta Ltd)
CONSULTANT : Nauvata Engineering Pvt Ltd.,
No. OF UNITS : 2 (2W+0S)



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	4570 kW
Nominal Power	3968 kW
Motor Speed at Full Load	1485 rpm
Nominal Torque at Full speed (Case3_MinMW)	2589 kgm
Max Torque (Case1_MinMW)	2613 kgm
Static Torque (Max)	391.95 kgm
GD2 (Referred to Motor Speed)	5600 kgm2
Direction of Rotation seen from Coupling end (for Motor)	CW
Shaft end cylindrical diameter	220 mm #
No. of Keys on Shaft end	1
Speed Range % :	80-105% **
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



** Trip speed shall be 107.1%. Motor / VFD to be designed for the same. **(Rev 02)**
(#) Considered for coupling sizing. Motor group to check adequacy and decide.
Please refer enquiry specification for all other technical details to finalize the motor design

STEAM TURBINES AND COMPRESSORS				Date	Dept. code
				04-07-2024	420
Format No.	**Prepared**	**Checked**	**Approved**	**Drawing No.**	**Rev**
CA0-1-034-00	KARTEEK	SRIDHAR	NEMA	C2421001/ ST	02

FIRST ANGLE PROJECTION

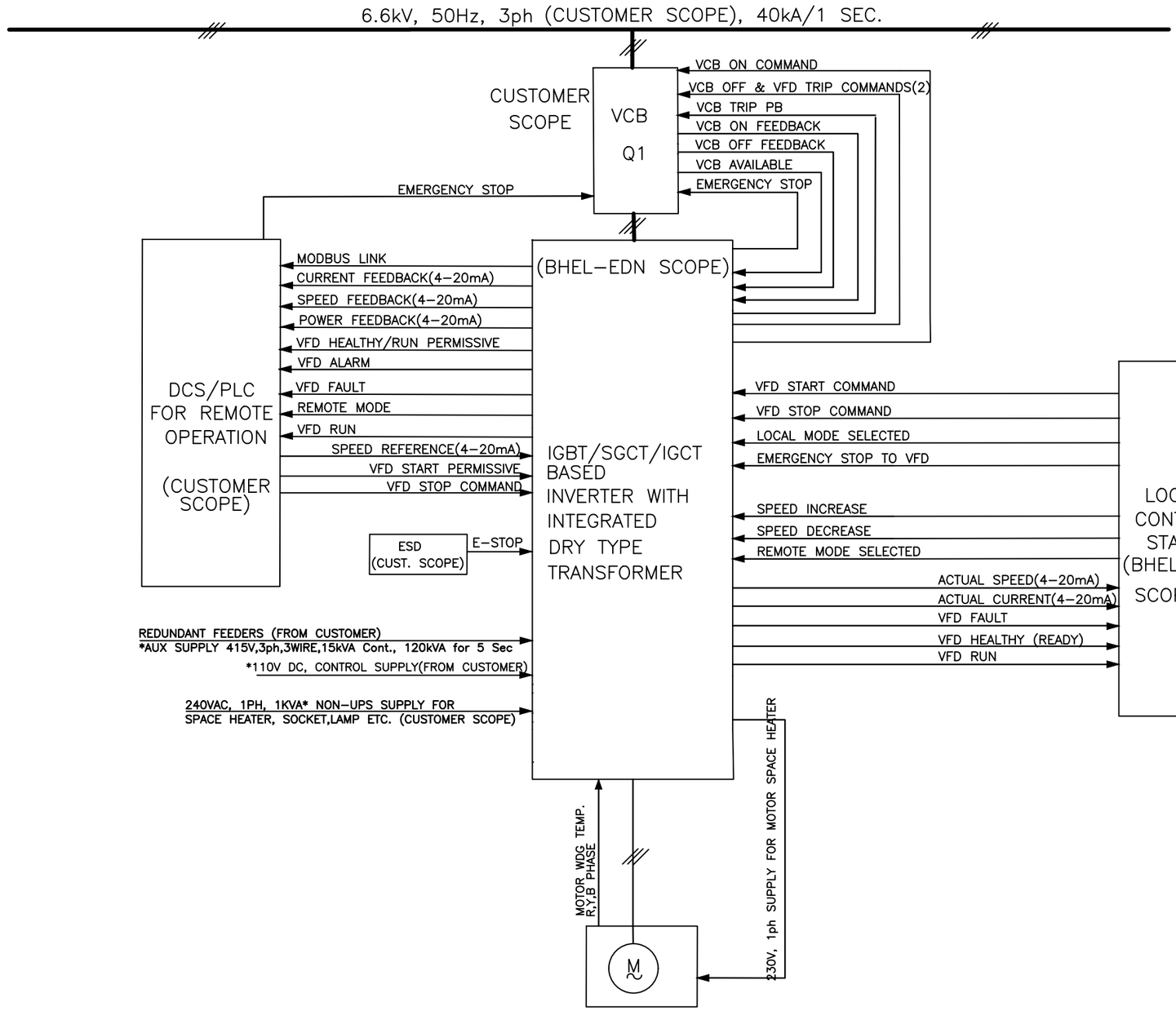
(ALL DIMENSIONS ARE IN mm)

