BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESS ENGINEERING MANAGEMENT
NOIDA

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TYPE OF DOC.	TECHNICAL SPECFICATION	NAME	DKS/AA	SKS/VK	RS
TITLE: **66kV Gas Insulated Switchgear (GIS) with Local Control Cabinet (LCC) & Control Relay Panel (CRP)** (Suitable for coastal & highly corrosive environment)		SIGN			
		DATE	28.05.2018	28.05.2018	28.05.2018
		GROUP	TBEM		
		WO No.	87010		

CUSTOMER	Hindustan Petroleum Corporation Limited (HPCL)
PROJECT MANAGEMENT CONSULTANT (PMC)	Engineers India Limited (EIL)
PROJECT	66 KV GIS system for CPP package for Visakh Refinery Modernization Project (VRMP), Vishakhapatnam.
TENDER NO./ NOA NO.	17000406-HP-46004/AK dtd. 15.02.2018

Contents

Remarks: Bidder to note that data and details of Guaranteed Technical Particulars shall not be reviewed during Technical Evaluation/ Review, hence compliance of Guaranteed Technical Particulars in line with Technical Specification shall be bidder's responsibility.

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Section 1:
Scope, Project specific technical requirements & Bill of Quantities

The Break-up for section is as follows,

1. Scope
2. Specific Technical Requirements
3. Other General Requirements
4(i). Bill of Quantities for GIS & its Accessories (Annexure-GIS BOQ is attached)
4(ii). Bill of Quantities for CRP & its Accessories (Annexure-CRP BOQ is attached)
5. Type Testing
6. Quality Plan
7. Inspection & Testing
8. Field Testing & Commissioning
9. Makes of Equipment/ Components
10.Packing & Dispatch
11 Abbreviations Used
12. Layout Drawing for 66kV GIS
13. Plot Plan for Unit
14. Single Line Diagram for 66kV GIS & CT VT Parameters
15. Hardware datasheet for EHV GIS
16. Inspection & Test Plans (ITPs)

Section 1: Scope, Project specific technical requirements & Bill of Quantities

1.1 SCOPE

This technical specification covers the requirements of design, manufacture, inspection and testing at manufacturer's works, proper packing and delivery to project site and supervision of erection, testing & commissioning of **66kV Gas Insulated Switchgear (GIS) with Local Control Cabinet (LCC) & Control Relay Panel (CRP)** complete in all respect for efficient & trouble free operation mentioned under this specification.

Hence, the electrical scope of work under this requisition shall include but not be limited to basic and detailed engineering, as required, manufacturing, supply, transportation to site, inspection at manufacturer's work, installation, testing and commissioning, **Electrical power system studies**, supply of all mandatory spares, commissioning spares, special tools and tackles as defined in the equipment datasheet, drawings, standard specifications, standards, etc. attached or referred with technical specification.

This section covers the specific technical requirements of **66kV Gas Insulated Switchgear (GIS) with Local Control Cabinet (LCC) & Control Relay Panel (CRP).** This constitutes minimum technical parameters for the above item as specified by the Owner/PMC (Project Management Consultant). The offered **66kV Gas Insulated Switchgear (GIS) with Local Control Cabinet (LCC) & Control Relay Panel (CRP)** shall also comply with the Section-3 (Project Details and General technical requirements for all equipment under the Project) of this specification.

The specification comprises of following sections:

Section-1 : Scope, Project specific technical requirements & Bill of Quantities.
Section-2 : Equipment Specification under scope of supplies.
Section-3 : Project Details and General technical requirements (For all equipment under the Project).
Section-4 : Annexures
Annexure-A (Schedule of Technical Deviations)
Annexure-B (Compliance Certificate)
Annexure-C (Guaranteed Technical Particulars)
Annexure-D (Technical Checklist)

The following order of priority shall be followed. In case of conflict between requirements specified in various documents, the more stringent one shall be followed. BHEL/Owner/PMC concurrence shall, however, be obtained before taking a final decision in such matters.

1. Statutory Regulations
   In particular, the latest version of the following statutory regulations, as applicable, shall be followed for system,
   - o Indian Electricity Act
   - o CEA regulations
   - o The Factory Act
   - o The Petroleum Rules

- o OISD standards
- o Requirements of other statutory bodies as applicable, e.g. CEA, CCE, LPCB.

2. Section-1
3. Section-2
4. Section-3
5. Codes & standards

Bidder shall furnish list of conflicts/ ambiguities/ deviations, if any, along with their technical offer and also furnish the basis that is considered for submitting technical offer. BHEL/Owner/PMC will resolve listed conflicts prior to award. In case of ambiguity, bidder shall inform BHEL/Owner/PMC of their interpretation. In case bidder fails to convey the same prior to award, the Owner's decision on interpretation shall be considered final if need arises during the execution. No additional cost or extra time on account of conflicts/ ambiguities/ deviations shall be admissible.

In general, no deviation from the requirements specified in various clauses of this specification shall be allowed and hence, a certificate to this effect shall have to be furnished along with the offer (Annexure-B), however bidder shall furnish list of conflicts/ ambiguities/ deviations (Annexure-A), if any. Any conflicts/ ambiguities/ deviations mentioned elsewhere in technical offer shall not be reviewed.

The equipment is required for the following project:

Name of the Customer	:	**Hindustan Petroleum Corporation Limited (HPCL)**
Name of PMC	:	**Engineers India Limited (EIL)**
Name of Main Contractor	:	**Bharat Heavy Electricals Limited**
Name of the Project	:	**66 KV GIS system for CPP package for Visakh Refinery Modernization Project (VRMP), Vishakhapatnam.**

The scope of supplies shall be as per commercial terms and conditions enclosed separately with the notice inviting tender/ enquiry.

1.2 SPECIFIC TECHNICAL REQUIREMENTS

Specific technical requirements **66kV Gas Insulated Switchgear (GIS) with Local Control Cabinet (LCC) & Control Relay Panel (CRP)** shall be as follows,

Sl. No.	Technical Parameters	Unit	66 kV GIS
1	Type of GIS		Indoor Type
2	Location		Indoor
3.1	Maximum ambient temperature	^{0}C	45
3.2	Minimum ambient temperature	^{0}C	12.50
3.3	Design ambient temperature	^{0}C	45
4	Relative humidity	%	95
5	Nominal voltage class, kV rms	kV	66
6	Maximum System voltage, kV	kV	72.5

7	Rated frequency,	Hz	50
8	Number of phases	Nos	3
9	Rated normal current of Bus at 50 Hz	Arms	2500
10	Rated short circuit current at rated maximum voltage, not less than, kArms (symmetrical)	kArms	40 for 1sec
11	Duty Cycle of circuit breaker		O-3 min-CO- 3 min-CO
12	Operating mechanism of circuit breaker		Spring charged/ electro hydraulic or combination
13	Auxiliary Supply		
13.1	AC	V	240V AC±10% SPN/415V AC±10% TPN
13.2	DC	V	110V DC±10%
14	Maximum guaranteed gas leakage rate per year over the life time of the switchgear	Per year	0.5%
15	Degree of Protection for gas compartments		IP 65
16	Degree of Protection for supporting frames, low voltage and other compartments		IP4X
17	Painting		Epoxy & Shade RAL 7032

All current carrying components of the equipment specified shall be capable of continuous operation at the specified rated current without exceeding the maximum temperature rise specified in the relevant IEC standards.

Thermal calculations shall be based on the climatic conditions mentioned elsewhere in specification.

1.3 OTHER GENERAL REQUIREMENTS

Other general requirements **66kV Gas Insulated Switchgear (GIS) with Local Control Cabinet (LCC) & Control Relay Panel (CRP)** shall be as follows,

(i) Storage shall be provided by BHEL/ its contractor. However, bidder shall provide their tentative space requirement for covered and/ or open store area during tender stage only. In addition to this, bidder shall submit their standard storage instruction manual also.

(ii) Bidder shall submit list of consumables with shelf life of less than two years and same shall be dispatched just before the erection and only after specific clearance from BHEL/Owner/PMC.

(iii) Project Site is located in coastal area, which is highly corrosive. Hence, proper care shall be taken during design, material selection and construction of GIS & its accessories so that it should be suitable for the climate/ metrological conditions, mentioned elsewhere in specification.

(iv) In addition to this, packing of GIS & its accessories shall be suitable for long term storage (minimum 2 years, if required).

(v) Bidder shall offer their latest type tested compact model to accommodate the specified & allocated space as per attached layout drawing of GIS. Bidder to note that if bidder fails to meet above requirement, its technical offer is liable for non-evaluation.
(vi) Bidder shall conduct insulation co-ordination studies for establishing surge arrester rating, quantity and any other requirement for successful operation of GIS.
(vii) Bidder shall be required to submit 3D OGA Drawing for complete GIS & its accessories.
(viii) Bidder shall check and ensure adequacy of system protection for successful operation of GIS. After checking of system by bidder, GIS shall be installed and if any failure, malfunction of any part occurs after/ during commissioning, same shall be replaced immediately without any extra cost.
(ix) EOT crane shall be provided for GIS. However, EOT crane for GIS has not been envisaged in bidder's scope but bidder shall provide all the calculations basis for sizing of EOT crane during tender stage only.
(x) The bidder is to ensure that offered GIS and associated system gets accommodated in the space allocated in GIS Layout & SLD drawings attached.
(xi) GIS shall have provision for I/O signal to ECS as per list furnished in section-2 (Typical ECS I/O list for different type of Feeders of ECS system).
(xii) CT/ VT parameters mentioned in SLD is indicative only. Bidder has to ensure correctness of CT/VT sizing as per relays selected for GIS during contact stage / detailed Engineering stage.
(xiii) Any change in bay pitch (distance between bays) as per civil requirement for foundation layout during detailed engineering stage shall be incorporated by the bidder without any cost and delivery implication to BHEL.
(xiv) Bidder shall include painting and marking of all buses, individual incomers, all outgoing feeders etc. with details such as tag no., feeder rating, sending end source reference etc. for all switchboards.
(xv) Painting of all structural steel supports provided for installation of all electrical equipment, associated components, cables, earthing etc.
(xiv) **Earthing of GIS**: Supply of earthing material and supervision of erection of all earthing connection for GIS to GIS and GIS to earth mesh on floor shall be in bidder's scope. The required quantity shall be estimated by the bidder only, based on their proven design philosophy. However, supply of earthing material i.e. 40mm MS rod & GI flat & erection of earthmat on floor shall be done by BHEL in supervision of bidder/manufacturer as per manufacturer's design. Any other earthing material except 40mm MS rod & GI Flat if required shall be in bidder's scope of supply only.

1.4 BILL OF QUANTITIES

Quantities for supply and services for **66kV Gas Insulated Switchgear (GIS) with Local Control Cabinet (LCC) & Control Relay Panel (CRP)** shall be as per **Annexure-GIS BOQ & Annexure-CRP BOQ**. However, the scope broadly covers the following requirements,

66 kV, 2500A, 40 kA for 1 second, Double bus bar Gas insulated switchgear (GIS) complete with LCC, CRP, plugs/sockets for cable terminations, CTs, protection relays, differential relays and portable gas handling cart.

1.5 TYPE TESTING

Bidder shall ensure that the electrical equipment procured have valid type test certificates as per relevant IS/IEC from CPRI or any other accredited testing lab. Type test certificates for

GIS and relays shall not be more than five years old as on scheduled date of original bid opening. In those cases, where type test certificates are more than five years old from original scheduled date of technical bid opening, Bidder/manufacturer shall carry out the type tests at CPRI or any other accredited testing lab prior to dispatch of equipment with no commercial implication to BHEL/Owner/PMC.

In case any of Type tests have not been conducted on the offered design of GIS and relays or there has been a change in the design after the type tests the requisite tests shall be conducted by bidder on the offered design of GIS and relays without any extra cost and delivery impact to BHEL/Owner/PMC.

Type test should have been carried out as per relevant IEC standards at a recognized and well reputed test laboratory. The following type test certificates shall be required for verification as evidence of successful completion of type tests.

The bidder shall submit the following type tests reports for the tests conducted on the GIS & its accessories. However, any other Type Tests reports not mentioned but required shall also be submitted,

a) Test to verify the insulation level of the equipment including partial discharge test and dielectric tests viz:
(i) Lightning impulse test
(ii) Switching impulse test (if applicable)
(iii) One minute power frequency test
(iv) Partial discharge test
b) Test to prove the temperature rise of any part of the equipment and measurement of the resistance of the main circuit.
c) Test to prove the ability of the main and the earthing circuits to carry the rated peak and the rated short time withstand current.
d) Test to verify the making and breaking capacity of circuit breaker.
e) Test to prove the satisfactory operation of switching devices i.e., circuit breaker, dis-connector, earth switch.
f) Tests to prove the strength of enclosures.
g) Test for degree of protection of the enclosure.
h) Tests to assess the effects of arcing due to an internal fault (internal arc test).
i) Gas tightness tests.
j) Type tests on Circuit breakers, dis-connectors, earth switches, surge arrestors, CT, PT etc. as per the relevant standards.
k) Tests to prove the radio interference voltage (RIV) level (if applicable).
l) Electromagnetic compatibility tests (EMC)
m) Additional tests on auxiliary and control circuits.
n) Tests on partitions.
o) Tests to prove the satisfactory operation at limit temperatures.
p) Tests to prove performance under thermal cycling and gas tightness tests on Insulators.
q) Corrosion test on earthing connections (if applicable).

1.6 QUALITY PLAN

The successful bidder shall submit the Quality Plan for BHEL/ OWNER/ PMC approval. In case bidder has reference Quality plan agreed with BHEL/Owner/PMC, same can be

submitted for specific project after award of contract for BHEL/Owner/PMC approval. There shall be no commercial implication to BHEL on account of Quality Plan approval.

All materials shall be procured, manufactured, inspected and tested by vendor/ sub-vendor as per approved quality plan. The supplier shall perform all tests necessary to ensure that the material and workmanship conform to the relevant standards and comply with the requirements of the specification. Charges for all these tests for all the equipment & components shall be deemed to be included in the bid price.

Bidder to note that Third Party Inspection Agency (TPIA) shall be finalized for Inspection of Materials and same agency shall also approve Quality Plans and carry out inspection as per approved Quality Plans.

1.7 INSPECTION & TESTING

(i) GIS and its associated materials shall be subject to inspection by BHEL/owner/PMC or authorized representative at bidder/manufacturers' works. Hence, Bidder shall furnish all necessary information concerning the supply to BHEL/owner/PMC.
(ii) During fabrication, the equipment shall be subject to inspection by BHEL/owner/PMC or by an agency authorized by the owner to assess the progress of work as well as to ascertain that only quality raw material is used.
(iii) Routine and acceptance tests as listed in relevant Indian/ International standard and equipment specifications shall be conducted. ITPs (Inspection and test plans) attached herewith, are generic and indicative only. Immediately after receipt of the order, bidder shall submit within one week of receiving LOA, job specific ITPs based on the indicative ITPs, if available. Further, bidder shall also submit Quality Assurance Plan for project activities in the scope of contract, starting from manufacturing to handing over/ commissioning, these plans shall cover/identify the activities, relevant procedure, if any, code of conformance, resources for performance and checking/monitoring, approval requirements and authority, records to be generated and audit scope by BHEL/PMC/Owner. Type test if listed in indicative ITPs and in the relevant data sheet shall be conducted. Type test, if specified, shall be conducted only on one of equipment of each type and rating. These tests shall be carried out by the Bidder/ vendor and shall be witnessed by BHEL/owner/PMC or an agency authorized by BHEL/owner/PMC.
(iv) Bidder shall ensure that the hazardous area equipment provided shall have the necessary test certificates and valid CCOE approval certificates.
(v) Bidder shall also furnish factory acceptance and site acceptance testing procedures from manufacturers for OWNER/PMC approval. The equipment manufacturer shall carry out these tests at site only. Site testing procedures shall be got approved from OWNER/PMC before performing these tests at Site.

1.8 FIELD TESTING & COMMISSIONING

(i) Bidder shall carry out the supervision of installation, field testing and commissioning of GIS and CRP including associated system. Further appropriate test and commissioning reports and as-built documentation as necessary be submitted.
(ii) Field testing and commissioning of GIS and CRP including associated system of 66kV GIS shall be done by Bidder/OEM only.
(iii) Bidder shall also submit site acceptance testing (SAT) procedures and get them approved from BHEL/Owner/PMC before carrying out the site testing at site.

(iv) All switchboard protection shall be subject to primary injection test before commissioning.
(v) Contractor shall coordinate with manufacturers of other equipment wherever required and shall freely and readily supply all technical information for this purpose as and when called for.
(vi) All electrical equipment shall be said to be installed and mechanically complete after circuit testing, primary and secondary injection testing and loop simulation is complete. Due care and consideration shall be given to the installation of GIS and CRP including associated system.

1.9 MAKES OF EQUIPMENT/ COMPONENTS

(i) Bidder/ vendor while ordering 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. Bidder/ vendor shall give a notice of at least one year to the BHEL/Owner/PMC before phasing out the products/spares to enable the owner for placement of order for spares and services.
(ii) Bidder/ Vendor may procure material from any of owner/ PMC-approved vendors. However, current validity and range of approval as per PMC enlistment letter, workload, stability and solvency need to be verified by the Bidder/vendor before placement of order.
(iii) Bidder/ Vendor can offer equipment/ components of makes other than specified in the tender during order execution. The alternate makes of equipment/ components will be evaluated post order, based on the satisfactory track record and test certificates to be furnished by the Bidder/Vendor. In case the alternate makes are not found acceptable, equipment/ components shall be strictly as per vendor list enclosed with the tender.

1.10 PACKING AND DISPATCH

(i) The equipment shall be carefully packed for transport by sea, rail and road in such a manner that it is protected against the climatic conditions and for any damage during transportation, transit and storage.
(ii) The SF6 equipment shall be shipped in the largest factory assembled units within transport and loading limitations and considering handling facilities on site to reduce the erection and installation work on site to a minimum. Where possible all items of equipment or factory assembled units shall be boxed in substantial crates or containers to facilitate handling in a safe and secure manner.
(iii) Each individual piece to be shipped, whether crate, container or large unit, shall be marked special notations such as 'Fragile', 'This side up', 'Center of gravity', 'Weight', 'Owner's particulars', 'PO no.' etc., and other details as per purchase order.
(iv) The equipment may be stored outdoors for long periods before installation. The packing shall be completely suitable for outdoor storage in areas with heavy rains and high ambient temperature.
(v) Special precautions shall be taken to protect any parts containing electrical insulation against the ingress of moisture. This applies particularly to the equipment of which each gas section shall be sealed and pressurized prior to shipping. Either dry nitrogen/air or dry SF6 gas shall be used and the pressure shall be such as to ensure that, allowing for reasonable leakage, it will always be greater than the atmospheric pressure for all variations in ambient temperature and the atmospheric pressure encountered during shipment to site and calculating the pressure to which the sections shall be filled to ensure positive pressure at all times during shipment.

(vi) All blanking plates, caps, seals, etc., necessary for sealing the gas sections during shipment to site shall be provided. Any seals, gaskets, `0' rings, etc. that will be used as part of the arrangement for sealing off gas sections for shipment of site, shall not be used in the final installation of the equipment at site. Vendor to provide quantity of components accordingly considering permanent installation.