DRG. No.

REF. DRG. No.

SIGN. & DATE

INVENTORY No.



INDUCTION MOTOR, 4570kW
6.6kV, 50HZ (BHEL–BHOPAL SCOPE)

REMARKS :

1. ALL HT POWER CABLES,CABLE TERMINATION KITS, LT POWER CABLES, CONTROL & INSTRUMENTATION CABLES ARE IN CUSTOMER SCOPE.
2. INPUT VCB SHOULD HAVE PROVISION OF 2 TRIP COILS FOR FAIL PROOF OPERATION
3. NO SPECIAL CABLES ARE ENVISAGED FOR VFD SYSTEM
4. CUSTOMER TO CONSIDER 50/51, 50/51N PROTECTION FOR VFD INPUT BREAKER

* FEEDER RATING WILL BE CONFIRMED AFTER FINALIZATION OF VFD VENDOR

NOTE :
DCS : DISTRIBUTED CONTROL SYSTEM
PLC : PROGRAMMABLE LOGIC CONTROLLER
VFD : VARIABLE FREQUENCY DRIVE

IP CLASS	VFD PANEL: IP31 LCS: IP55

VFD START (CONTROL LOGIC MADE IN VFD)		
LCS L/R SW. POS.	VFD L/R SW. POS.	CONTROL FROM
LOCAL	LOCAL/ REMOTE	LCS
REMOTE	LOCAL	VFD
REMOTE	REMOTE	DCS/PLC

PROJECT – RDG ADDITIONAL INFILL WELLS, FEED FOR IGC PROJECT
CUSTOMER – VEDANTA LTD

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

	NAME	SIGN	DATE
DRAWN	MG		11.01.25
CHECKED	LSL		11.01.25
APPROVED	LSL		11.01.25

DISTRIBUTION OF PRINTS

DEPT. | CODE

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

CARD CODE

TITLE: SINGLE LINE DIAGRAM FOR VFD – IGC
CAIRN OIL & GAS LTD.

No. OF SHEETS	00
SHEET No.	00
REV	00

M.O. No. | AS PER OPEN TOLERANCE TO ED 0230499 | DRG. No.

FORM No. A3–03

A3 SIZE

soon as practical, but not later than 24 hours after completion of the Quality Surveillance Verification activity. Where approved by the Company this may be extended to a maximum of 48 hours. Company reserves the right to be present during Contractor's Quality Surveillance activities and notification periods shall be agreed in advance for this purpose.

Fabrication Records

The Contractor shall ensure that the complete fabrication history of each structure, equipment item or piping system is documented as required by the Company's Completion Management System requirements and is made available to Company. These records include but are not limited to,

- Material traceability and certification;
- Allocation of unique joint reference numbers and marking;
- Welding consumable control records
- Calibration and recording control
- Weld mapping
- Record of all forming operations including MTRs, relevant heat treatment charts and inspection certificates;
- Record of materials joined including MTRs;
- Record of all welding / laminating / bonding procedure specifications and supporting procedure qualification records,
- Records of all welders / laminators / bonders with supporting performance qualification certificates;
- Record of all post weld heat treatment of joints including procedures and chart records;
- Record of all inspection, NDE, PMI and production tests including procedures and relevant test reports
- Records of all NDE and PMI operatives involved in inspection with supporting performance qualification certificates;
- Records of all repair or rectification work and subsequent inspection / testing;
- Records of all load testing and certification of lift points
- Records of all surface preparations and coatings
- Records of any design changes to equipment, structures or piping isometric and the subsequent approvals
- As constructed red-line mark-ups and as-builts
- Records of Type Tests, Routine Tests and FAT Reports
- Records of Satutatory Approvals
- Inspection release notes and certificates
- MDR files
- Record of all baseline survey results.