1.11 ABBREVIATIONS USED

GIS:	Gas Insulated Switchgear
LCC:	Local Control Cabinet
CRP:	Control Relay Panel
CT:	Current Transformer
DC:	Direct Current
HV:	High Voltage
EHV:	Extra High Voltage
kV:	Kilovolt
Hz:	Hertz
IP:	Ingress Protection
IEC:	International Electro Technical Commission
IS:	Indian Standards
ITP:	Inspection and Test Plan
DCI:	Document Control Index
PMC:	Project Management Consultant
CEA:	Central Electricity Authority
OISD:	Oil Industry Safety Directorate
CCE:	Continuous and Comprehensive Evaluation
LPCB:	Loss Prevention Certification Board
TPIA:	Third Party Inspection Agency
SAT:	Site Acceptance Testing
CCOE:	Chief Controller of Explosives
OEM:	Original Equipment Manufacturer
EIL:	Engineers India Limited
HPCL:	Hindustan Petroleum Corporation Limited
VRMP:	Vishakh Refinery Modernization Project

				ANNEXURE-GIS BOQ
BILL OF QUANTITIES FOR GIS & ACCESSDRIES				
Sl. No.	**Description**	**Detailed Description**	**Unit**	**Qty**
A1	**Supply Item: 66kV, 2500A, 40kA(1 sec) GIS Double Bus Scheme as per attached Single Line Diagram**	**66kV, 2500A, 40kA (1 sec) Double Bus GIS complete with local control cabinet (LCC), plug/ sockets for cable terminations etc. Typical Bay includes Busbar, Circuit Breaker, Disconnector & Earthing Switch, Maintenance Earthing Switch, High Speed Earthing Switch, Current Transformer, Voltage Transformer, Surge Arrestor, Cable Connection Module, Gas Monitoring Devices, Pressure Switches etc. (Refer attached Single Line Diagram).** **The Switchgear shall be complete with all necessary terminal boxes, inspection windows, SF6 gas filling, interconnecting cabling & wirings, grounding connections, gas monitoring systems and pipings, trays, support structures. Hence, the scope shall include supply, erection and mounting of hardware and interconnecting cables between GIS to LCC and between LCC to LCC including Cable Trays, Tags, Glands, ferrules, Lugs etc.**		
1	Incomer Generator Transformer (GTG) Bay (GTG-07 Bay)	SF6 gas-insulated metal enclosed bay module including bus bar module. Each shall be complete in all respect and comprising of following but not limited to, (a) One (1) set of 3x1-phase, SF6 insulated circuit breaker, complete with operating mechanism (b) One (1) set of 3x1-phase, multi-core, muiti ratio, current transformers as per attached SLD. (c) Three (3) set of 3x1-phase, disconnector switches, complete with manual and motor driven operating mechanisms. (d) Two (2) sets of 3x1-phase, safety earthing switches, complete with manual and motor driven operating mechanisms. (e) One (1) sets of 3x1-phase, group operated high speed make proof earthing switches, complete with manual and motor driven operating mechanisms. (f) One (1) set of 3x1-phase, multi winding, voltage transformer as per attached SLD. A removable link, which disconnects and isolates the GIS from the surge arresters during high-voltage test for convenience and ease of operations shall also be provided (if applicable). (g) Gas monitoring system, pressure relief device, busbar, insulator, expansion joint/ flexible connection etc. as required. (h) Any other item required to complete in all respect but not limited to above, howver, it excludes EHV cable termination module & surge arrestor, which is covered separately in BOQ.	Set	1
2	Incomer Future Grid Transformer Bay (Future GT Bay)	SF6 gas-insulated metal enclosed bay module including bus bar module. Each shall be complete in all respect and comprising of following but not limited to, (a) One (1) set of 3x1-phase, SF6 insulated circuit breaker, complete with operating mechanism (b) One (1) set of 3x1-phase, multi-core, multi ratio, current transformers as per attached SLO. (c) Three (3) set of 3x1-phase, disconnector switches, complete with manual and motor driven operating mechanisms. (d) Two (2) sets of 3x1-phase, safety grounding switches, complete with manual and motor driven operating mechanisms. (e) One (1) sets of 3x1-phase, group operated high speed make proof earthing switches, complete with manual and motor driven operating mechanisms. (f) One (1) set of 3x1-phase, multi winding, voltage transformer as per attached SLD. A removable link, which disconnects and isolates the GIS from the surge arresters during high-voltage test for convenience and ease of operations shall also be provided (if applicable). (g) Gas monitoring system, pressure relief device, busbar, insulator, expansion joint/ flexible connection etc. as required. (h) Any other item required to complete in all respect but not limited to above, howver, it excludes EHV cable termination module & surge arrestor, which is covered separately in BOQ.	Set	1
3	Incomer Station Transformer (STG) Bay (STG-01 Bay)	SF6 gas-insulated metal enclosed bay module including bus bar module. Each shall be complete in all respect and comprising of following but not limited to, (a) One (1) set of 3x1-phase, SF6 insulated circuit breaker, complete with operating mechanism (b) One (1) set of 3x1-phase, multi-core, multi ratio, current transformers as per attached SLD. (c) Three (3) set of 3x1-phase, disconnector switches, complete with manual and motor driven operating mechanisms. (d) Two (2) sets of 3x1-phase, safety grounding switches, complete with manual and motor driven operating mechanisms. (e) One (1) sets of 3x1-phase, group operated high speed make proof earthing switches, complete with manual and motor driven operating mechanisms. (f) One (1) set of 3x1-phase, multi winding, voltage transformer as per attached SLD. A removable link, which disconnects and isolates the GIS from the surge arresters during high-voltage test for convenience and ease of operations shall also be provided (if applicable). (g) Gas monitoring system, pressure relief device, busbar, insulator, expansion joint/ flexible connection etc. as required. (h) Any other item required to complete in all respect but not limited to above, howver, it excludes EHV cable termination module & surge arrestor, which is covered separately in BOQ.	Set	1
4	Incomer Transformer (SS-93 (220kV GIS) TR-9301 Bay, TR-9302 Bay)	SF6 gas-insulated metal enclosed bay module including bus bar module. Each shall be complete in all respect and comprising of following but not limited to, (a) One (1) set of 3x1-phase, SF6 insulated circuit breaker, complete with operating mechanism (b) One (1) set of 3x1-phase, multi-core, multi ratio, current transformers as per attached SLD. (c) Three (3) set of 3x1-phase, disconnector switches, complete with manual and motor driven operating mechanisms. (d) Two (2) sets of 3x1-phase, safety grounding switches, complete with manual and motor driven operating mechanisms. (e) One (1) sets of 3x1-phase, group operated high speed make proof earthing switches, complete with manual and motor driven operating mechanisms. (f) One (1) set of 3x1-phase, multi winding, voltage transformer as per attached SLD. A removable link, which disconnects and isolates the GIS from the surge arresters during high-voltage test for convenience and ease of operations shall also be provided (if applicable). (g) Gas monitoring system, pressure relief device, busbar, insulator, expansion joint/ flexible connection etc. as required. (h) Any other item required to complete in all respect but not limited to above, howver, it excludes EHV cable termination module & surge arrestor, which is covered separately in BOQ.	Set	2

BILL OF QUANTITIES FOR GIS & ACCESSORIES				
Sl. No.	Description	Detailed Description	Unit	Qty
5	Bus Coupler Bay (Bus Coupler 1-2 Bay, 3-4 Bay)	SF6 gas-insulated metal enclosed bay module including bus bar module. Each shall be complete in all respect and comprising of following but not limited to, (a) One (1) set of 3x1-phase, SF6 insulated circuit breaker, complete with operating mechanism (b) One (1) set of 3x1-phase, multi-core, multi ratio, current transformers as per attached SLD. (c) Two (2) set of 3x1-phase, disconnector switches, complete with manual and motor driven operating mechanisms. (d) Two (2) sets of 3x1-phase, safety grounding switches, complete with manual and motor driven operating mechanisms. (If required, high speed fault make grounding switch to be provided) (e) Gas monitoring system, pressure relief device, busbar, insulator, expansion joint/ flexible connection etc. as required. (f) Any other item required to complete in all respect but not limited to above.	Set	2
6	Bus Sectionalizer Bay (Bus Sectionlizer 1-3 Bay, 2-4 Bay)	SF6 gas-insulated metal enclosed bay module including bus bar module. Each shall be complete in all respect and comprising of following but not limited to, (a) One (1) set of 3x1-phase, SF6 insulated circuit breaker, complete with operating mechanism (b) One (1) set of 3x1-phase, multi-core, multi ratio, current transformers as per attached SLD. (c) Two (2) set of 3x1-phase, disconnector switches, complete with manual and motor driven operating mechanisms. (d) Two (2) sets of 3x1-phase, safety grounding switches, complete with manual and motor driven operating mechanisms. (If required, high speed fault make grounding switch to be provided) (e) Gas monitoring system, pressure relief device, busbar, insulator, expansion joint/ flexible connection etc. as required. (f) Any other item required to complete in all respect but not limited to above.	Set	2
7	Outgoing Transformer Feeder (SS-94 (CPP) TR-9401 Feeder, TR-9402 Feeder, TR-9403 Feeder, TR-9404 Feeder)	SF6 gas-insulated metal enclosed bay module including bus bar module. Each shall be complete in all respect and comprising of following but not limited to, (a) One (1) set of 3x1-phase, SF6 insulated circuit breaker, complete with operating mechanism (b) One (1) set of 3x1-phase, multi-core, multi ratio, current transformers as per attached SLD. (c) Three (3) set of 3x1-phase, group operated disconnector switches, complete with manual and motor driven operating mechanisms. (d) Two (2) sets of 3x1-phase, safety grounding switches, complete with manual and motor driven operating mechanisms. (e) One (1) sets of 3x1-phase, high speed make proof earthing switches, complete with manual and motor driven operating mechanisms. (f) Gas monitoring system, pressure relief device, busbar, insulator, expansion joint/ flexible connection etc. as required. (g) Any other item required to complete in all respect but not limited to above, howver, it excludes EHV cable termination module & surge arrestor, which is covered separately in BOQ.	Set	4
8	Fully Equipped Spare Feeder (Spare-01 Feeder, Spare-02 Feeder)	SF6 gas-insulated metal enclosed bay module including bus bar module. Each shall be complete in all respect and comprising of following but not limited to, (a) One (1) set of 3x1-phase, SF6 insulated circuit breaker, complete with operating mechanism (b) One (1) set of 3x1-phase, multi-core, multi ratio, current transformers as per attached SLD. (c) Three (3) set of 3x1-phase, disconnector switches, complete with manual and motor driven operating mechanisms. (d) Two (2) sets of 3x1-phase, safety grounding switches, complete with manual and motor driven operating mechanisms. (e) One (1) sets of 3x1-phase, high speed make proof earthing switches, complete with manual and motor driven operating mechanisms. (f) Gas monitoring system, pressure relief device, busbar, insulator, expansion joint/ flexible connection etc. as required. (g) Any other item required to complete in all respect but not limited to above, howver, it excludes EHV cable termination module & surge arrestor, which is covered separately in BOQ.	Set	2
9	Outgoing Transformer Feeder (SS-83 (CD/VDU) TR-8301 Feeder, TR-8302 Feeder)	SF6 gas-insulated metal enclosed bay module including bus bar module. Each shall be complete in all respect and comprising of following but not limited to, (a) One (1) set of 3x1-phase, SF6 insulated circuit breaker, complete with operating mechanism (b) One (1) set of 3x1-phase, multi-core, multi ratio, current transformers as per attached SLD. (c) Three (3) set of 3x1-phase, disconnector switches, complete with manual and motor driven operating mechanisms. (d) Two (2) sets of 3x1-phase, safety grounding switches, complete with manual and motor driven operating mechanisms. (e) One (1) sets of 3x1-phase, high speed make proof earthing switches, complete with manual and motor driven operating mechanisms. (f) Gas monitoring system, pressure relief device, busbar, insulator, expansion joint/ flexible connection etc. as required. (g) Any other item required to complete in all respect but not limited to above, howver, it excludes EHV cable termination module & surge arrestor, which is covered separately in BOQ.	Set	2
10	Outgoing Transformer/ Motor Feeder (SS-84 (RUF) TR-8401 Feeder, TR-8302 Feeder, Large Motor-01 Feeder, Large Motor-02 Feeder)	SF6 gas-insulated metal enclosed bay module including bus bar module. Each shall be complete in all respect and comprising of following but not limited to, (a) One (1) set of 3x1-phase, SF6 insulated circuit breaker, complete with operating mechanism (b) One (1) set of 3x1-phase, multi-core, multi ratio, current transformers as per attached SLD. (c) Three (3) set of 3x1-phase, disconnector switches, complete with manual and motor driven operating mechanisms. (d) Two (2) sets of 3x1-phase, safety grounding switches, complete with manual and motor driven operating mechanisms. (e) One (1) sets of 3x1-phase, high speed make proof earthing switches, complete with manual and motor driven operating mechanisms. (f) Gas monitoring system, pressure relief device, busbar, insulator, expansion joint/ flexible connection etc. as required. (g) Any other item required to complete in all respect but not limited to above, howver, it excludes EHV cable termination module & surge arrestor, which is covered separately in BOQ.	Set	4

BILL OF QUANTITIES FOR GIS & ACCESSORIES				
Sl. No.	**Description**	**Detailed Description**	**Unit**	**Qty**
11	Outgoing Transformer Feeder (SS-82 (FCHCU) TR-8201 Feeder, TR-8302 Feeder)	SF6 gas-insulated metal enclosed bay module including bus bar module. Each shall be complete in all respect and comprising of following but not limited to, (a) One (1) set of 3x1-phase, SF6 insulated circuit breaker, complete with operating mechanism (b) One (1) set of 3x1-phase, multi-core, multi ratio, current transformers as per attached SLD. (c) Three (3) set of 3x1-phase, disconnector switches, complete with manual and motor driven operating mechanisms. (d) Two (2) sets of 3x1-phase, safety grounding switches, complete with manual and motor driven operating mechanisms. (e) One (1) sets of 3x1-phase, high speed make proof earthing switches, complete with manual and motor driven operating mechanisms. (f) Gas monitoring system, pressure relief device, busbar, insulator, expansion joint/ flexible connection etc. as required. (g) Any other item required to complete in all respect but not limited to above, howver, it excludes EHV cable termination module & surge arrestor, which is covered separately in BOQ.	Set	2
12	Outgoing Transformer Feeder (SS-86 (CT), TR-8601 Feeder, TR-8602 Feeder)	SF6 gas-insulated metal enclosed bay module including bus bar module. Each shall be complete in all respect and comprising of following but not limited to, (a) One (1) set of 3x1-phase, SF6 insulated circuit breaker, complete with operating mechanism (b) One (1) set of 3x1-phase, multi-core, multi ratio, current transformers as per attached SLD. (c) Three (3) set of 3x1-phase, disconnector switches, complete with manual and motor driven operating mechanisms. (d) Two (2) sets of 3x1-phase, safety grounding switches, complete with manual and motor driven operating mechanisms. (e) One (1) sets of 3x1-phase, high speed make proof earthing switches, complete with manual and motor driven operating mechanisms. (f) Gas monitoring system, pressure relief device, busbar, insulator, expansion joint/ flexible connection etc. as required. (g) Any other item required to complete in all respect but not limited to above, howver, it excludes EHV cable termination module & surge arrestor, which is covered separately in BOQ.	Set	2
13	Outgoing Transformer Feeder (SS-90 (HGO) TR-9001 Feeder, TR-9002 Feeder)	SF6 gas-insulated metal enclosed bay module including bus bar module. Each shall be complete in all respect and comprising of following but not limited to, (a) One (1) set of 3x1-phase, SF6 insulated circuit breaker, complete with operating mechanism (b) One (1) set of 3x1-phase, multi-core, multi ratio, current transformers as per attached SLD. (c) Three (3) set of 3x1-phase, disconnector switches, complete with manual and motor driven operating mechanisms. (d) Two (2) sets of 3x1-phase, safety grounding switches, complete with manual and motor driven operating mechanisms. (e) One (1) sets of 3x1-phase, high speed make proof earthing switches, complete with manual and motor driven operating mechanisms. (f) Gas monitoring system, pressure relief device, busbar, insulator, expansion joint/ flexible connection etc. as required. (g) Any other item required to complete in all respect but not limited to above, howver, howver, it excludes EHV cable termination module & surge arrestor, which is covered separately in BOQ.	Set	2
14	Bus Measurement Bay with Disconnector & Earthswitch	SF6 gas-insulated metal enclosed bay module inciuding bus bar module. Each shall be complete in all respect and comprising of following but not limited to, (a) One (1) set of 3x1-phase, multi winding, Voltage Transformer as per attached SLD. A removable link, which disconnects and isolates the GIS from the surge arresters during high-voltage test for convenience and ease of operations shall also be provided (if applicable). (b) One (1) set of 3x1-phase group, operated disconnector switches, complete with manual and motor driven operating mechanisms. (c) One (1) set of 3x1-phase, safety grounding switches, complete with manual and motor driven operating mechanisms. (Suitable for Bus Bar Earthing Duty) (d) Gas monitoring system, pressure relief device, busbar, insulator, expansion joint/ flexible connection etc. as required. (e) Any other item required to complete in all respect but not limited to above.	Set	4
15	Bus Earth Switch Bay	SF6 gas-insulated metal enclosed bay module including bus bar module. Each shall be complete in all respect and comprising of following but not limited to, (a) One (1) set of 3x1-phase, safety grounding switches, complete with manual and motor driven operating mechanisms. (Suitable for Bus Bar Earthing Duty) (b) Gas monitoring system, pressure relief device, busbar, insulator, expansion joint/ flexible connection etc. as required. (c) Any other item required to complete in all respect but not limited to above.	Set	4
16	EHV Cable Termination module	SF6 gas-insulated metal enclosed module. Each shall be complete in all respect and comprising of following but not limited to, (a) EHV cable termination module shall be of the plug-in type with dry-type or fluid-filled terminations. The interfaces conform to IEC standards. A removable link, which disconnects and isolates the GIS from the cable during high-voltage test for convenience and ease of operations shall also be provided (if applicable). (b) Gas monitoring system, pressure relief device, busbar, insulator, expansion joint/ flexible connection etc. as required. (c) Any other item required to complete in all respect but not limited to above. The bidder shall have to make provision in termination module for fixing the cable / termination kit supplied by BHEL/its vendor. Bidder has to supply GIS with cable termination modules for all incomer & Outgoing feeder bays.	Set	23
17	Surge Arrestors including Surge Counters	SF6 gas-insulated metal enclosed module. Each shall be complete in all respect and comprising of following but not limited to, (a) The rated arrester voltage shall be 60kV. Surge arrester shall be provided with a discharge counter located at an accessible position. A removable link, which disconnects and isolates the GIS from the surge arresters during high-voltage test for convenience and ease of operations shall also be provided (if applicable). (b) Gas monitoring system, pressure relief device, busbar, insulator, expansion joint/ flexible connection etc. as required. (c) Any other item required to complete in all respect but not limited to above.	Set	23