8.5 Inspection and Test Plans (ITP's)

Contractor shall ensure that Inspection and Test Plans (ITP's) are developed and approved by Company to define the inspection and testing activities which are to be performed for the Works. The Contractor ITP register shall include those documents prepared by its sub-contractor and vendor/suppliers.

As a minimum the content of all ITPs shall include but not be limited to:

- Approved header block containing project specific data
- Item identification;
- Manufacturing and process description, item and activity, covering all stages of the work under the contract;
- The description of each test, examination or inspection to be performed;
- The location at which each inspection and testing activity will take place;
- The applicable control documents (e.g. project spec'/standard), for each activity including the acceptance criteria being clearly stated;
- The timing and the frequency of each specified/required inspection activity
- The certifying or verifying document generated (unique inspection test records) to provide objective evidence of compliance with specified requirements; (signing line items within the ITP without supporting ITR documents is not acceptable as field inspection Verification and will be rejected.)
- The responsible inspectorate for performing the inspection, testing and Quality Surveillance (a suitable coding legend will be used to identify which position within Contractor's organisation is responsible for performing the activity);
- Sample signature legend register, noting name, position and level of inspection authority and allocated QC stamp number. (can be independent document);
- Inspection and testing points (defined in terms of 'Hold', 'Witness', 'Monitor' and 'Review' Points);
- Columns allowing Company to inform Contractor and its Subcontractors of any additional Quality Surveillance required by Company

ITPs shall be in strict compliance with all relevant specifications, Standards, codes of practice, statutory, regulatory and contractual requirements, meaningful and specific to the actual work under the contract to be performed. ITP's shall be Contract specific, generic ITP's are not acceptable.

ITP's shall be approved by Contractor prior to submission for review and approval by Company. All ITP's shall be approved prior to commencement of the relevant work.

CONTRACTOR shall meet Inspection Test Plan requirement as per Company's approved CAIRN-TSG-Q-GUI-0004 Guideline for Inspection Test Plan.

8.6 COMPANY's Quality Surveillance

In addition to Contractor's own Quality Surveillance activities, Company reserves the right to undertake its own Quality Surveillance at source including, but not limited to, technical reviews, witnessing of tests, routine inspections, audits, etc. in order to verify the adequacy, effectiveness and implementation of the contract QMS and PQP, and to verify compliance with the requirements outlined in the contract and specifications.

Contractor shall ensure that Company has full access to premises, information and personnel required to undertake such Quality Surveillance activities. Contractor shall ensure that Company's right of access extends to all Subcontractors.

TECHNICAL SERVICES GROUP

GUIDELINE FOR INSPECTION TEST PLAN

CAIRN-TSG-Q-GUI-0004

CAIRN ENGINEERING STANDARD

Revision	Date	Description	Originator	Checker	Approver
B1	15.02.2016	Issued for implementation	Nitin Jadhav	Krishna Naik	Paresh Katvi
A2	03.02.2016	Issued for Review	Nitin Jadhav	Krishna Naik	Paresh Katvi
A1	04.11.2015	Issued for Review	Nitin Jadhav	Krishna Naik	Paresh Katvi

REVISION RECORD

Revision Philosophy

All revisions for review will be issued at A1, with subsequent A2, A3, etc as required.

All revisions approved for issue or implementation will be issued at B1, with subsequent B2, B3, etc. as required.

All revisions approved for issue or design and construction will be issued at C1, with subsequent C2, C3, etc as required.

Narrative sections revised from previous approve issues are to be noted in the table below and/or highlighted using the appropriate revision status thus: | A2

Previous revision highlighting to be removed at subsequent issues.

Drawings/diagrams revised from previous approved issues are highlighted by 'clouding' the affected areas and by the use of a triangle containing the revision status.

Revision History

Revision No.	Date of issue	Reason for change
A1	04.11.2015	Issued for Review
A2	03.02.2016	Issued for Review
B1	15.02.2016	Issued for implementation

CONTENTS

1.0 SCOPE

The scope of this document is to detail the steps required to develop an Inspection Test Plan for specifying the inspections and tests to be carried out for a specific project, work phase or specific work activity within a project.