BILL OF QUANTITIES FOR GIS & ACCESSORIES				
Sl. No.	**Description**	**Detailed Description**	**Unit**	**Qty**
18	Dummy Panel for bus bar extension (Optional)	SF6 gas-insulated metal enclosed module/ dummy panels shall be provided on GIS building expansion joints to lengthen busbar to avoid fouling with floor beams etc. Approximate beam width shall be 800mm.	Set	2
19	Local Control Cabinet (LCC)	Local Control Cabinet (LCC) for each bay shall be supplied. LCCs shall be either separate freestanding floor mounted type panel or mounted on GIS assembly as per bidder's standard design. If separate LCCs are provided, it shall be be located near GIS. The details are requirement are as follows, (a) Incomer Generator Transformer (GTG) Bay (GTG-07 Bay)-**01set** (b) Incomer Future Grid Transformer Bay (Future GT Bay)-**01set** (c) Incomer Station Transformer (STG) Bay (STG-01 Bay)-**01set** (d) Incomer Transformer (SS-93 (220kV GIS) TR-9301 Bay, TR-9302 Bay)-**02set** (e) Bus Coupler Bay (Bus Coupler 1-2 Bay, 3-4 Bay)-**02set** (f) Bus Sectionalizer Bay (Bus Sectionlizer 1-3 Bay, 2-4 Bay)-**02set** (g) Outgoing Transformer Feeder (SS-94 (CPP) TR-9401 Feeder, TR-9402 Feeder, TR-9403 Feeder, TR-9404 Feeder)-**04set** (h) Fully Equipped Spare Feeder (Spare-01 Feeder, Spare-02 Feeder)-**02set** (i) Outgoing Transformer Feeder (SS-83 (CD/VDU) TR-8301 Feeder, TR-8302 Feeder)-**02set** (j) Outgoing Transformer/ Motor Feeder (SS-84 (RUF) TR-8401 Feeder, TR-8302 Feeder, Large Motor-01 Feeder, Large Motor-02 Feeder)-**04set** (k) Outgoing Transformer Feeder (SS-82 (FCHCU) TR-8201 Feeder, TR-8302 Feeder)-**02set** (l) Outgoing Transformer Feeder (SS-86 (CT), TR-8601 Feeder, TR-8602 Feeder)-**02set** (m) Outgoing Transformer Feeder (SS-90 (HGO) TR-9001 Feeder, TR-9002 Feeder)-**02set** (n) Bus Measurement Bay with Disconnector & Earthswitch & Bus Earth Switch Bay-**02set** (If required) (o) Any other item required to complete in all respect but not limited to above.	Set	29
20	SF6 gas required for first filling for placing GIS & its accessories into successful operation. In addition 10% of total gas requirement shall be supplied in separate non returnable gas cylinder as a spare requirement.	First filling of SF6 gas required for placing it into successful operation. In addition 10% of total gas requirement shall be supplied in separate non returnable gas cylinder as a spare requirement.	Lot	1
21	Supply of structure material, required for complete installation of GIS including support structure (foundation bolts/ embedded parts) in floor, walkway platform & railing etc. (The civil works will be done based on supplier design & drawings).	Supply of structure material, required for complete installation of GIS including support structure (foundation bolts/ embedded parts) in floor, walkway platform & railing etc. shall be in bidder's scope. The civil works shall be done based on bidder's design & drawings.	Lot	1
22	Supply of Grounding/ earthing Material for GIS	Supply of Earthing Material (Except 40mm MS ROD & 75x12mm GIS Flat) and Supervision of erection of all Earthing connection for GIS to GIS and GIS to Earth Mesh on Floor shall be in Bidder's scope. The quantity shall be estimated by the bidder, based on their design philosophy. Supply of only 40mm MS ROD & 75x12mm/ 50x6mm GIS Flat and Erection of Earth mesh on floor shall be done by BHEL in supervision of Bidder as per Bidder's design. Design philosophy shall be submitted along with the bid in line with clause 8.00.00 of section-2. Only supply of MS Rod and GI Flat of 75x12mm/ 50x6mm as recommended by Bidder (for earth mesh on floor) shall be in BHEL's scope. Any other earthing material (If required) shall be in bidder's scope of supply.	Lot	1
23	Gas Monitoring and Alarm System	Gas monitoring system shall be complete in all respect and comprising of following but not limited to, (a) All gas compartments shall have their own independent gas supervision and alarm systems. There shall not be any interconnection between different gas compartments for the purpose of gas monitoring. (b) Individual temperature compensated gas pressure gauge(s)/ density device(s) shall be provided in each of the gas compartments which will continuously & automatically monitor and indicate the state of gas density. The system shall be such that it can be installed separately/ integrated with SAS/SCADA (As applicable)	Lot	1
24	Consumables required for GIS	Consumables required during erection, testing and commissioning for complete package. It shall be supplied just before erection after confirmation from BHEL.	Lot	1
25	Any other supply item required for completion of GIS work and not covered above	Any other supply item required for completion of GIS work and not covered above shall be covered in bidder's scope.	Lot	1
B1	**Supply Item: Mandatory Maintenance Equipment**			
1	Portable gas filling equipment/SF6 gas cart	Gas processing unit shall be suitable for filing and evacuating and recycling the SF6 gas into and from the GIS equipment shall be supplied by the bidder to enable any maintenance work to be carried out within reasonable time (maximum 8hrs). Gas processing unit shall be provided with all necessary pipes, couplings, flexible tubes and valves for coupling to the GIS equipment. The offered makes and model shall be equivalent or higher technical capability of DILO, economy series in combination of other requirement in line with details & description of clause 6.11 of section-2. However, Final make & model shall be approved by BHEL/Owner/PMC.	Set	1
2	Portable ladder with adjustable height	The portabe ladder shall be movable on wheels and shall have the plateform for easy maintenance/ repair/ access of GIS items. However, Final make & model shall be approved by BHEL/Owner/PMC.	Set	1
3	SF6 Gas Leak Oetector	The offered makes and model shall be equivalent or higher technical capability of DILO, model 3-033-R002. However, Final make & model shall be approved by BHEL/Dwner/PMC.	Set	1
4	Breaker Operation Analyzer with Transducers	The offered makes and model shall be equivalent or higher technical capability of Scope Hisac Ultima with laptop. However, Final make & model shall be approved by BHEL/Owner/PMC.	Set	1
C1	**Supply Item: Mandatory Spares for GIS**			
1	Handle for disconnector switch drive		No	4
2	Handle for earthing switch drive		No	4
3	Pre selection key for three position switch		No	1
4	Power cable termination kit		Set	2
5	Tripping coil (Per Switchgear)		No	1
6	Closing coil (Per Switchgear)		No	1
7	Capacitive type voltage detectors		Set	1
8	Control fuses/MCB	1 Set= 1 No of each rating and type	Set	10
9	Density monitoring device	1 Set= 1 No of each type	Set	2
10	Pressure Gauge	1 Set= 1 No of each type	Set	2
11	Indication lamp covers	1 Set= 1 No of each colour	Set	5
12	Indication lamps	1 Set= 20% or 3 nos. (min) whichever is more	Set	1
13	Network switches	1 Set= 1 No of each type	Set	1

BILL OF QUANTITIES FOR GIS & ACCESSORIES				
Sl. No.	Oescription	Oetailed Oescription	Unit	Qty
D1	**Supply Item: Operation & Maintenance Spares**	**Bidder to quote BOQ for recommended spares for two years of normal operation & maintenance from the date of commissioning.**		
1	GIS	Bidder shall quote recommended spares for two years of normal operation & maintenance from the date of commissioning. In case of no such requirement, bidder shall submit the certification stating that " We do not hereby recommend any operation & maintenance spares for the period of two years from the date of commissioning, however in case of such requirement in future, same shall be supplied free of cost."	Set	1
E1	**Supply Item: Special Tools & Tackles**	**Complete outfit/range of special tools & tackles including lifting, drilling etc. necessary for complete assembly, erection, testing & commissioning of GIS at site, shall be included in the scope of bidder on non-returnable basis with unit price. This shall include following tools & tackles also but not limited to these,**		
1	Analogue & Digital multi meters	1 Set= 1 No of each rating and type. Final make & model shall be approved by BHEL/Owner/PMC.	Set	1
2	Clip-on meters of different ranges	1 Set= 1 No of each rating and type. However, Final make & model shall be approved by BHEL/Owner/PMC.	Set	1
3	Tong testers	1 Set= 1 No of each rating and type. However, Final make & model shall be approved by BHEL/Owner/PMC.	Set	1
4	Allen Keys	1 Set= 1 No of each rating and type.	Set	1
S	Hammers	1 Set= 1 No of each rating and type.	Set	1
6	Illuminated SLD		Set	1
7	Complete Tool kit for the Electrician	Complete tool kit for the Electrician comprising of screw drivers, testers, pliers spanners, cable cutter / stripper, adhesive tapes etc. Bidder to provide BOQ of all items.	Set	1
8	Battery and mains operated portable Megger	1 Set= 1 No of each rating and type. Final make & model shall be approved by BHEL/Owner/PMC.	Set	1
F1	**Services: Supervision of Erection, Testing & Commissioning**			
1	Site Visit for supervision of unloading & verification of materials for proper storage & upkeeping at site.	This includes following activities but not limited to, (a) Supervision of safe unloading of GIS & its accessories at site. (b) Reconciliation, storage & upkeeping of materials, with due instructions/ traing to site persons for long storage.	Lot	1
2	Supervision of Erection of GIS including earthing	This includes following activities but not limited to, (a) Supervision of Erection of GIS including structure work, earthing, cabling etc. excluding EHV Cable termination module.	Lot	1
3	Supervision of Erection of GIS- for EHV Cable Termination module	This includes following activities but not limited to, (a) Supervision of erection EHV Cable termination module. (b) Supervision during installation & termination of EHV cable, which shall be carried out in stages. as required at site.	Set	23
4	Testing & Commissioning of GIS	Carrying out site acceptance testing for GIS as per customer approved SAT procedure shall be bidder's scope.	Lot	1
S	Testing & Commissioning of GIS- for EHV Cable Termination module		Set	23
6	Final Successful HV/ Power Frequency Testing of GIS including arranging of HV test kit along with operator	Carrying out successful HV/ Power Frequency Testing of GIS as per IEC including Arrangement of HV Test kit (on returnable basis) shall be in scope of bidder, which includes charges HV test kit with operator, accessories & tools required for completion of HV testing. Bays may be commissioned separately.	Lot	1
7	Insulation Co-ordination Studies for GIS System	This deemed to be included for complete GIS.	Lot	1
8	Final Documentation	This includes As Bulit Drawings, Schematics, Site ITPs & protocols etc.	Lot	1
9	Any other Service item required for completion of work and not covered above	Any other Service item required for completion of work and not covered above shall be in bidder scope.	Lot	1
G1	**Service: Training**			
1	Training for GIS of 6 no. Engineers (4 no. customer engineers+2 no. BHEL engineers) for a period of at least one week at Manufacturer's works		Lot	1
2	Lodging and boarding of 4 no. customer engineers for a period of at least one week at Manufacturer's works		Lot	1
3	To and Fro charges of 4 no. customer engineers for a period of at least one week at Manufacturer's works	1 Lot= 4 no. customer engineers to & fro charges by 2AC/Air Delhi/ Vizag to manufacturer works.	Lot	1
4	Training for GIS of 12 no. Engineers (10 no. customer engineers+2 no. BHEL engineers) for a period of at least one week at site		Lot	1
5	Lodging and boarding of 10 no. customer engineers for a period of at least one week at site		Lot	1
6	To and Fro charges of of 10 no. customer engineers for a period of at least one week at site	1 Lot= 10 no. customer engineers to & fro charges by 2AC/Air Delhi/ Vizag to site.	Lot	1
H1	**Supply: Reference unit prices of individual item/ Equipment for any addition or deletion due to change in SLD, damage or replacement etc.**			
1	Circuit Breaker	1 Set= 1 No of each rating and type with all three poles with enclosure & without operating mechanism	Set	1
2	Oisconnector	1 Set= 1 No of each rating and type with all three poles with enclosure & without operating mechanism	Set	1
3	Safety Earthing Switch	1 Set= 1 No of each rating and type with all three poles with enclosure & without operating mechanism	Set	1
4	High Speed make proof Earthing Switch	1 Set= 1 No of each rating and type with all three poles with enclosure & without operating mechanism	Set	1
5	Surge Arrestor including Surge Counter (Rated arrester voltage – 60 kV)	1 Set= 1 No of each rating and type with enclosure.	Set	1
6	Current Transformer	1 Set= 1 No of each rating and type with enclosure.	Set	1

BILL OF QUANTITIES FOR GIS & ACCESSORIES				
Sl. No.	**Description**	**Detailed Description**	**Unit**	**Qty**
7	Voltage Transformer	1 Set= 1 No of each rating and type with enclosure.	Set	1
8	EHV Cable Termination module	1 Set= 1 No of each rating and type with enclosure.	Set	1
9	Operating Mechanism for Circuit Breaker	1 Set= 1 No of each rating and type	Set	1
10	Operating Mechanism box for Disconnector	1 Set= 1 No of each rating and type	Set	1
11	Operating Mechanism for Safety Earthing Switch	1 Set= 1 No of each rating and type	Set	1
12	Operating Mechanism for High Speed make proof Earthing Switch	1 Set= 1 No of each rating and type	Set	1
13	Conductor for GIS		Mtr	1
14	Conductor/ Bus Support Insulator		No	1
15	Gas Barrier Insulator		No	1
16	Gas Permeable/ Communication Insulator		No	1
17	Density Monitor Switch		No	1
18	Elbows		No	1
19	Expansion joints/ Flexible connections		No	1
I1	**Service: Reference unit prices of individual item/ Equipment for any addition or deletion due to change in SLD, damage or replacement etc.**			
1	Services for supervision of erection of GIS		Manday	1
2	Services for Testing & Commissioning of GIS		Manday	1
3	Hiring charges of HV test kit with operator	Additional HV testing charges includes charges of HV test kit with operator, accessories & tools required for completion of HV test (Dielectric Test after installation of GIS/ Maintenance of GIS bay (s)). HV testing shall include testing of one or more bay at site.	Lot	1

Note:

1. The word 'TYPE' means the Make, Model no., Type, Range, Size/ Length, Rating, Material as applicable.
2. Wherever % age is identified, Contractor shall supply next higher rounded figure.
3. The terminology used under 'Part Description' is the commonly used name of the part and may vary from manufacturer to manufacturer.
4. Mandatory spares as indicated above do not cover commissioning spares, however, bidder shall provide the commisioning spare required during testing & commissioning free of cost.
5. Mandatory spares as indicated above do not cover two year O&M spares.

				ANNEXURE-CRP BOQ
		BILL OF QUANTITIES FOR CRP & ACCESSORIES		
Sl. No.	Description	Detailed Description	Unit	Qty
A2	Supply Item: Control & Protection Panel for 66 kV			
1	Incomer Generator Transformer Bay	Control and Protection panel for 66kV GTG-07 (Bay 04) Control and Protection panel for 66kV STG-01 (Bay 12)	Set	2
2	Incomer Grid Transformer Bay	Control and Protection panel for 66kV Future Bay (Bay 09) , Control and Protection panel for 66kV TR-9301 incomer No.1 (Bay 18) Control and Protection panel for 66kV TR-9302 incomer No.2 (Bay 22)	Set	3
3	Bus Coupler Bay	Control and Protection panel for 66kV Bus Coupler-1 (Bay 01), Control and Protection panel for 66kV Bus Coupler-2 (Bay 27)	Set	2
4	Bus Sectionalizer Bay	Control and Protection panel for 66kV Bus Section-1 (Bay 14), Control and Protection panel for 66kV Bus Section-2 (Bay 15)	Set	2
5	Outgoing 66/11.5kV Transformer Feeder	Control and Protection panel for 66kV SS-94 (CPP) : TR 9401 (Bay 02) , Control and Protection panel for 66kV SS-94 (CPP) : TR-9403 (Bay 10), Control and Protection panel for 66kV SS-94 (CPP) : TR-9402 (Bay 16) , Control and Protection panel for 66kV SS-94 (CPP) : TR-9404 (Bay 19)	Set	4
6	Outgoing Plant feeders	Control and Protection panel for 66kV Spare Feeder (Bay 03) , Control and Protection panel for 66kV SS-83 (CDU/VDU) TR-8301 (Bay 05) , Control and Protection panel for 66kV SS-84 TR-8401 (RUF) (Bay-06), Control and Protection panel for 66kV SS-84 TR-8403 (Large Motors) (RUF) (Bay-07), Control and Protection panel for 66kV SS-82 TR-8201 (HCU)(Bay-08), Control and Protection panel for 66kV SS-86 TR-8601 (CT)(Bay-11), Control and Protection panel for 66kV SS-90 TR-9001(HGU) (Bay-13), Control and Protection panel for 66kV SS-83 TR-8302 (CDU/VDU)(Bay-17), Control and Protection panel for 66kV SS-82-TR-B202 (HCU) (Bay 20), Control and Protection panel for 66kV SS-86 TR-8602(CT) (Bay 21) , Control and Protection panel for 66kV SS-90 TR-9002(HGU)(Bay23), Control and Protection panel for 66kV Spare Feeder (Bay 24), Control and Protection panel for 66kV SS-84 TR-8402 (RUF) (Bay-25), Control and Protection panel for 66kV SS-84 TR-8404(RUF) (Bay-26)	Set	14
7	Bus VT Bay	Control and protection panel Bus VT-1,2,3 & 4 along with 8us earth switches. Each set shall comprise of relay and control fitments for Bus 1&2 PT and its associated isolator & Earth switches / 8us 3&4 PT and its associated isolator & Earth switches respectively.	Set	2
8	Busbar Protection Panel for 66kV GIS	Please refer SLD for no. of bays , Bus bar protection shall include Spare as well future bays with necessary network/optical cables, end connectors, tees etc. as required is included in scope of supply.	Set	1
9	Common Data Concentrator Panel for EHV/HV/MV System (66kV/33kV/11kV/415Vsystem/GRP)	(a) The offered data concentrator shall be in line with interface requirements as per typical system architecture drawing B016-606-16-50-SK-4504 Rev.A of Technical Specification. (b) A Common Data concentrator (DC) is required for interface with ECS (Electrical Control system) and relay MMI. (c) All Numerical relays of EHV /HV/MV system shall be looped and connected to data concentrators. Looping of all relays under present scope(EHV-66kV) shall be in bidders scope. However provision should be given for termination of the looped relays of HV/MV/415V system at the data concentrator. Hence the CPU module shall have sufficient communication ports for the relay LAN requirement. (d) To assess the number of IEDs Which will be looped Pls reafer the SLDs of 33kV ,11kV & 415V . (e) ECS will be interfaced to Data concentrators for polling of relay data. For ECS interface, we prefer if data concentrator provides data on Modbus-RTU protocol. (f) Data concentrator shall have provision for direct hardwired DI /AI interface as per System architecture such as solar power system, UPS, DC System, MCC, ASB, LDB , Any other equipment requiring monitoring, Transformer Oil temperature, Transformer winding temperature. (g) Data concentrator shall be supplied with all communication infrastructure (cables, network switches etc as required) for communication between, (i) Relays (under present scope) to Data concentrator and (ii) Data Concentrator to HMI (h) Serial link/lan cables for numericall relays , data concentrator ,HMI and other electrical equipment for meeting the technical specification requirement shall be in bidders scope. (i) Any other item required to complete the system in all respect as per technical specification but not limited to above.	Set	1
10	Transducer Panel for ECS/RTU/SCAP interface	(a) A microprocessor based Electrical Control System (ECS) is proposed for all EHV GIS (66kV) , HV GIS , HV Switchboards of the project. The ECS system shall permit remote monitoring of breaker operation and remote metering. A plant wide load shedding scheme is being implemented through ECS that will trip some of the breaker feeders to which the ECS monitoring is extended. The supply of ECS is not in bidders scope. For purpose of data acquisition for ECS , suitable number of data acquisition units (RTUs) will be placed in each substation. The supply of RTU's are not in bidders scope. (b) The I/O interface required for the RTUs shall be in bidders scope. The I/D interface system shall consist of transducers, interposing relays and hardwired AI, DI & AO. The following shall be in bidders scope - (i) Separate free standing Interposing relay panels shall be provided for mounting interposing relays (of each bay) for data acquisition and remote control (hardwired DO signal interface) through Owner supplied RTU/ ECS panel. (ii) Separate free standing panels for mounting Signal transducers (of each bay) for hardwired AI signal interface with Dwner supplied RTU/ECS Panel and SCAP panel. Transducers (Current and voltage) for 27Nos. 66kV Bays , Bus Voltage , frequency shall be in bidders scope of supply. (iii) Separate free standing Dummy panels shall be provided for hardwired AI(4-20mA), DI and AO Signal interface (of each bay) with Owner supplied RTU/ ECS panel and SCAP Panel . (c) A typical ECS I/O list is attached as part of Section 2 of the technical specification. Technical specification ECS is attached along with Section 2 for reference and interface compliance by bidder. (d) Testing , commissioning of all ECS /RTU panels and I/O integration of bidder supplied panels with ECS shall be done by others/customer . However any mistake or omission found out within the scope of bidder during integration of the ECS system shall have to be made good by bidder without any time / cost implication. (e) The bay Control and relay panels shall have local/remote switch with control from ECS/SCAP (both not in bidders scope of supply) as remote. The schemes shall have dedicated hardwired contacts / status for interface with ECS and	Lot	1