2.0 PURPOSE

The pupose of this Guideline to guide CIL persons while reviewing vendor and contractor ITP's. This Guidline also serve to Contractor or vendor to develop their Inspection Test Plan.

It applies to Inspection Test Plans that are developed for all disciplines within CIL projects.

3.0 DEFINITIONS & ABBREVIATIONS

3.1 Definitions

Acceptance Criteria: The criteria by which the work is measured and deemed acceptable or not.

Inspection Test Plans (ITP): Documents that nominate the tests and inspections required for a particular activity; the applicable standards; acceptance criteria; hold points and methods of recording results.

Inspector: The qualified nominated person who is required to conduct an inspection or test of the process and verify that it meets the specified requirements.

Specification or Standard: The documented requirement that states the minimum standard of workmanship to be achieved.

Quality Check: An activity where Quality Person have input by way of adding knowledge to improve.

Vendor/Supplier: The supplier in this instance shall mean any organisation, firm, and entity capable of supplying plant, equipment, materials or services to the **CIL** project and shall include its representatives, successor's assigns and employees

3.2 Abbreviations

ITP	Inspection Test Plan
MDR	Manufacturing Data Report
VDRL	Vendor Data Requirement List

4.0 REFERENCES

ISO 9001	Quality Management Systems – Requirements
CAIRN-TSG-Q-PRO-0068	Quality Exhibit

5.0 RESPONSIBILITIES

CIL Project Engineers and Package Engineers are responsible for ensuring that Suppliers submit Inspect ion & Test Plans (ITP's), the contents of which should as a minimum contain those items as described under Section 8.5 of Quality Exhibit. Supplier ITP's shall be subject to relevant

Quality group checks, discipline of Quality group which shall be determined by the relevant Project Manager and/or Package Engineer after consultation with the CIL Quality Manager.

The following responsibilities apply for all personnel undertaking activities covered by this document.

5.1 Development

The responsibility for development of the Inspection Test Plan (ITP) rests with the Project Quality Manager with assistance from the Quality Leads and Discipline Engineer (if required) the template of which is attached.

Input can be gained from the Engineering Team, Commissioning and Construction Team managing the Project or activity within the project.

Therefore document may be subjected to review in the form of a Quality check, this review group discipline wise shall be determined by the Project Quality Manager or for some the Contracts Manager.

5.2 Data Information

The Project Manager shall ensure the persons reviewing the document have all relevant information pertaining to the activity at hand and relevant areas of management are captured.

This requires access to;

- Scope of Work
- Purchase Order
- RFQ Documents (Standard & Specification, procedures etc.)
- Approved Data Sheet
- Approved Drawing
- Relevant Approved Procedure

CIL has identified Welding, Coating, NDT and Flange Management as specialised processes. Vendor need to include activities related to said specialised processes by default as applicable in their ITP.

5.3 Approval

Once the ITP has been verified by the Quality Team, it shall be stamped for approval by the concern Quality Lead and issued for implementation.

6.0 PROCEDURE

6.1 Format

There are many forms used to document an Inspection Test Plan however CIL follow the guidelines of ISO 9001: 2008 validation of process for production and service provision in logical working order of to include:

- Task or Activity Number or Serial Number
- Description of task or Inspection Activity
- Characteristic to be verified

- Quantum of check
- Reference Code to include Codes , Specification, Procedures and Standards
- Acceptance Criteria to include Codes , Specification and Standards c/w ref clauses;
- Verifying documents to identifying records
- Intervention points for all stakeholders (Monitor, Hold , Review ,Surveillance, Witness Points)
- Signature of the Authorised Person

6.2 Heading

The Form shall have a number containing a heading with the following data for reference purposes;

- Contractor / Manufacturer & Company Logo
- Company, Contractor / Manufacturer Details
- Project , Contract Number/ Purchase Order Number & Job/Material Description
- Document (ITP) number , Revision & Date on each page (as per Company document Numbering system)
- Approval Authority and date with stamp
- Footer shall include for page number and document number.

6.3 Other Parties

Regulatory and other 3rd party bodies may be involved in the process, this will cause extra columns to be added to accommodate for signature, date and also expansion of the table for identification of signatories.

Other parties shall be nominated and approved before directing tasks

7.0 DEVELOPMENT

Following the above format the development of the ITP shall be as follows:

7.1 Heading Project & Job Description

The ITP header shall clear display the project Identifier and scope of work, job description, revision number and date. (See 6.2 above)

The footer shall display page number.

7.2 Task or Activity Number or Serial Number

Tasks or activities or serial number shall be in a logical order of the process from start to finish and numbered accordingly. Should a task be subcontracted it shall be noted as a "nominated "sub-contractor referring to that company's aligning ITP and relevant documents

7.3 Description of Task or Inspection Activity

The logical steps shall be established and any activities requiring inspection and testing shall be listed within the ITP.

The description shall be simple with enough detail to clearly describe the task or inspection activity.

7.4 Characteristic to be verified

The Inspection authority shall monitor and measure the characteristics of the product to verify that product requirements have been met. This shall be carried out at appropriate stages of the product realisation process

7.5 Quantum of Check

Quantum of check define that how many number of quantity of product shall be undergo through inspection/Testing and it should be define as per relevant code and standard.

7.6 Reference Code

This column describe which applicable standard, specification or code for each activity shall be referred during inspection of product

7.7 Acceptance Criteria

The acceptance criteria, be it the Code; Standard; Scope of Work and or Activity Procedure, shall be nominated with a particular guiding note and clause for both the Supervisor and Inspectors reference.

In some case it may reflect the drawing number and/or materials take off.

7.8 Verifying Documents

This column shall be describe which documents/reports (e.g. MTC, WPS/PQR, Test Reports, NDT Reports, Inspection Reports, Painting Reports, FAT Reports, CMRI /CCOE Certificate etc.) shall be verify by inspection authority during inspection.

7.9 Intervention points

- **Review Point (R)** - the process of verifying by examination of documentary evidence that nominated inspections and/or tests have been satisfactorily conducted or that nominated document deliverables meet requirements. This evidence must be offered to Company for review as soon as practicable.
- **Witness Point (W)** - an activity defined in the Inspection Test Plan required to be witnessed by the nominated inspector. In the case of a witness point nominated by Company, If Company or its representative is not present after being provided with the required written notice, then Contractor may proceed with the Quality Surveillance activity.
- **Hold Point (H)** - an activity identified in the Inspection Test Plan beyond which further work shall not proceed without the attendance of the nominated inspector. In the case of a 'Hold' Point nominated by Company, Contractor shall not proceed with the work without Company or its representative being present, except where Company has notified Contractor in writing that it may proceed
- **Monitor Point (M)** - At this point during the activity, the nominated Company Inspector is required to carry out random inspections. This does not stop the activity going forward unless he observes a noncompliance. The Contractor can continue the works under surveillance by the Contractors' representative.
- **Surveillance point (S)** - At this point during the activity, the nominated Inspector is required to Surveillance visit at works to ensure that the item or activities performing by vendor/contractor are meeting with specified requirement.

In other words, the respective signification of these words may be compared as follows,

- Surveillance by monitoring, observing, checking of documents and /or records, auditing
- Surveillance visit conducted by Customer or Contractor or its representative or the organization(as a second level above its own inspection or in case of its own sub-suppliers performance survey)

- Surveillance visit to ensure that the organization process are controlled and meet with specified requirements.

7.10 Authorised Person

Authorised Person (Contractor or Vendor) shall be prepared reviewed and endorsed the Inspection Test plan as per specific requirement. After submission the Customer authorised person will review, approve and endorse the document. Authorised person shall be from Quality Team.

7.11 Nominated Person

The nominated person is the one who is most determined to be qualified in witnessing a certain activity; this nominee may vary for a given activity.

This persons initials or his/her abbreviated title shall be shown in the appropriate column.

For certified materials, equipment or process, the person shall carry the correct qualifications, in accordance with the codes or standards.

CIL may ask for and be given the persons CV.

The nominated persons from both parties shall sign off and date the appropriate line item as it is completed in accordance with the acceptance criteria.