BILL OF QUANTITIES FOR CRP & ACCESSORIES					
Sl. No.	**Description**	**Detailed Description**	**Unit**		**Qty**
11	Dummy Panel for interface between CR Panel and owner supplied RTU/ECS/SCAP Panels.	SCAP (Synchronization , control and annunciation Panel) separately.	Lot		1
12	Interposing relay panel for ECS/RTU/SCAP interface		Lot		1
13	Supply Item: Substation Automation System (SAS) : Operator Work station with necessary software.		Set		2
14	Supply Item: Substation Automation System (SAS) : Engineering station with necessary software.		Set		1
15	Supply Item: Substation Automation System (SAS) : Laser Printer for HMI		Set		1
16	Supply Item: Substation Automation System (SAS) : UPS for HMI		Set		1
17	Supply Item: Substation Automation System (SAS) : Complete Computer Furniture (Table, Chairs, UPS rack trolley etc.) for HMI PC, printer , UPS etc.		Set		1
18	Supply Item: Substation Automation System (SAS) : Laptop with software		Set		1
19	Substation Automation System (SAS) : Time Synchronisation Equipment		Set		1
20	Substation Automation System (SAS) : Ethernet Switches as per communication/SAS architecture requirment.		Lot		1
21	Substation Automation System (SAS) : Armoured Optical Fibre cable system and Copper medium Communication cable system for Substation automation system, data concentrator panel interface & busbar protection (where applicable)	Bidder shall estimate the actual requirement of F.O cable & Cu medium communication cable as per the philosophy followed during detailed engineering.	Lot		1
22	Substation Automation System (SAS) : Auxiliary Control Panel for control and data acquisition of Auxiliary DC & AC system		Set		1
C2.1	**Supply Item: Mandatory Spares for Protection System (CRP, BusBar Protection, Interposing relay Panel, transducer panel, dummy panel)**				
1	Protection Relays (1 Set= 1 No of each type)		Set		1
2	Auxiliary Relays (1 Set= 1 No of each type)		Set		1
3	Interposing Relays (As applicable)(1Set= 5 Nos. of each type)		Set		1
4	Transducers (1set = 20 % of estimated quantity of each type or one no (min) of each make & type, whichever is more)		Set		1
C2.2	**Supply Item: Mandatory Spares for Substation Automation System (SAS)/ Data Concentrator /HMI**				
1	All cards such as input & output cards, power supply cards, processor cards etc. (1 Set= 1 No of each type)	1 Set= 1 No of each type	Set		1
2	Ethernet/Network switches (1 Set= 1 No of each type)	1 Set= 1 No of each type	Set		1
3	Control fuses/ MCB (1 Set= 10 No of each rating and type)	1 Set= 10 No of each rating and type	Set		1

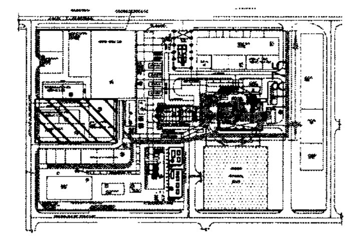
BILL OF QUANTITIES FOR CRP & ACCESSORIES				
Sl. No.	**Description**	**Detailed Description**	**Unit**	**Qty**
D	**Supply Item: Operation & Maintenance Spares**	**Bidder to quote BOQ for recommended spares for two years of normal operation & maintenance from the date of commissioning.**		
1	Bidder recommended Operation & Maintenance Spares for two years of normal operation from date of commissioning : CRP & BusBar Protection Panel	Bidder shall submit the recommended spares list for customer approval during detailed engineering/contract stage. No price implication in this regard will be entertained during execution stage.	Set	1
2	Bidder recommended Operation & Maintenance Spares for two years of normal operation from date of commissioning : Data Concentrator, SAS & HMI	Bidder shall submit the recommended spares list for customer approval during detailed engineering/contract stage. No price implication in this regard will be entertained during execution stage.	Set	1
F	**Services:**			
1	Supervision of Testing and Commissioning of protection relays and complete Substation automation system at site. Scope shall be as following but not limited to (Any item even if not specifically included in BOQ but required for successful completion of work as per technical specification shall be in bidders scope): a) Testing & commissioning of main protection relays and Numerical Busbar protection including Relay parameterization and configuration. b) Testing & commissioning of SAS system including termination of network/optical cables (complete with all end connectors, tees etc as required). c) For network/optical cables which are in the bidder's scope, the laying of cables shall be in BHEL scope. However, Dptical cable will be laid under bidder's supervision. Splicing and Termination shall be in bidder's scope. d) Site acceptance Tests(SAT) as per technical specification. e) Arranging all necessary tools , tackles and equipment for protection and communication testing including automatic relay test kit shall be bidder's responsibility. f)Maintenance support services.	(a) During detailed engineering bidder shall furnish Factory acceptance test procedure (FAT) and site acceptance testing (SAT) procedures from equipment manufacturers for approval. The equipment manufacturer shall carry out the SAT at site based on the approved SAT procedure. (b) Bidders scope shall also include preparation of interface drawings, interconnection drawings with RTU/ ECS/Dwner supplied panels/equipment, relay-coordination drawings , protection coordination drawings , relay setting calculations and relay parameterisation for complete 66kV GIS System . (c) Bidders scope shall also include collection of data from site /owner as required for carrying out detailed engineering. (d) Proper sizing of UPS to be done by bidder, which shall be approved by Customer/BHEL . Breakup of 29 Lots : a) 27 Lots for GIS bays b) 1 Lot for Bus PT 1 & 2 c) 1 Lot for Bus PT 3 &4	Lot	29
2	Supervision of Testing and Commissioning of Common data concentrator at site. Scope shall be as following but not limited to (Any item even if not specifically included in BOQ but required for successful completion of work as per technical specification shall be in bidders scope): a) Testing & commissioning of common data concentrator including termination of network/optical/Cu medium communication cables (complete with all end connectors, tees etc as required).		Lot	1
3	Final Documentation	This includes As Bulit Drawings, Schematics, Relay Parameters etc.	Lot	1
4	Relay Setting calculation	Backup detailed calculations to be submitted along with settings in OEM format.	Lot	1
G2	**Service: Training**			
1	Training in Numerical relay , Substation Automation System (SAS) and Data Concentrator for 6 no. Engineers (4 no. customer engineers+2 no. BHEL engineers) for a period of at least one week at Manufacturer's works		Lot	1
2	Lodging and boarding of 4 no. customer engineers for a period of at least one week at Manufacturer's works		Lot	1
3	To and Fro charges of 4 no. customer engineers for a period of at least one week at Manufacturer's works	1 Lot= 4 no. customer engineers to & fro charges by 2AC/Air Delhi/ Vizag to manufacturer works.	Lot	1
4	Training in Numerical relay , Substation Automation System (SAS) and Data Concentrator of 12 no. Engineers (10 no. customer engineers+2 no. BHEL engineers) for a period of at least one week at site		Lot	1
5	Lodging and boarding of 10 no. customer engineers for a period of at least one week at site		Lot	1
6	To and Fro charges of of 10 no. customer engineers for a period of at least one week at site	1 Lot= 10 no. customer engineers to & fro charges by 2AC/Air Delhi/ Vizag to site.	Lot	1
Note:				
	1. The word 'TYPE' means the Make, Model no., Type, Range, Size/ Length, Rating, Material as applicable.			
	2. Wherever % age is identified, Contractor shall supply next higher rounded figure.			
	3. The terminology used under 'Part Description' is the commonly used name of the part and			
	may vary from manufacturer to manufacturer.			
	4. Mandatory spares as indicated above do not cover commissioning spares, however, bidder shall provide the commisioning spare required during testing & commissioning free of cost.			
	5. Mandatory spares as indicated above do not cover two year O&M spares.			

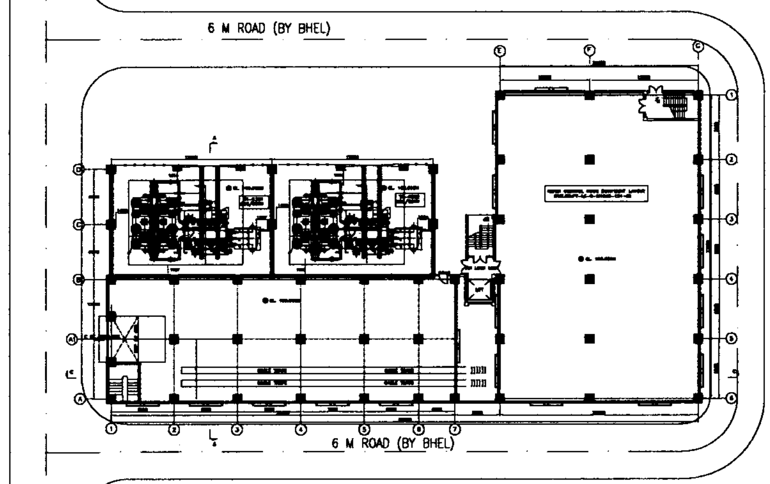
FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

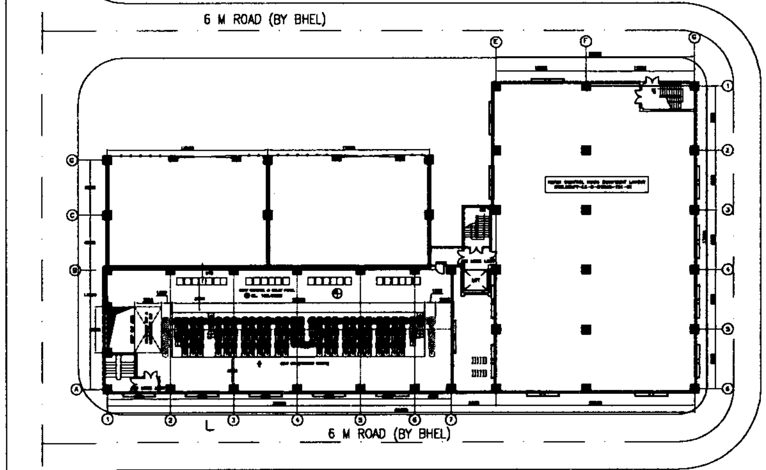
ESP-001-11A

ORG. NO. PY-LE-1-M104-2019-01 | SH. 2 OF





PLAN AT EL.100.000 M LEVEL FOR 66Kv & 33 Kv GIS BUILDING



PLAN AT EL. 103.600 M LEVEL FOR 66Kv & 33 Kv GIS BUILDING

NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETRES AND LEVELS ARE IN METRES.
2. THIS DRAWING SHOWS EQUIPMENT LAYOUT IN SWITCHGEAR ROOM FOR OTHER DETAILS REFER CIVIL ARCHITECTURAL AND MECHANICAL LAYOUT DRAWINGS.
3. ALL MCCs/PMCC ARE SINGLE FRONT & DRAWOUT TYPE . ALL DBs ARE SINGLE FRONT & DRAW OUT TYPE DESIGN.
4. ALL THE GRID DIMENSIONS SHOWN IN THE DRAWING ARE FROM CENTER LINE OF THE COLUMNS & SIDE AND REAR CLEARANCES OF PANELS ARE FROM CENTER LINE OF COLUMNS.
5. FLOOR CUT OUT DETAILS FOR ELECTRICAL PANEL ARRANGEMENT ,CABLE TRAYS ARRANGEMENT IN CELLAR,AND DUCT OPENINGS SHALL BE SHOWN IN THEIR RESPECTIVE DWGS.
6. DETAILS OF PACKAGES LIKE FIRE FIGHTING PROTECTION, AC AND VENTILATION ETC.APPLICABLE FOR THE SUBSTAION ARE BEING TAKEN CARE BY CONCERNED ENGG. GROUPS & SHALL BE INDICATED IN THEIR RESPECTIVE DRAWINGS.
7. ALL SWITCH BOARDS AND CONTROL PANELS SHALL HAVE BOTTOM ENTRY FOR CABLES
8 EQUIPMENT DIMENSIONS INDICATED SHALL BE REVIEWED AFTER RECEIPT OF EQUIPMENT FINAL OUTLINE DRAWINGS FROM RESPECTIVE VENDOR.

PROJECT: CAPTIVE POWER PLANT (CPP) PACKAGE
VISAKH REFINERY MODERNIZATION PROJECT (VRMP)
JOB NO. B016

OWNER: HINDUSTAN PETROLEUM CORPORATION LIMITED

PMC: ENGINEERS INDIA LIMITED (EIL), NEW DELHI

BHARAT HEAVY ELECTRICALS LTD.
HYDERABAD

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.	A.V.SURESH	-sd-	27.03.18	
CHD.	P.SURESH	-sd-	27.03.18	
APPD.	J.K.PATTANIK	-sd-	27.03.18	

DEPT.	UNTOL. DIMS.	SCALE	WEIGHT (KG)	REF. TO ASSY. DRG.	ITEM NO.	NO.OF ITEMS
PE&SD CODE. 450	CR. G/A/A/F			-N.A.-	-N.A.-	-N.A.-

TITLE
SWITCHGEAR ROOM EQUIPMENT LAYOUT (SS-93)

CARD CODE: N.A.
BHEL DRG NO. PY-LE-1-M104-2019-01
CUST DRG NO.
REV. 01
SHT. No 01 | NO. OF SHT. 02

REV.	DATE	ALTERED	CHD/APPD
01	11.05.18	A.V.S	P.S/AP

ZONE: REVISED INLINE WITH EIL/HPCL COMMENTS

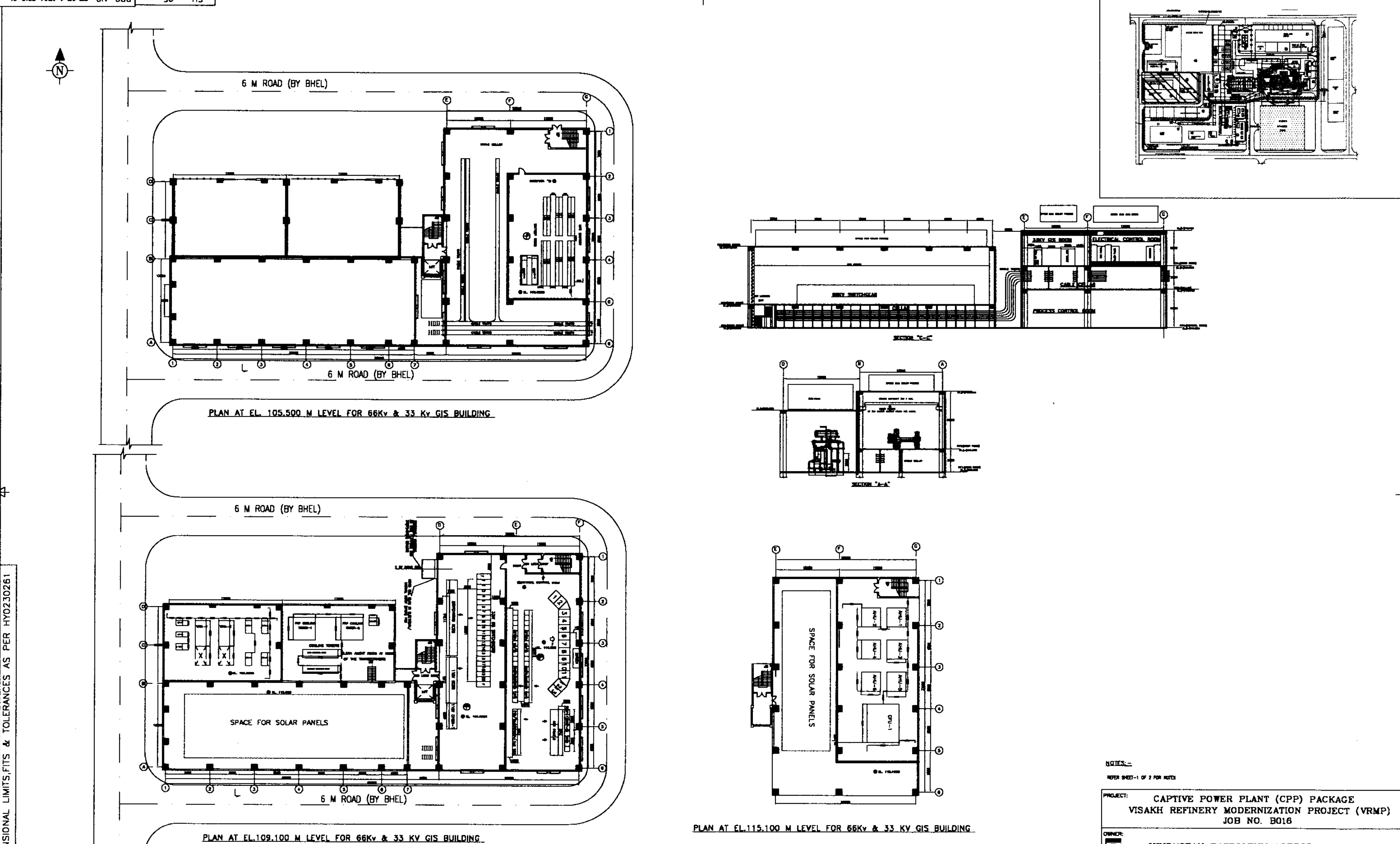
GENERAL DIMENSIONAL LIMITS,FITS & TOLERANCES AS PER HY0230261

INVENTORY NO | SIGN. AND DATE | REF. DRG. NO. | COMPUTER FILE NAME

ESP-001-11A

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)



NOTES:-

REFER SHEET-1 OF 2 FOR NOTES

PROJECT: CAPTIVE POWER PLANT (CPP) PACKAGE
VISAKH REFINERY MODERNIZATION PROJECT (VRMP)
JOB NO. B016

OWNER: HINDUSTAN PETROLEUM CORPORATION LIMITED

PMC: ENGINEERS INDIA LIMITED (EIL), NEW DELHI

BHARAT HEAVY ELECTRICALS LTD. HYDERABAD

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DEPT. PE&SD CODE. 450 | UNTOL. DIMS. CR. | SCALE | WEIGHT (KG) | REF. TO ASSY. DRG. -N.A.- | ITEM NO. -N.A.- | NO.OF ITEMS -N.A.-

TITLE: SWITCHGEAR ROOM EQUIPMENT LAYOUT (SS-93)

CARD CODE N.A. | BHEL DRG NO. PY-LE-1-M104-2019-01 | CUST DRG NO. | REV. 01 | SHT. No 02 | NO. OF SHT. 02

REV.	DATE	ALTERED	CHD/APPD
01	11.05.18	ALTERED A.V.S / REVISED INLINE WITH CL/HPCL COMMENTS	P.S/JKP

GENERAL DIMENSIONAL LIMITS,FITS & TOLERANCES AS PER HY0230261

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ESP-001-11A

BHEL's reply to EIL/HPCL comments

DOC. NO.	B016		--
	JOB NO.	TR. NO.	S.NO

PROJECT: VRMP PROJECT, VIZAG
NAME OF PACKAGE: CPP package

CLIENT: M/s HPCL-Vizag
CONTRACTOR: M/s BHEL

SL. NO.	COMMENT/ OBSERVATION	BHE's reply to EIL/HPCL comments
1	**DRAWING / DOCUMENT TITLE : SWITCHGEAR ROOM EQUIPMENT LAYOUT (SS-93)** **DOCUMENT NUMBER: PY-LE-1-M104-2019-01 R 00** **CATEGORY/CODE:**	
	This is preliminary drawing to finalize the tentative dimensions of the building. Broad comments are as follows	
	At elevation EL. 100.000 M level	
1.1	Indicate the 220/66kV power transformer dimensions and all around clearances available. Indicate the NIFPS system of the 220/66kV power transformers.	Noted and incorporated in the revised layout drawing
1.2	Lift may be relocated to the northside.	Lift position is fixed by taking care entry into 66kV GIS building and 33kV GIS building.
1.3	Cable cellar can be extended upto the control room to utilize the unused space between lift and the cable trays.	Noted.
	At elevation EL. 103.600 M level	
1.4	Indicate the loading / unloading area.	Noted and incorporated in revised equipment layout
1.5	Clarify the extent of coverage of EOT crane above 66kV GIS.	Noted and same will be indicated in the architectural drawings.
1.6	Mono rail shall be provided in the loading / unloading area.	Noted and incorporated in the revised equipment layout
1.7	Airlock lobby shall be provided for entry into the GIS hall.	Noted and incorporated in the revised equipment layout
1.8	Indicate the equipment entry door.	Noted and indicated revised layout
1.9	Show wall on west side of the GIS air conditioned hall.	
1.10	66kV GIS switchgear hall shall be sized considering 2 future GIS bays on each side with minimum 2M clearances from future bays to wall. Minimum size of 66kV GIS switchgear room shall be 42M.	1 future bay each side of the 66kV GIS is considered as per standard philosophy.
1.11	Please check whether CRP panels require rear maintenance. If required, minimum 1M rear access shall be provided.	Noted.
1.12	GIS switchgear hall shall be extended upto control room building to utilize the unused space between lift and the cable trays.	Noted
	At elevation EL. 105.500 M level	
1.13	66kV cables shall not pass through 33kV cellar. Separate route for 66kV cables shall be provided.	66kV cables will be routed through 33kV GIS building with sufficient clearances
	At elevation EL. 109.100 M level	
1.14	Indicate giant screen for ECS behind the consoles.	Noted and incorporated in the revised equipment layout
1.15	Indicate the battery charger and batteries for 110V DC system.	Noted and incorporated in the revised equipment layout
1.16	Clearly indicate the panels / consoles supplied by BHEL and supplied by Owner. Dimensions of the panels and consoles to be indicated.	Noted and incorporated in the revised layout
1.17	Indicate the panel dimensions, minimum clearances available. Ensure that minimum clearances as per the tender document are considered.	Noted and incorporated in the revised layout