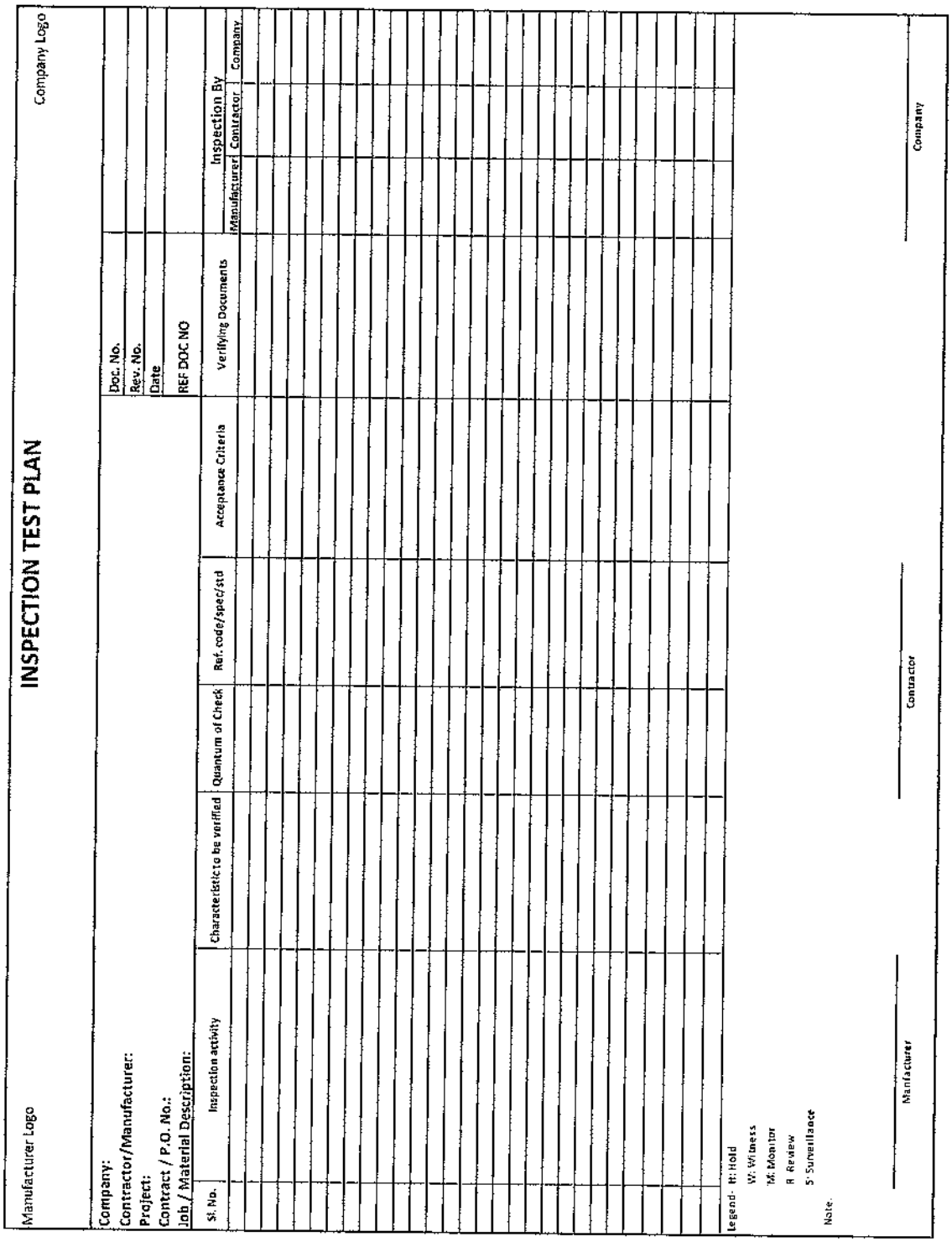
8.0 DOCUMENTATION

The Inspection Test Plan fully signed off, completed with all check lists, and shall be entered into the Project Manufacturing Data Report (MDR).

9.0 APPENDIX A

Inspection Test Plan (ITP) Template

APPENDIX-A



Manufacturer Logo — Company Logo

INSPECTION TEST PLAN

Company:
Contractor/Manufacturer:
Project:
Contract / P.O. No.:
Job / Material Description:

Doc. No.
Rev. No.
Date
REF DOC NO

Sl. No.	Inspection activity	Characteristic to be verified	Quantum of Check	Ref. code/spec/std	Acceptance Criteria	Verifying Documents	Inspection By: Manufacturer	Contractor	Company

Legend- H: Hold
W: Witness
M: Monitor
R: Review
S: Surveillance

Note:

Manufacturer | Contractor | Company