BHEL's reply to EIL/HPCL comments

DOC. NO.	B016		--
	JOB NO.	TR. NO.	S.NO

PROJECT: VRMP PROJECT, VIZAG
NAME OF PACKAGE: CPP package

CLIENT: M/s HPCL-Vizag
CONTRACTOR: M/s BHEL

SL. NO.	COMMENT/ OBSERVATION	BHE's reply to EIL/HPCL comments
1.18	ECS interface panels (transducer panels, dummy panels and interposing relay panels) supplied by BHEL shall be in the same lineup of ECS RTU panels. BHEL to clearly indicate the number of ECS interface panels considered.	Noted and incorporated in the revised layout
1.19	Space for 2 future panels on each side shall be considered for 33kV GIS.	1 future bay each side of the 33kV GIS is considered as per standard philosophy.
1.20	Indicate the loading and unloading area of the 33kV GIS.	Noted and incorporated in the revised layout
1.21	Indicate air lock lobby for entrance into the electrical control room.	Noted and incorporated in the revised layout
	SECTION "A-A"	
1.22	Minimum 3 Meters clear height shall be provided from bottom of beam in cable cellar below 66kV GIS.	As per specifications 2.5M clear height in cellar is considered.
	SECTION "C-C"	
1.23	Minimum 3 Meters clear height shall be provided from bottom of beam in cable cellar below 33kV GIS.	As per specifications 2.5M clear height in cellar and 4M clear height in switchgear room is considered.
1.24	Minimum 4 meter clear height shall be provided below false ceiling in 33kV GIS room.	
1.25	Indicate false ceiling in electrical control room and 33kV GIS room.	Noted and incorporated in the revised layout
	GENERAL	
1.26	Solar panels shall be provided on the roof top of the substation and the transformer bays.	Noted and indicated in the revised layout

BHEL'S REPLY TO THE EIL/HPCL COMMENTS

CLIENT : M/s HPCL , VIZAG
PROJECT : VRMP
PLANT : Captive Power Plant (CPP) Package
CONTRACTOR : M/s.BHEL, Hyderabad

EIL Job No	B016
EIL Transmission Document No	
Document No	PY-LE-1-M104-2019-01 (2 Sheets) Equipement Layout SS 93
Review Code	2

Sl. No	COMMENTS / OBSERVATION	BHEL's reply to EIL/HPCL comments
	Contractor shall ensure incorporation of following comments during next submission. Contractor to reply his resolution /action taken against each comment in tabular form. Also Contractor to note that, if comments are not incorporated next time, drawings shall not be reviewed & returned.	
	Regardless of the PMC Comments given below, it is contractor's sole responsibility to design and construct the building as per functional and other requirements as given in bid package and conform to all statutory codal provision for the same.	
1	Contractor to note that Internal arrangement of Substation Building, sizes, provision of various rooms/ spaces, sizes of various equipments as indicated in the drawing are not reviewed. Adequacy of sizes, heights of building/ rooms is entirely Contractor's responsibility and it is understood that the above mentioned parameters have been finalized as per the concerned department(s) inputs and functional requirements. In case of any change in these during course of engineering, Contractor shall implement the same without any implication to Owner/ PMC irrespective of code given on Architectural drawings. Contractor to note and confirm.	Noted
2	Cutouts for cables and pipes in floors/ walls/ slabs of switchgear room, Cable Cellar, AC plant room, AHU room shall be as per the respective equipment layout and considering all functional requirements. Contractor to confirm.	Noted
3	Coordinates of the building is not marked in the drawing. It is entirely Contractor's responsibility that the building is located as per approved/ reviewed dwg by EIL. Contractor to note and confirm.	Noted
4	Key plan showing approaches, adjoining facilities, units etc. shall be included in the drawing. Location, orientation & co-ordinate of the building to be marked in	Key plan is indicated in the layout

BHEL'S REPLY TO THE EIL/HPCL COMMENTS

CLIENT : M/s HPCL , VIZAG
PROJECT : VRMP
PLANT : Captive Power Plant (CPP) Package
CONTRACTOR : M/s.BHEL, Hyderabad

EIL Job No	B016
EIL Transmission Document No	
Document No	PY-LE-1-M104-2019-01 (2 Sheets) Equipement Layout SS 93
Review Code	2

	accordance with approved/ reviewed dwg by EIL.	
5	Expansion joint at suitable location to be provided in the building	Noted.
6	Since no doors or openings are marked in the layout, contractor to ensure the provision of door sizes are adequate for entry/ exit of equipments (considering packing size) in all the rooms.	Noted
7	Requirement of fire door/ fire glazed partition in the building as per NBC – 2016 Part IV to be clarified and confirmed by the contractor.	Noted
8	Loading and unloading area shall be provided on both sides of the substation. Monorail shall be provided in the loading and unloading platform	3MX2M loading/unloading plat form with mono rail beam is indicated in the revised layout
9	Staircases along with loading and unloading boys to be provided on both side (east as well as west side) of substation	noted
10	Air lock lobby shall be provided at the entrance of the switchgear hall/ GIS hall.	Noted and incorporated in the revised layout
11	Toilets shall be relocated to east/ west side of the switchgear hall. This shall be located along the loading / unloading platform.	Refer control room equipment layout
12	Indicate false ceiling in electrical control room and 33kV GIS room.	Noted and incorporated in the revised layout
13	Minimum 3 Meters clear height shall be provided from bottom of beam in both cable cellars.	As per specifications 2.5M clear height in cellar and 4M clear height in switchgear room is considered.
14	Minimum 4.5 meter clear height from false ceiling shall be provided at switchgear hall/ GIS hall.	
15	Adequate space to be made available above false ceiling and beam bottom for AC ducting layout. According building height shall be provided.	Noted
16	Solar panels shall be provided on the roof top of the substation and the transformer bays.	Noted and incorporated in the revised layout
17	All staircase to be provided upto terrace level	Noted

BHEL'S REPLY TO THE EIL/HPCL COMMENTS

CLIENT : M/s HPCL , VIZAG
PROJECT : VRMP
PLANT : Captive Power Plant (CPP) Package
CONTRACTOR : M/s.BHEL, Hyderabad

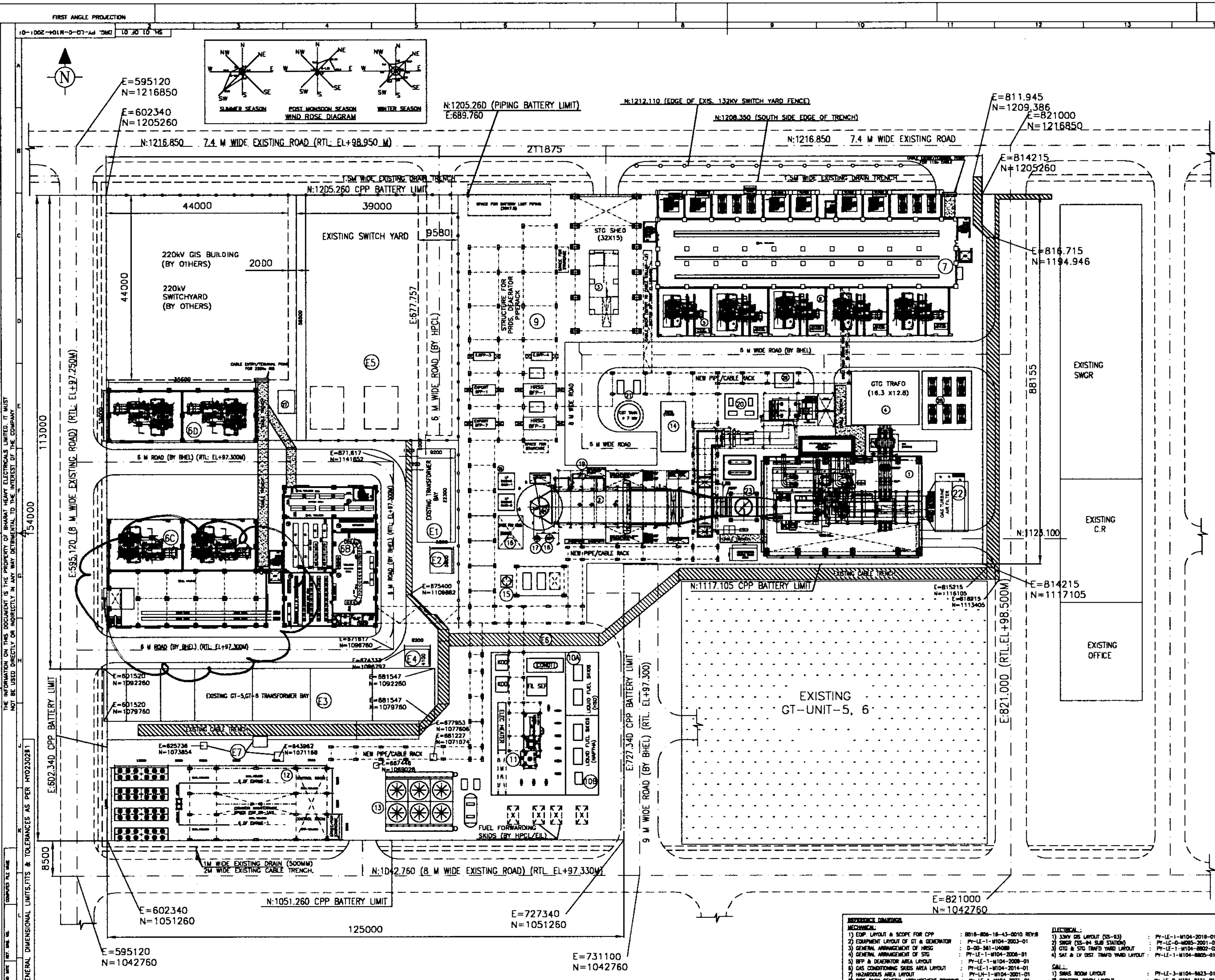
EIL Job No	B016
EIL Transmission Document No	
Document No	PY-LE-1-M104-2019-01 (2 Sheets) Equipement Layout SS 93
Review Code	2

18	All walls to be flushed outside to have clear elevation (with no column protruding outwards)	Noted and incorporated in the revised layout
19	Location of fire hydrant (1200mm X 750mm – clear dimensions) near staircases to be provided in the drawing.	Same will be incorporated after receipt of vendor data
20	Complete architectural drawings along with detailed plans, elevations, section, doors/ windows details, schedule of internal and external finishes to be provided once the equipment layout is finalized.	Noted

FIRST ANGLE PROJECTION

DRG. PY-LQ-0-M104-2001-01

(ALL DIMENSIONS ARE IN mm)



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GENERAL DIMENSIONAL LIMITS,FITS & TOLERANCES AS PER HY0230281

LIST OF EQUIPMENTS/BUILDINGS (PRELIMINARY)

SL NO	DESCRIPTION	QTY.	SIZE (M X M)
1	GTG SHED	1	37X21.7
2	HRSG AREA	1	44.40X17.5
3	STG BUILDING	1	32X15
4	GT GENERATOR TRANSFORMER	1	16.3X12.8
5	ST GENERATOR TRANSFORMER	1	12.8X11.8
6A	GIS BUILDING (66KV)	1	38X13
6B	GIS BLDG (33KV),CONTROL ROOM	1	33X22
6C	TRANSFORMER BAY (220/ 66Kv)	1	35.6X12
6D	TRANSFORMER BAY (220/ 33Kv)	1	35.6X12
7	SWGR BLDG	1	72X16
8	TRANSFORMER AREA (66/11/0.433) (4+6 NOS)	1	72X12.5
9	BFP AND DEAERATOR STRUCTURE	01	46X21
10A	LIQUID FUEL AREA (HSD)	01	15X12
10B	LIQUID FUEL AREA (NAPTHA)	01	24X12
11	GAS CONDITIONING SKID AREA	1	36X17
12	DG SHED	1	48.7X21
13	DUMP CONDENSER, COND TANK, PUMP (2 NOS)	1	14.1X16.2
14	SWAS	1	12X6
15	AIR COMPRESSOR SHED	1	9X7.5
16	CEMS FOR HRSG	1	6X6
17	CBD TANK FOR HRSG	1	DIA 1.5M
18	IBD TANK FOR HRSG	1	DIA 2.0 M
19	SPACE FOR FEED WATER CONTROL VALVE STATION FOR HRSG	1	4.5X2.0
20	PLATE HEAT EXCHANGER, PUMP	2+2	6X8
21	CONDENSATE STORAGE TANK	1	DIA 5.5X7M HT
22	GT INLET AIR FILETER	1	12 X 8
23	GT BYPASS STACK	1	DIA 3.9
24	HRSG EXHAUST STACK	1	DIA 4.5
25	LP DOSING SKIDS 2 NOS, SAFETY SHOWER	2+2	4X4
20	COMMON TRAFO OIL PIT		4(L)X3(B)X3(H)
27	COMMON TRAFO OIL PIT		5(L)X3.5(B)X3(H)
28	CAPACITOR BANKS	3+3	1.4 X 1.2
29	HSD, NAPTHA DRAIN TANK	1+1	7.9 X 5.9

LIST OF EXISTING FACILITIES

SL NO	DESCRIPTION	QTY.	SIZE (M X M)
E1	EXISTING TRANSFORMER BAY	1	22.3 X 9.2
E2	TRANSFORMER OIL PIT	1	5.8X5.8
E3	EXISTING TRAFO BAY (GT-5,6)	1	81.1 X 12.5
E4	TRANSFORMER OIL PIT	1	8.2X4.1
E5	EXISTING SWITCH YARD	1	58.5X39
E6	EXISTING CABLE TRENCH	1	---
E7	EXISTING PIT, FIRE DV STATION	3	

NOTES:

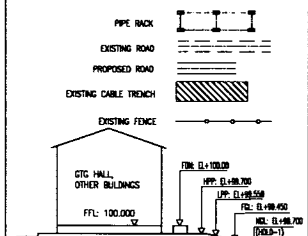
1. ALL CO-ORDINATES ARE IN METERS
2. ALL DIMENSIONS ARE IN MM
3. FFL OF BUILDINGS IS EL+100.00M, WHICH IS CORRESPONDS TO RL+4.80M
4. ALL ROADS INSIDE THE CPP BATTERY LIMIT SHALL BE SUITABLE FOR HYDRA/CRANE MOVEMENT.

HOLD:

1. NGL SHALL BE FINALISED AFTER COMPLETION OF TOPOGRAPHY SURVEY.

LEGEND:

NGL : NATURAL GROUND LEVEL
FGL : FINISHED GROUND LEVEL
LPP : LOWEST PAVED POINT
HPP : HIGHEST PAVED POINT AND ROAD LEVEL
FDN : HRSG/GTG, STG HALL/PIPERACK FOUNDATIONS LEVEL
FFL : FINISHED FLOOR LEVEL
RTL : ROAD TOP LEVEL



REFERENCE LEVELS OF FLOORS/FOUNDATIONS

REFERENCE DRAWINGS

MECHANICAL:

1) EQIP. LAYOUT & SCOPE FOR CPP : B018-806-16-43-0010 REV:B
2) EQUIPMENT LAYOUT OF GT & GENERATOR : PY-LE-1-M104-2003-01
3) GENERAL ARRANGEMENT OF HRSG : 0-00-561-U4089
4) GENERAL ARRANGEMENT OF STG : PY-LE-1-M104-2006-01
5) BFP & DEAERATOR AREA LAYOUT : PY-LE-1-M104-2009-01
6) GAS CONDITIONING SKIDS AREA LAYOUT : PY-LE-1-M104-2014-01
7) HAZARDOUS AREA LAYOUT : PY-LH-1-M104-2001-01
8) PIPE RACK GENERAL ARRANGEMENT DRAWING : PY-LE-1-M104-2031-01

ELECTRICAL:

1) 33KV GIS LAYOUT (SS-93) : PY-LE-1-M104-2019-01
2) SWGR (SS-94 SUB STATION) : PY-LC-0-M095-2001-01
3) GTG & STG TRAFO YARD LAYOUT : PY-LE-1-M104-8802-02
4) SAT & LV DIST. TRAFO YARD LAYOUT : PY-LE-1-M104-8805-01

C&I:

1) SWAS ROOM LAYOUT : PY-LE-3-M104-9623-01
2) CONTROL ROOM LAYOUT : PY-LE-0-M104-8121-01

REV.	DATE	ALTERED / CHD/APPD	DESCRIPTION
02	28.04.18	SNM R / SNMR / GS	REVISED AS PER EIL COMMENTS DTD: 19.04.18 AND UPDATED AS PER TOPO SURVEY DTD-11.04.18.
01	28.03.18	FRK / SNMR / GS	REVISED AS PER EIL OBSERVATIONS DTD-21.03.18

CUSTOMER: HINDUSTAN PETROLEUM CORPORATION LIMITED VISAKH REFINERY, VISHAKHAPATNAM

CONSULTANT: ENGINEERS INDIA LIMITED (EIL), NEW DELHI
EIL JOB NO : B018

PROJECT: 76 MW CAPTIVE POWER PLANT (CPP) PACKAGE (1x Fr 6Fa GTG + 3 x 186 TPH HRSG + 3 x 15 MW BPTG) FOR VISAKH REFINERY MODERNIZATION PROJECT (VRMP)

BHARAT HEAVY ELECTRICALS LTD. HYDERABAD

	NAME	SIGN.	DATE
DRN.	SNM R		10.03.18
CHD.	SNM R		10.03.18
APPD.	G.SRIKANTH		10.03.18

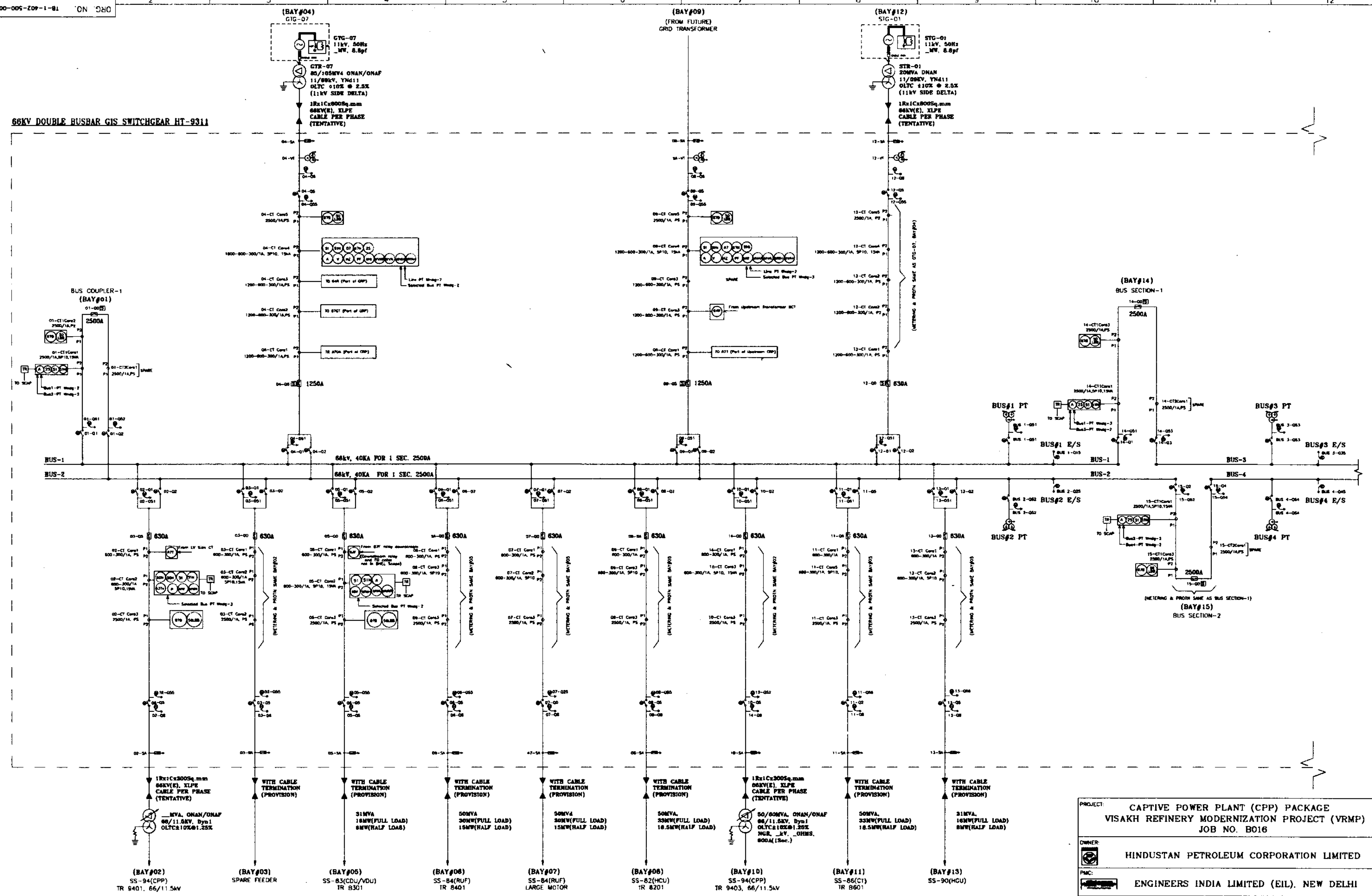
NO.OF VAR.: NA
SCALE: 1:350
WEIGHT (KG): NA
REF. TO ASSY. DRG.: --N.A.--
ITEM NO.: --N.A.--
NO.OF ITEMS: --N.A.--

TITLE: PLOT PLAN

DRAWING NO. PY-LQ-0-M104-2001-01 REV. 02
SHT. No. 01 NO. OF SHT. 01

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN mm)

DRG. NO. TB-1-402-500-001



PROJECT: CAPTIVE POWER PLANT (CPP) PACKAGE
VISAKH REFINERY MODERNIZATION PROJECT (VRMP)
JOB NO. B016

OWNER: HINDUSTAN PETROLEUM CORPORATION LIMITED

PMC: ENGINEERS INDIA LIMITED (EIL), NEW DELHI

BHARAT HEAVY ELECTRICALS LTD
HYDERABAD

	NAME	SIGN.	DATE
DRN.	PK		19.04.18
CHD.	DKS/AA		19.04.18
APPD.	SKS/VK		19.04.18

DEPT. TBG CODE 450 | SCALE -N.A.- | WEIGHT (KG) -N.A.- | REF. TO ASSY. DRG. -N.A.- | ITEM NO. -N.A.- | NO. OF ITEMS -N.A.-

TITLE: SINGLE LINE DIAGRAM FOR 66KV GIS

BHEL DRG. NO. TB-1-402-500-001 | REV. 00
CUST DRG. NO. N.A.
SHT. No. 01 | NO. OF SHT. 03

DOCUMENT REVIEW DETAILS

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN mm)

DRG. NO. TB-1-402-500-001

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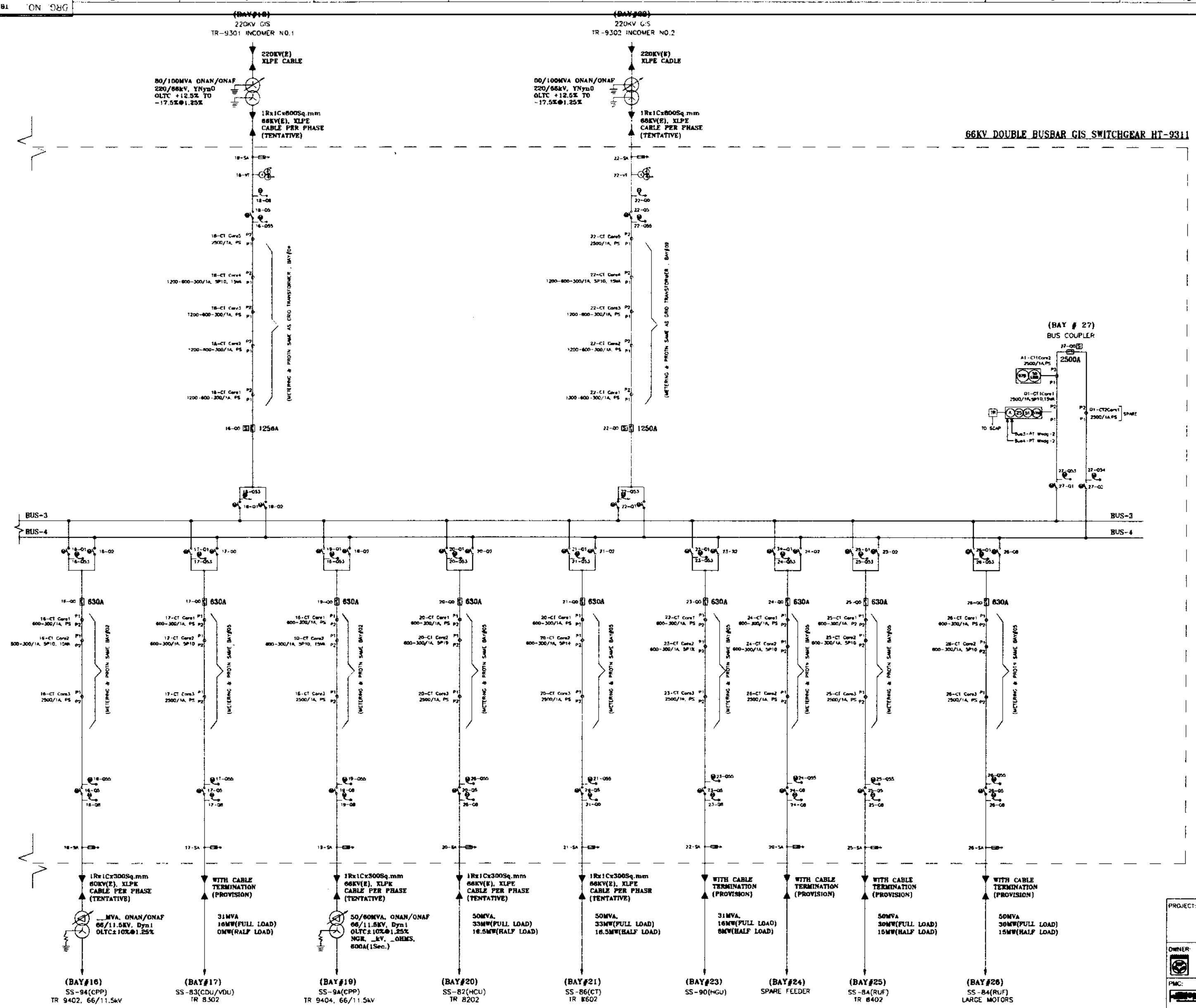


PROJECT: CAPTIVE POWER PLANT (CPP) PACKAGE
VISAKH REFINERY MODERNIZATION PROJECT (VRMP)
JOB NO. B016

OWNER: HINDUSTAN PETROLEUM CORPORATION LIMITED

PMC: ENGINEERS INDIA LIMITED (EIL), NEW DELHI

BHARAT HEAVY ELECTRICALS LTD. HYDERABAD

	NAME	SIGN.	DATE
DRN	PK		19.04.16
CHD.	DKS/AA		19.04.16
APPD.	SKS/YK		19.04.16

DEPT. TBG CODE 450 | UNTOL. DIMS. GR. | SCALE -N.A.- | WEIGHT (KG) -N.A.- | REF. TO ASSY. DRG -N.A.- | ITEM NO. -N.A.- | NO. OF ITEMS -N.A.-

TITLE: SINGLE LINE DIAGRAM FOR 66KV GIS

BHEL DRG NO. TB-1-402-500-001 | REV. 00 | CUST DRG NO. | SHT. No 92 | NO. OF SHT. 93

DOCUMENT REVIEW DETAILS

Page 2 of 6

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN mm)

DRG. NO. TB-1-402-500-001

A. LEGENDS:-

SL.NO.	EQUIPMENT DESCRIPTION	CURRENT CAPACITY (A)	VOLTAGE LEVEL (kV)	SYMBOL	DEVICE DESIGNATION
1.	CIRCUIT BREAKER (3-PH)	2500, 1250, 630	72.5		Q0
2.	DISCONNECTOR	-	72.5		Q1, Q3 FOR BUS1&3 Q2, Q4 FOR BUS2&4 Q61, Q63 FOR BUS1&3 PT Q62, Q64 FOR BUS2&4 PT Q5 FOR LINE SIDE
3.	HIGH SPEED MAKE PROOF EARTHING SWITCH	-	72.5		Q8
4.	SAFETY EARTHING SWITCH	-	72.5		Q51, Q52, Q53, Q54, Q55 Q51, Q53 FOR BUS1&3 PT Q52, Q54 FOR BUS2&4 PT Q5 FOR LINE SIDE Q15 FOR BUS -1 Q25 FOR BUS -2 Q35 FOR BUS -3 Q45 FOR BUS -4
5.	CURRENT TRANSFORMER	-	72.5		
6.	POTENTIAL TRANSFORMER	2500, 1250, 630	72.5		
7.	SURGE ARRESTOR	-	72.5		
8.	66kV XLPE CABLE	-	72.5		

B. BAY/FEEDER DESCRIPTION :-

SL.NO.	BAY/FEEDER DESCRIPTION	BAY NO.	RATING	QTY.
1.	INCOMER GENERATOR TRANSFORMER (GTG) BAY (GTG-07 BAY)	04	1250A	01 SET
2.	INCOMER FUTURE GRID TRANSFORMER BAY (FUTURE BAY)	09	1250A	01 SET
3.	INCOMER STATION TRANSFORMER (STG) BAY (STG-01 BAY)	12	630A	01 SET
4.	INCOMER TRANSFORMER (SS-93 (220kV GIS) TR-9301 BAY, TR-9302 BAY)	18, 22	1250A	02 SET
5.	BUS COUPLER BAY (BUS COUPLER 1-2 BAY, 3-4 BAY)	01, 27	2500A	02 SET
6.	BUS SECTIONALIZER BAY (BUS SECTIONALIZER 1-3 BAY, 2-4 BAY)	14, 15	2500A	02 SET
7.	OUTGOING TRANSFORMER FEEDER (SS-94 (CPP) TR-9401 FEEDER, TR-9402 FEEDER, TR-9403 FEEDER, TR-9404 FEEDER)	02, 16 10, 19	630A	04 SET
8.	FULLY EQUIPPED SPARE FEEDER (SPARE-01 FEEDER, SPARE-02 FEEDER)	03, 24	630A	02 SET
9.	OUTGOING TRANSFORMER FEEDER (SS-83 (CD/VDU) TR-8301 FEEDER, TR-8302 FEEDER)	05, 17	630A	02 SET
10.	OUTGOING TRANSFORMER/ MOTOR FEEDER (SS-84 (RUF) TR-8401 FEEDER, TR-8302 FEEDER, LARGE MOTOR-D1 FEEDER, LARGE MOTOR-D2 FEEDER)	06, 25 07, 26	630A	04 SET
11.	OUTGOING TRANSFORMER FEEDER (SS-82 (HCU) TR-8201 FEEDER, TR-8202 FEEDER)	08, 20	630A	02 SET
12	OUTGOING TRANSFORMER FEEDER (SS-86 (CT) TR-8601 FEEDER, TR-8602 FEEDER)	11, 21	630A	02 SET
13.	OUTGOING TRANSFORMER FEEDER (SS-90 (HGU) FEEDER-1, 2)	13, 23	630A	02 SET
14.	BUS PT BAY WITH DISCONNECTOR & EARTHSWITCH	BUS#1, 2, 3, 4 PT	630A	04 SET
15.	BUS EARTH SWITCH BAY	BUS EARTH SWITCH#1, 2, 3, 4	630A	04 SET

REFERENCE DRAWINGS/ DOCUMENTS:-

1. KEY SINGLE LINE DIAGRAM B016-606-16-50-00001 REV. B
2. EHV GIS DATA SHEET B016-606-16-50-DS-1029 REV. A
3. ENGINEERING DESIGN BASIS-ELECTRICAL A758-999-16-50-EDB-1001 REV0
4. CT & VT SIZING CALCULATION FOR 66KV GIS , TB-402-510-024

C. RELAYING:-

SL.NO.	NEMA DEVICE DESIGNATION	FUNCTION
1.	50	INSTANTANEOUS OVER CURRENT RELAY
2.	50N	INSTANTANEOUS EARTH FAULT RELAY
3.	51	IDMT OVER CURRENT RELAY
4.	51N	IDMT EARTH FAULT RELAY
5.	63	AUXILIARY RELAY FOR TRANSFORMER
6.	64R	TRANSFORMER RESTRICTED EARTH FAULT
7.	67	DIRECTIONAL OVER CURRENT RELAY
8.	67N	DIRECTIONAL EARTH FAULT RELAY
9.	87T	TRANSFORMER DIFFERENTIAL
10.	87F	FEEDER DIFFERENTIAL
11.	87B	BUS BAR DIFFERENTIAL
12.	50LBB	LOCAL BREAKER BACKUP PROTECTION
13.	51G	BACK UP EARTH FAULT RELAY
14.	S	CIRCUIT BREAKER WITH SYNCHRONISING FACILITY

NOTE :-

1. FOR OWNER'S OUTGOING FEEDERS, FEEDER DIFF RELAY WILL BE PROVIDED AT 66 KV GIS END ONLY. FIBRE OPTIC CABLE AND MATCHING RELAY AT REMOTE END WILL BE PROVIDED BY CUSTOMER.
2. FOR FEEDERS(GRID IN COMERS AND BUS SECTIONALIZERS / BUS COUPLERS) PROTECTION AND METERING SHALL BE SUITABLE FOR BI-DIRECTIONAL POWER FLOW.
3. 415 AC BULK FEEDERS(2NOS.) AND EMERGENCY FEEDER SHALL BE PROVIDED BY PE&SD

PROJECT: CAPTIVE POWER PLANT (CPP) PACKAGE
VISAKH REFINERY MODERNIZATION PROJECT (VRMP)
JOB NO. B016

OWNER: HINDUSTAN PETROLEUM CORPORATION LIMITED

PMC: ENGINEERS INDIA LIMITED (EIL), NEW DELHI

BHARAT HEAVY ELECTRICALS LTD. HYDERABAD

	NAME	SIGN.	DATE
DRN	PK		19.04.18
CHD	DKS/AA		19.04.18
APPD	SKS/VK		19.04.18

DEPT. CODE 450 · SCALE -N.A.- · WEIGHT (KG) -N.A.- · REF. TO ASSY. DRG. -N.A.- · ITEM NO. -N.A.- · NO. OF ITEMS -N.A.-

TITLE: SINGLE LINE DIAGRAM FOR 66KV GIS

BHEL DRG NO. TB-1-402-500-001 · REV. 00 · SHT. No 03 · NO. OF SHT. 03

DOCUMENT REVIEW DETAILS

Refer attached comment sheet

DOCUMENT REVIEW DETAILS

[1] No Comments.

[2] ✓ Proceed with manufacture / fabrication as per the commented document. Revised document required.

[3] Document does not conform to basic requirements as marked. Resubmit for review.

[R] Retained for Records. [V] Void.

Signature with Date 01-MAY-2018

Name of Reviewer SAI ACHUTUNI (A738)

Transmittal No.

COMMENT SHEET

DOC. NO.	B016		--
	JOB NO.	TR. NO.	S.NO

PROJECT: VRMP PROJECT, VIZAG
NAME OF PACKAGE: CPP package

CLIENT: M/s HPCL-Vizag
CONTRACTOR: M/s BHEL

SL. NO.	COMMENT/ OBSERVATION	RESOLUTION / ACTION
1	**DRAWING / DOCUMENT TITLE : SINGLE LINE DIAGRAM FOR 66KV GIS** **DOCUMENT NUMBER: TB-1-402-500-001 R 00** **CATEGORY/CODE: 2**	
1.	Show capacitive voltage detectors in each feeder / incomer	
2.	Include a note indicating the components mounted in CRP.	
3.	Please clarify whether transducers for SCAP and ECS will be part of CRP. Incase yes, indicate the transducers in CT circuit.	
4.	Spare CT indicated in bus coupler / bus sectionaliser shall be indicated as differential CT. The same shall be connected to differential relays in other bus section to form overlapping zone.	
5.	Indicate the current ratings of disconnector switches.	
6.	PT symbol in the SLD and the legend are not matching. Please maintain uniformity.	
7.	Indicate knee point voltage of Class-PS CTs.	
8.	Indicate parameters of Line PTs & Bus PTs	
9.	Please check and correct the moving arm of the disconnectors (for eg 04-Q1 & 04-Q2 etc)	
10.	Please clarify whether high impedance type differential protection or low impedance type differential protection is used. Include a note in the SLD. In case of low impedance differential protection, the representation of bay units of differential relay shall be clearly indicated in each feeder along with the main relay at central location for each bus.	
11.	Each bus shall have separate differential relay.	
12.	Indicate protection elements 51V, 86 & 95 in all numerical relays.	
13.	Indicate protection element 25 in grid transformer incomers.	
14.	Spare feeder Bay#03 shall be similar to Bay#05. Update the details	
15.	Please note that all outgoing feeders for Owner's substations are plant feeders. However the downstream transformer numbers are indicated for ease of reference in the SLD. Please update the description as below Bay#07- SS-84 TR-8403 (RUF) Bay#13- SS-90 TR-9001 (HGU) Bay#26- SS-84 TR-8404 (RUF) Bay#23- SS-90 TR-9002 (HGU)	
16.	Stabilizing resistors and metrosils shall be provided for numerical relays to prevent any spurious tripping. Add a note regarding the same.	
17.	Also refer comments on CT PT sizing calculation document.	
18.	*Client comments will be sent separately.*	

NOTE: CONTRACTOR IS OBLIGED TO FURNISH THIS SHEET (DULY FILLED UP WITH RESOLUTION TO ALL EIL COMMENTS) ALONGWITH REVISED DRAWINGS

DOCUMENT REVIEW DETAILS

[1] No Comments.
[2] ✓ Proceed with manufacture / fabrication as per the commented document. Revised document required.
[3] Document does not conform to basic requirements as marked. Resubmit for review.
[R] Retained for Records. [V] Void.

Signature with Date: 01-MAY-2018
Name of Reviewer: SAI ACHUTUNI (A756)
Transmittal No.

Comments By: (SIGN/ DATE): 01/05/18
Department: Electrical
Name: SAI

ENGINEERS INDIA LIMITED, NEW DELHI

BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION PROJECTS ENGINEERING MANAGEMENT

DOCUMENT No.	TB-402-510-024	Rev. No.	00		Prepared	Checked	Approved
TYPE OF DOC.	DESIGN DOCUMENT			NAME	AA	VK	VK
TITLE				SIGN	-Sd-	-Sd-	-Sd-
CT & VT SIZING CALCULATION FOR 66KV GIS				DATE	24-03-18	24-03-18	24-03-18
				GROUP	TBEM	W.O. No	87010

CUSTOMER	HPCL
CONSULTANT	EIL
PROJECTS	66KV GIS OF CCPP FOR VRMP, Vishakhapattanam

CONTENTS

BIDDER/VENDOR TO CHECK THE CT/PT REQMTS BASED ON THEIR OFFERED RELAY, METERS ETC INTERFACE & APPLICATION CHECK IS IN BIDDER'S SCOPE.

DOCUMENT REVIEW DETAILS

1 No Comments.
2 Proceed with manufacture / fabrication as per the commented document. Revised document required.
3 Document does not conform to basic requirements as marked. Resubmit for review.
R Retained for Records.

Signature with Date 25-APR-2018
Name of Reviewer SAI ACHUTUNI (A738)
Transmittal No.

Rev No.	Date	Altered	Checked	Approved	REVISION DETAILS
V Void.				Distribution	
				Copies	- - - -

Bharat Heavy Electricals Limited
Project :CPP of VRMP .
Customer : HPCL
Consultant : EIL

Document Title: **CT & VT sizing calculation** Doc No. **TB-402-510-024, Rev No. 00**

Please note the following proposed parameters for Indoor GIS CT & VT are subject to confirmation from the customer approved GIS suppliers.

Summary of Core details of 66kV Current Transformer:

Applicable for-

I) Incomer from Generator Transformer: GTG#7 TR Bay (Applicable bay # 04)

II) Incomer from Generator Transformer : STG#01 TR Bay (Applicable bay # 12)

CT1 Core No.	Current Ratio	Accuracy Class	Min. Burden	Min kPV (V)	Max Im at kPV	Purpose
1.	1200-600-300 / 1	PS	-	1200-600-400	30mA-60mA-120mA	Transf. Overall Diff. Protn. 87O
2.	1200-600-300 / 1	PS	-	1200-600-400	30mA-60mA-120mA	Transf. Diff. Protn. 87GT
3.	1200-600-300 / 1	PS	-	1200-600-400	30mA-60mA-120mA	Transf. REF Protn. 64R
4.	1200-600-300 / 1	5P10	15VA	-	-	Overcurrent Protn & Metering
5.	2500/ 1	PS	-	2500	30mA	Busbar Diff. Protn.

III) Incomer from Transformer : 220/66kV Transformer TR9301 , TR9302 & Future grid transformer (Applicable bay # 09, 18, 22)

CT1 Core No.	Current Ratio	Accuracy Class	Min. Burden	Min kPV (V)	Max Im at kPV	Purpose
1.	1200-600-300 / 1	PS	-	1200-600-400	30mA-60mA-120mA	Transf. Diff. Protn. 87T (Upstream CRP scope)
2.	1200-600-300 / 1	PS	-	1200-600-400	30mA-60mA-120mA	Transf. REF Protn.
3.	1200-600-300 / 1	PS	-	1200-600-400	30mA-60mA-120mA	Spare
4.	1200-600-300 / 1	5P10	15VA	-	-	Overcurrent Protn & Metering
5.	2500/ 1	PS	-	2500	30mA	Busbar Diff. Protn.

DOCUMENT REVIEW DETAILS
1 No Comments.
2 Proceed with manufacture / fabrication as per the commented document. Revised document required.
3 Document does not conform to basic requirements as marked. Resubmit for review.
R Retained for Records. V Void.
Signature with Date 25-APR-2018
Name of Reviewer SAI ACHUTUNI (A738)
Transmittal No.

IV) Bus Coupler#1, Bus Section #1, Bus Section#2, Bus Coupler#2 (Applicable bay # 01, 14, 15, 27)

CT1 Core No.	Current Ratio	Accuracy Class	Min. Burden	Min kPV (V)	Max Im at kPV	Purpose
1	2500 / 1	5P10	15VA	-	-	Over current Protection
2	2500 / 1	PS	-	2500	30mA	Busbar Differential protection

CT2 Core No.	Current Ratio	Accuracy Class	Min. Burden	Min kPV (V)	Max Im at kPV	Purpose
1	2500 / 1	PS	-	2500	30mA	Spare

V) Outgoing Transformer Feeders :

a) 66/11.5kV Transformer TR9403 , TR9404, TR9401, TR9402, Spare Feeder (Applicable bay # 10, 19, 02, 16, 03)

b) Outgoing Transformer Feeders : a)TR-8301 SS-83 (CDU/VDU) b)TR-8302 SS-83 (CDU/VDU) c) TR01 SS-90(HCU) d)TR02 SS-90(HCU) e) Spare Feeder (Applicable bay # 05, 17, 13,23 & 24)

c) Outgoing Transformer Feeders : a)TR-8201 SS-82 (HCU) b)TR-8202 SS-82 (HCU) c)TR-8601 in SS-86(CT) d)TR-8602 in SS-86(CT) e) TR-8401 SS-84 (RUF) f) TR-8402 SS-84(RUF) (Applicable bay numbers : 08, 20 , 11, 06, 25 & 21)

g) Outgoing Feeders : To Large Motors in SS-84 (RUF) Applicable bay numbers : 07, 26

CT1 Core No.	Current Ratio	Accuracy Class	Min. Burden	Min kPV (V)	Max Im at kPV	Purpose
1.	600-300 / 1	PS	-	600-400	30mA-60mA	Diff. Protn. 87T /87F
2.	600-300 / 1	5P10	15VA	-	-	Overcurrent Protn & Metering
3.	2500/ 1	PS	-	2500	30mA	Busbar Diff. Protn.

Bharat Heavy Electricals Limited
Project :CPP of VRMP .
Customer : HPCL
Consultant : EIL

Document Title: **CT & VT sizing calculation** Doc No. **TB-402-510-024, Rev No. 00**

Summary of Winding details of 66kV Potential Transformer :

I) Potential Transformer for Bus 1 , Bus 2 , Bus 1A, Bus 2A, GTG#7 TR Bay, STG#01 TR Bay, 220/66kV Transformer TR9301 , TR9302 & Future grid transformer (Applicable for bays 04, 09, 12 , 18 , 22)

Winding No.	Voltage Ratio	Accuracy Class	Min. Burden	Purpose
1	66kV/√3 / 110V/√3	3P	50 VA	Protn.
2	66kV/√3 / 110V/√3	1	100 VA	Metering & Dir O/C

DOCUMENT REVIEW DETAILS

1 No Comments.
2 ✓ Proceed with manufacture / fabrication as per the commented document. Revised document required.
3 Document does not conform to basic requirements as marked. Resubmit for review.
R Retained for Records. V Void.

Signature with Date 25-APR-2018
Name of Reviewer SAI ACHUTUNI (A738)
Transmittal No.

COMMENT SHEET

DOC. NO.	B016		--
	JOB NO.	TR. NO.	S.NO

PROJECT: VRMP PROJECT, VIZAG
NAME OF PACKAGE: CPP package

CLIENT: M/s HPCL-Vizag
CONTRACTOR: M/s BHEL

SL. NO.	COMMENT/ OBSERVATION	RESOLUTION / ACTION
1	**DRAWING / DOCUMENT TITLE : CT & VT Sizing calculations for 66kV GIS** **DOCUMENT NUMBER: TB-402-510-024 R 00** **CATEGORY/CODE: 2**	
1.1	Furnish the reason for providing multi ratio CT in generator incomers where as only one CT ratio is used (i.e., 1200A for GTG incomer and 300A for STG incomer).	
1.2	Provide Class 5P20 CTs instead of Class 5P10.	
1.3	CT knee point voltage calculation for differential and REF protection shall be updated based on formula of final selected relay model. Alternatively, worst case formula of all possible relay models shall be selected.	
1.4	It is observed that Imag at knee point voltage in some cases has been indicated as 60mA and 120mA. Please note that Imag shall be 30mA.	
1.5	Metering core CT (Class 0.2) shall be provided for Current input to ECS & SCAP. In case transducer is used in series with overcurrent protection relay, the same shall be clearly shown in SLD for all incomers, bussectionaliser, bus couplers and outgoing feeders.	
1.6	Sizing calculation for metrosil and stabilizing resistor shall be included.	
1.7	CT2 core in buscouplers and bus sectionalisers is indicated as spare. The same shall be indicated as busbar differential protection.	
1.8	Please note that the downstream Owner's loads are plant feeders for various substations. Accordingly 40kA through fault current shall be considered for differential protection knee point voltage. However CT ratio shall be selected as per the loading of each feeder forwarded earlier.	
1.9	Future bays shall be renamed as HGU (SS-90) as commented on overall key SLD.	
1.10	Large motors in SS-84 (RUF) shall be renamed as SS-84 feeder- 3 & Feeder-4. Downstream load shall be considered as 50MVA for CT sizing. 40kA through fault current shall be considered for differential protection Knee point voltage calculation.	

NOTE: CONTRACTOR IS OBLIGED TO FURNISH THIS SHEET (DULY FILLED UP WITH RESOLUTION TO ALL EIL COMMENTS) ALONGWITH REVISED DRAWINGS

DOCUMENT REVIEW DETAILS

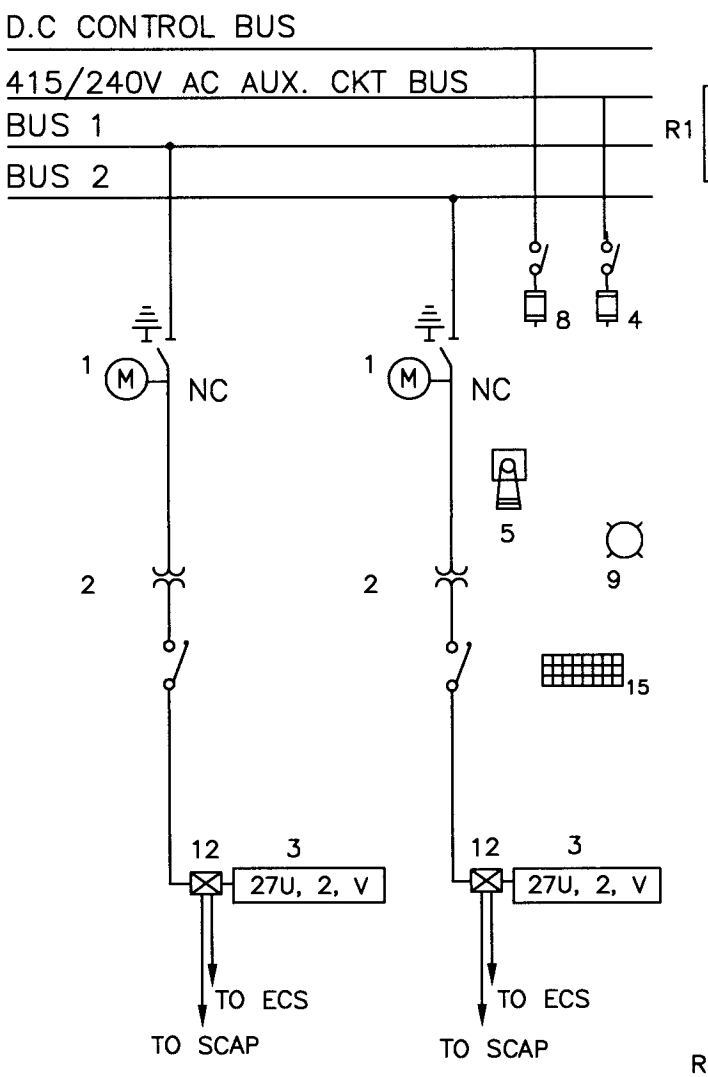
1 No Comments.
2 Proceed with manufacture / fabrication as per the commented document. Revised document required.
3 Document does not conform to basic requirements as marked. Resubmit for review.
R Retained for Records. V Void.

Signature with Date: 25/04/18
Name of Reviewer: SAI ACHUTUN (4736)
Transmittal No.

Comments By: (SIGN/ DATE): 25/04/18
Department: Electrical
Name: SAI

ENGINEERS INDIA LIMITED, NEW DELHI

PROJECT: VRMP CLIENT: M/s HPCL	REV	DATE	PURPOSE	BY	CHKD	APPRV
	A	19.05.17	ISSUED WITH TENDER	NNB	AS	PG



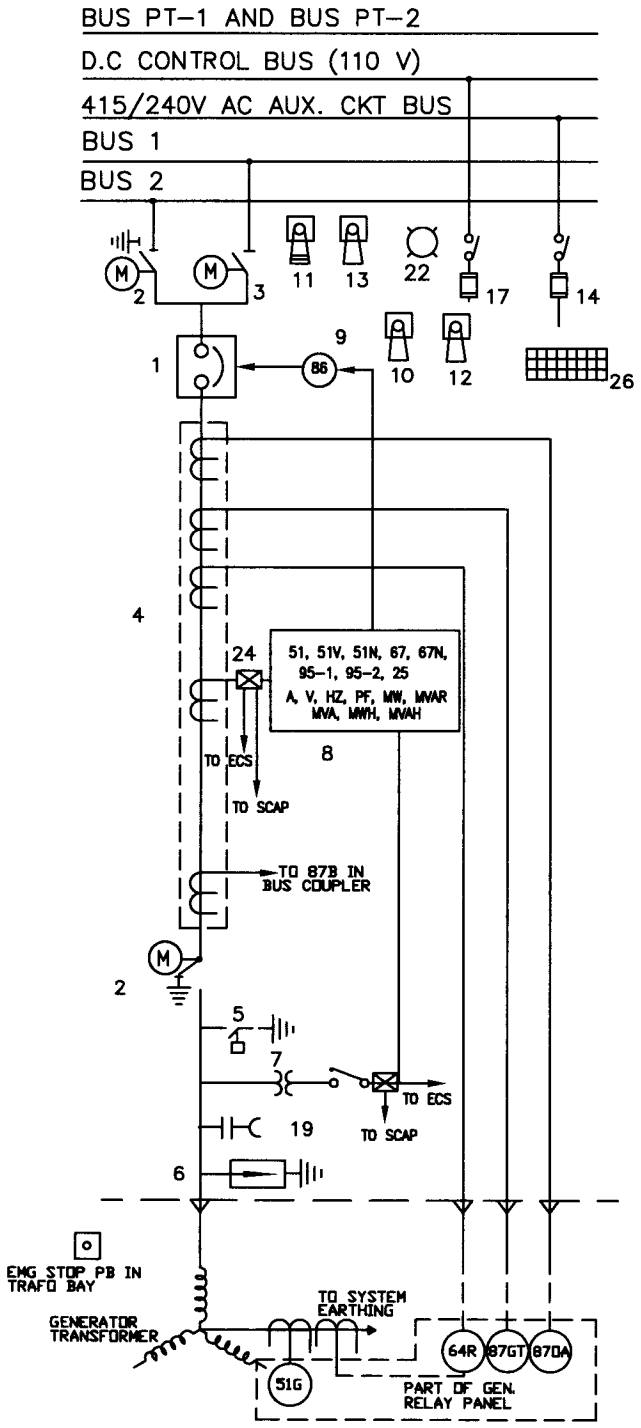
R1 ▭ PART OF NUMERICAL RELAY

EQUIPMENT DATA

ITEM NO.	NEMA NO.	QTY	DESCRIPTION
1	--	2	3 POSN. DISCONNECTOR SWITCH -ON/ISOLATED/EARTHED
2	--	2	PT EHV/√3/110V/√3 CL 1 WITH 4 POLE MCB
3	2	2	TIMER
	27U		UNDERVOLTAGE RELAY
			METERING AS INDICATED
4	--	2	MV POWER SUPPLY SWITCH FUSE FOR LCC & CRP
5	--	2	CONTROL SWITCH FOR DISCONNECTORS AND EARTH SWITCHES
6	--	2	CUBICLE LAMP WITH MCB, DOOR SWITCH FOR LCC & CRP
7	--	2	3 PIN SOCKET WITH TOGGLE SWITCH FOR LCC & CRP
8	--	2	D.P. SWITCH 10 A WITH FUSE FOR D.C. CONTROL SUPPLY FOR LCC & CRP
9	--	AS REQD.	CLUSTER LED TYPE IND. LAMP
10	--	AS REQD.	AUXILARY RELAY
12	--	AS REQD.	TRANSDUCERS, AS REQUIRED FOR SCAP & ECS INTERFACE
13	--	AS REQD.	SF6 GAS MONITORING, ALARMS & INDICATIONS
14	--	2	PANEL SPACE HEATER WITH THERMOSTAT FOR LCC & CRP
15	--	AS REQD.	WINDOW ALARM ANNUNCIATIONS
16	--	AS REQD.	STARTERS FOR MOTORS OF DISCONNECTOR & EARTH SWITCH
17	--	AS REQD.	INTERCONNECTING ARMOURED CABLE BETWEEN GIS, LCC & CRP

NOTES:
1. THE ONE LINE DIAGRAM SHOWN ABOVE IS ONLY INDICATIVE. ALL THE ITEMS SPECIFIED UNDER "EQUIPMENT DATA" AND IN JOB SPECIFICATION SHALL BE IN VENDOR'S SCOPE.
2. ALL PROTECTIVE RELAYS SHALL BE NUMERICAL TYPE OF APPROVED MAKES. METERING SHALL BE A PART OF NUMERICAL RELAY.
3. VA BURDEN OF PT SHALL BE DECIDED BY THE SWITCHBOARD VENDOR CONSIDERING VA BURDEN REQUIREMENTS FOR OWNER'S EQUIPMENTS AS WELL.
4. INDEPENDENT BUS PT PANEL SHALL BE PROVIDED FOR BOTH THE BUSES OF THE DOUBLE BUS GIS SWITCHBOARD.
5. TYPE OF RELAYS SHALL BE NUMERICAL RELAYS OR BAY CONTROL UNIT AS SPECIFIED IN DATA SHEET.
6. MIMIC DIAGRAM FOR OPERATION AND STATUS INDICATION OF ASSOCIATED DISCONNECTORS & EARTH SWITCH SHALL BE PROVIDED ON LCC & CRP. THIS SHALL BE IN ADDITION TO MIMIC PROVIDED IN RELAY/BCU.
7. THE COMPONENTS & EQUIPMENTS TO BE LOCATED ON GIS, LCC & CRP RESPECTIVELY SHALL BE AS SPECIFIED IN THE STANDARD SPECIFICATION.

PROJECT: VRMP CLIENT: M/s HPCL	REV	DATE	PURPOSE	BY	CHKD	APPRV
	A	19.05.17	ISSUED WITH TENDER	NNB	AS	PG



EQUIPMENT DATA

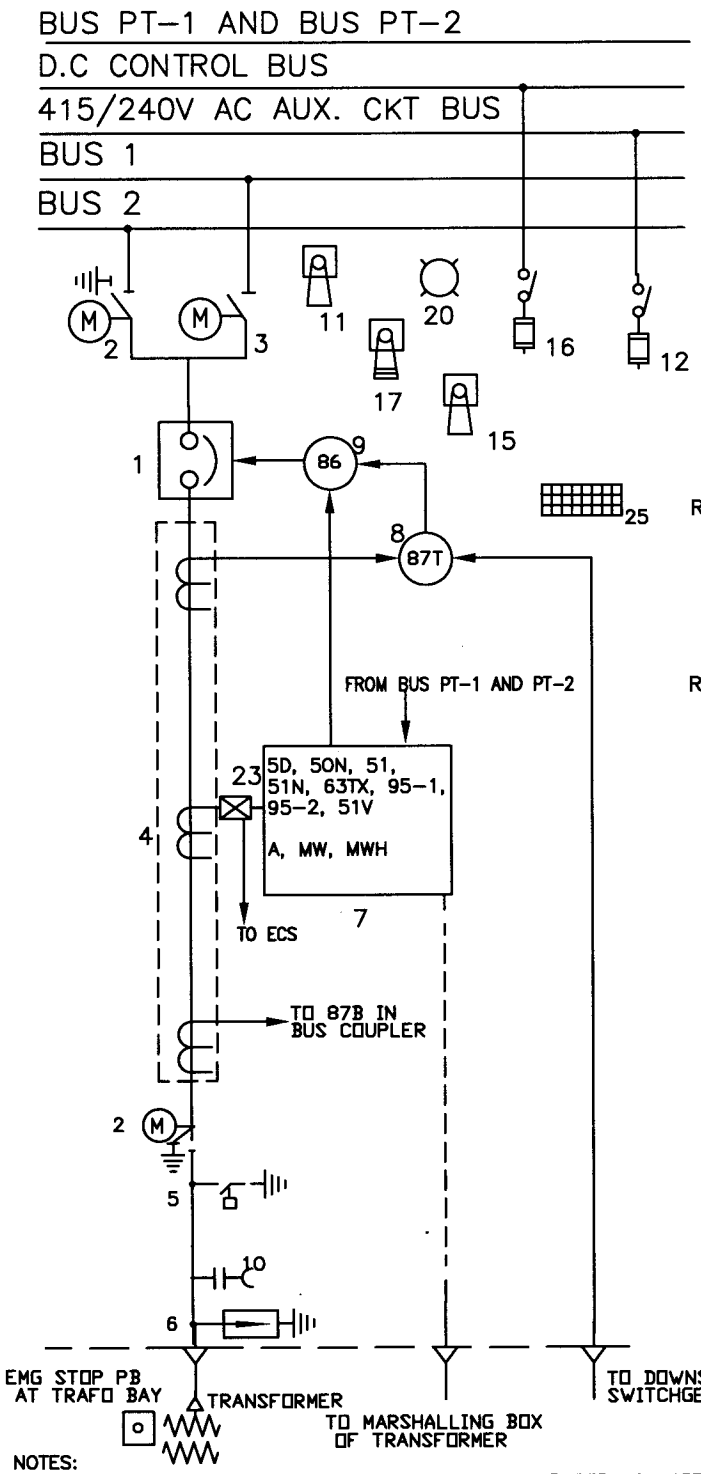
ITEM NO	NEMA NO.	QTY	DESCRIPTION
1	52	1	SF6 CIRCUIT BREAKER
2	---	2	3 POSN. DISCONNECTOR EARTHING SWITCH- ON/ISOLATED/EARTHED
3	---	1	2 POSN. DISCONNECTOR SWITCH- ON/ISOLATED
4	---	3	CORE-1 FOR 87GA CLASS PS
			CORE-2 FOR 87GT CLASS PS
			CORE-3 FOR 64R CLASS PS
			CORE-4 CLASS-5P10
			CORE-5 FOR 87B CLASS PS
5	---	1	HIGH SPEED MAKE PROOF EARTHING SWITCH
6	---	1	SURGE ARRESTOR
7	---	1	PT EHV/√3/110/√3, CL 1 WITH 4 POLE MCB
8	67	1	DIRECTIONAL IDMTL O/C RELAY
	51N		IDMTL E/F RELAY (10-40%)
	25		SYNCHRONISING CHECK RELAY
	95-1, 95-2		TRIP CIRCUIT SUPERVISION RELAY
R1	67N		DIRECTIONAL IDMTL E/F RELAY
	51V		VOLTAGE RESTRAINED OVERCURRENT RELAY
	51		IDMTL O/C RELAY (50-200%)
			METERING AS INDICATED
9	86	1	TRIPPING RELAY
10	---	1	UPSTREAM BREAKER TRIP SWITCH(2 POSITION)(STAYPUT & LOCKABLE)
11	---	4	CONTROL SWITCH FOR DISCONNECTORS & EARTH SWITCHES
12	---	1	LOCAL/OFF/REMOTE SELECTOR SWITCH
13	52C/S	1	BREAKER CONTROL SWITCH (TNC) CLOSE-NEUTRAL-TRIP (LOCKABLE WITH SPRING RETURN TO NEUTRAL)
14	---	2	MV POWER SUPPLY SWITCH FUSE FOR LCC & CRP
15	---	2	CUBICLE LAMP WITH MCB, DOOR SWITCH FOR LCC & CRP
16	---	2	3 PIN SOCKET WITH TOGGLE SWITCH FOR LCC & CRP
17	---	2	D.P. SWITCH 10 A WITH FUSE FOR D.C. CONTROL SUPPLY FOR LCC & CRP
18	---	1	SOCKET AT PANEL BACK FOR CABLE TESTING,CURRENT & VOLTAGE INJECTION
19	---	1	CAPACITIVE VOLTAGE DETECTOR
20	---	AS REQD.	SF6 GAS MONITORING, ALARMS AND INDICATIONS
21	---	AS REQD.	CLUSTER LED TYPE INDICATION LAMP
22	---	AS REQD.	AUXILARY RELAY
24	---	AS REQD.	TRANSDUCERS, AS REQUIRED FOR SCAP & ECS INTERFACE
25	---	2	PANEL SPACE HEATER WITH THERMOSTAT FOR LCC & CRP
26	---	AS REQD.	WINDOW ALARM ANNUNCIATIONS
27	---	AS REQD.	STARTERS FOR MOTORS OF CB, DISCONNECTOR & EARTH SWITCH
28	---	AS REQD.	INTERCONNECTING ARMOURED CABLE BETWEEN GIS, LCC & CRP

NOTES:
1. ANTIPUMPING RELAY USED, IF ANY, SHALL BE CONSIDERED AS PART OF BREAKER MECHANISM.
2. THE ONE LINE DIAGRAM SHOWN ABOVE IS ONLY INDICATIVE. ALL THE ITEMS SPECIFIED UNDER "EQUIPMENT DATA" AND IN JOB SPECIFICATION SHALL BE IN VENDOR'S SCOPE.
3. ALL PROTECTIVE RELAYS SHALL BE NUMERICAL TYPE OF APPROVED MAKES. METERING SHALL BE A PART OF NUMERICAL RELAY.
4. VA BURDEN OF CT & PT SHALL BE DECIDED BY THE SWITCHGEAR VENDOR CONSIDERING VA BURDEN REQUIREMENTS FOR OWNER'S EQUIPMENTS AS WELL.
5. TYPE OF RELAYS SHALL BE NUMERICAL RELAYS OR BAY CONTROL UNIT AS SPECIFIED IN DATA SHEET.
6. MIMIC DIAGRAM FOR OPERATION AND STATUS INDICATION OF CIRCUIT BREAKER AND ASSOCIATED DISCONNECTORS & EARTH SWITCH SHALL BE PROVIDED ON LCC & CRP. THIS SHALL BE IN ADDITION TO MIMIC PROVIDED IN RELAY/BCU.
7. THE COMPONENTS & EQUIPMENTS TO BE LOCATED ON GIS, LCC & CRP RESPECTIVELY SHALL BE AS SPECIFIED IN THE STANDARD SPECIFICATION.

R1 ▭ PART OF NUMERICAL RELAY-1

ENGINEERS INDIA LIMITED NEW DELHI	EHV GIS DATA SHEET HARDWARE DATASHEET FOR INCOMER FROM GENERATOR TRANSFORMER	DATA SHEET	REV
		B016-606-16-50-DS-1029 Sht.1 OF 6	A

PROJECT: VRMP CLIENT: M/s HPCL	REV	DATE	PURPOSE	BY	CHKD	APPRV
	A	19.05.17	ISSUED WITH TENDER	NNB	AS	PG



EQUIPMENT DATA

	ITEM NO.	NEMA NO.	QTY	DESCRIPTION
	1	52	1	SF6 CIRCUIT BREAKER
	2	--	2	3 POSN. DISCONNECTOR EARTHING SWITCH - ON/ISOLATED/EARTHED
	3	--	1	2 POSN. DISCONNECTOR SWITCH - ON/ISOLATED
	4	--	3	CORE-1 C.T. FOR 87T CLASS PS
				CORE-2 C.T CLASS-5P10
	0			CORE-3 C.T. FOR 87B CLASS PS
	5	--	1	HIGH SPEED MAKE PROOF EARTHING SWITCH
	6	--	1	SURGE ARRESTOR
	7	51N	1	IDMTL E/F RELAY (10-40%)
		50		INSTANTANEOUS O/C RELAY
		50N		INSTANTANEOUS E/F RELAY
R1		51		IDMTL O/C RELAY (50-200%)
		51V		VOLTAGE RESTRAINED RELAY
		95-1, 95-2		TRIP CIRCUIT SUPERSUPERVISION RELAY
		63TX		AUXILARY TRANSFORMER PROTECTION RELAY
				METERING AS INDICATED
R2	8	87T	1	TRANSFORMER DIFFERENTIAL RELAY
	9	86	1	TRIPPING RELAY
	10	--	1	CAPACITIVE VOLTAGE DETECTOR
	11	52 C/S	1	BREAKER CONTROL SWITCH (TNC) CLOSE-NEUTRAL-TRIP (LOCKABLE WITH SPRING RETURN TO NEUTRAL)
	12	--	2	MV POWER SUPPLY SWITCH FUSE FOR LCC & CRP
	13	--	2	CUBICLE LAMP WITH MCB, DOOR SWITCH FOR LCC & CRP
	14	--	2	3 PIN SOCKET WITH TOGGLE SWITCH FOR LCC & CRP
	15	--	1	LOCAL /OFF/REMOTE SELECTOR SWITCH
	16	--	2	D.P. SWITCH 10 A WITH FUSE FOR D.C. CONTROL SUPPLY FOR LCC & CRP
	17	--	4	CONTROL SWITCH FOR DISCONNECTORS AND EARTH SWITCHES
	18	--	1	SOCKET AT PANEL BACK FOR CABLE TESTING,CURRENT & VOLTAGE INJECTION
	19	--	AS REQD.	SF6 GAS MONITORING, ALARMS AND INDICATIONS
	20	--	AS REQD.	CLUSTER LED TYPE INDICATION LAMP
	21	--	AS REQD.	AUXILARY RELAY
	23	--	AS REQD.	TRANSDUCERS, AS REQUIRED FOR ECS INTERFACE
	24	--	2	PANEL SPACE HEATER WITH THERMOSTAT FOR LCC & CRP
	25	--	AS REQD.	WINDOW ALARM ANNUNCIATIONS
	26	--	AS REQD.	STARTERS FOR MOTORS OF CB, DISCONNECTOR & EARTH SWITCH
	27	--	AS REQD.	INTERCONNECTING ARMOURED CABLE BETWEEN GIS, LCC & CRP

NOTES:
1. ANTIPUMPING RELAY USED, IF ANY, SHALL BE CONSIDERED AS PART OF BREAKER MECHANISM.
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3. ALL PROTECTIVE RELAYS SHALL BE NUMERICAL TYPE OF APPROVED MAKES. METERING SHALL BE A PART OF NUMERICAL RELAY.
4. VA BURDEN OF CT & PT SHALL BE DECIDED BY THE SWITCHGEAR VENDOR CONSIDERING VA BURDEN REQUIREMENTS FOR OWNER'S EQUIPMENTS AS WELL.
5. TYPE OF RELAYS SHALL BE NUMERICAL RELAYS OR BAY CONTROL UNIT AS SPECIFIED IN DATA SHEET.
6. MIMIC DIAGRAM FOR OPERATION AND STATUS INDICATION OF CIRCUIT BREAKER AND ASSOCIATED DISCONNECTORS & EARTH SWITCH SHALL BE PROVIDED ON LCC & CRP. THIS SHALL BE IN ADDITION TO MIMIC PROVIDED IN RELAY/BCU.
7. THE COMPONENTS & EQUIPMENTS TO BE LOCATED ON GIS, LCC & CRP RESPECTIVELY SHALL BE AS SPECIFIED IN THE STANDARD SPECIFICATION.

R1 ☐ PART OF NUMERICAL RELAY-1
R2 ☐ PART OF NUMERICAL RELAY-2

ENGINEERS INDIA LIMITED NEW DELHI	EHV GIS DATASHEET HARDWARE DATASHEET FOR OUTGOING TRANSFORMER FEEDER	DATA SHEET	REV
		B016-606-16-50-DS-1029 Sht.4 OF 6	A

PROJECT: VRMP CLIENT: M/s HPCL	REV	DATE	PURPOSE	BY	CHKD	APPRV
	A	19.04.17	ISSUED WITH TENDER	NNB	AS	PG

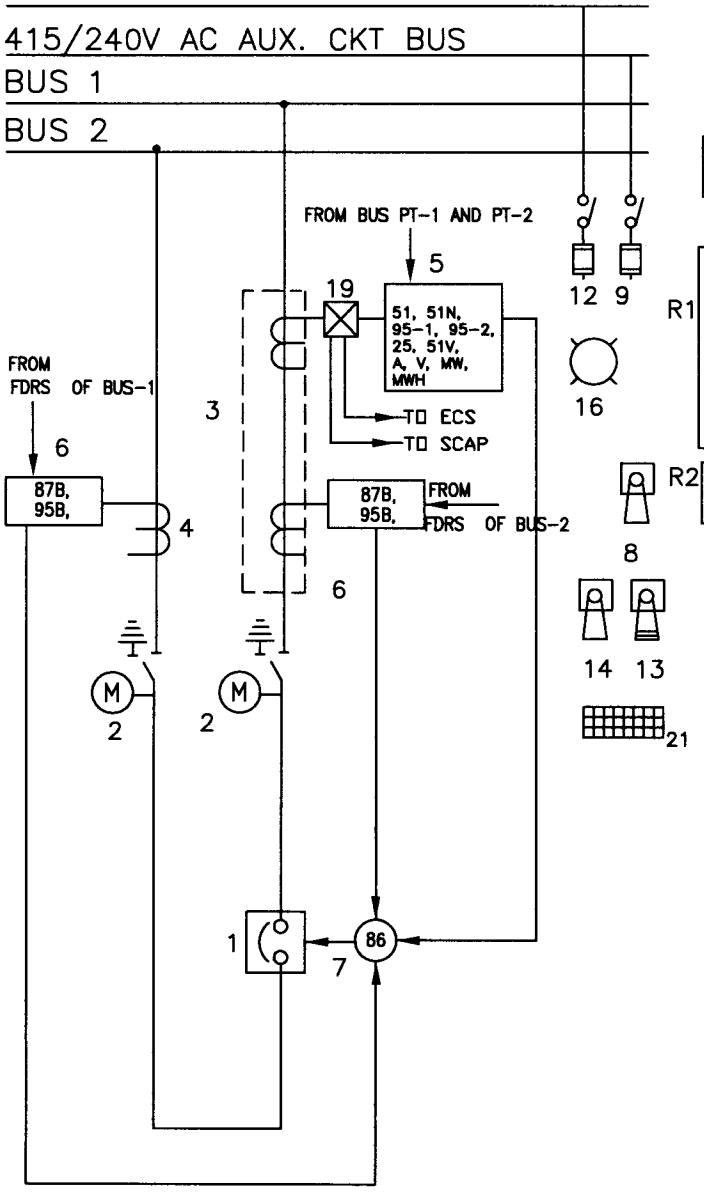
BUS PT-1 AND BUS PT-2

D.C CONTROL BUS

415/240V AC AUX. CKT BUS

BUS 1

BUS 2



EQUIPMENT DATA

ITEM NO.	NEMA NO.	QTY	DESCRIPTION
1	52	1	SF6 CIRCUIT BREAKER
2	---	2	3 POSN. DISCONNECTOR EARTHING SWITCH -ON/ ISOLATED/ EARTHED
3	---	3	CORE-1 CLASS-5P10
0		0	CORE-2 FOR 87B CLASS PS
4	---	3	CT FOR 87B CLASS PS
	25	1	SYNCHRONISING CHECK RELAY
5	51		IDMTL O/C RELAY (50-200%)
	51N		IDMTL E/F RELAY (10-40%)
	95-1, 95-2		TRIP CIRCUIT SUPERSUPERVISION RELAY
	51V		VOLTAGE RESTRAINED OVERCURRENT RELAY
			METERING AS INDICATED
6	95B	2	CT SUPERVISION RELAY
	87B		BUS DIFFERENTIAL RELAY
7	86	1	TRIPPING RELAY
8	52 C/S	1	BREAKER CONTROL SWITCH (TNC) CLOSE-NEUTRAL-TRIP (LOCKABLE WITH SPRING RETURN TO NEUTRAL)
9	---	2	MV POWER SUPPLY SWITCH FUSE FOR LCC & CRP
10	---	2	CUBICLE LAMP WITH MCB, DOOR SWITCH FOR LCC & CRP
11	---	2	3 PIN SOCKET WITH TOGGLE SWITCH FOR LCC & CRP
12	---	2	D.P. SWITCH 10 A WITH FUSE FOR D.C. CONTROL SUPPLY FOR LCC & CRP
13	---	2	CONTROL SWITCH FOR DISCONNECTORS AND EARTH SWITCHES
14	---	1	LOCAL/ OFF/ REMOTE SELECTOR SWITCH
15	---	AS REQD.	SF6 GAS MONITORING, ALARMS AND INDICATIONS
16	---	AS REQD.	CLUSTER LED TYPE INDICATION LAMP
17	---	AS REQD.	AUXILARY RELAY
19	---	AS REQD.	TRANSDUCERS, AS REQUIRED FOR SCAP & ECS INTERFACE
20	---	2	PANEL SPACE HEATER WITH THERMOSTAT FOR LCC & CRP
21	---	AS REQD.	WINDOW ALARM ANNUNCIATIONS
22	---	AS REQD.	STARTERS FOR MOTORS OF CB, DISCONNECTOR & EARTH SWITCH
23	---	AS REQD.	INTERCONNECTING ARMOURED CABLE BETWEEN GIS, LCC & CRP

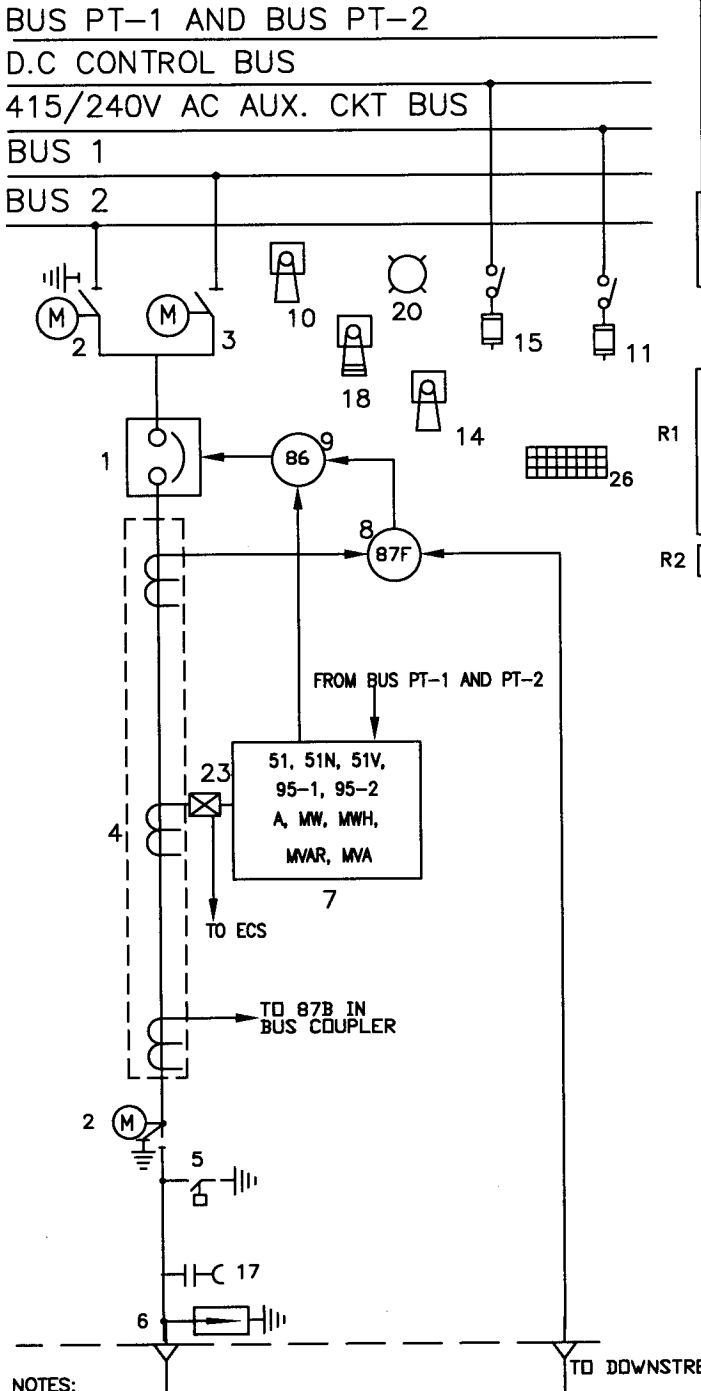
R1 ☐ PART OF NUMERICAL RELAY-1

R2 ☐ PART OF NUMERICAL RELAY-2

FOR BUS SECTIONALIZER:
READ BUS 1 = BUS 1A AND
BUS 2 = BUS 1B

NOTES:
1. ANTIPUMPING RELAY USED, IF ANY, SHALL BE CONSIDERED AS PART OF BREAKER MECHANISM.
2. THE ONE LINE DIAGRAM SHOWN ABOVE IS ONLY INDICATIVE. ALL THE ITEMS SPECIFIED UNDER "EQUIPMENT DATA" AND IN JOB SPECIFICATION SHALL BE IN VENDOR'S SCOPE.
3. ALL PROTECTIVE RELAYS SHALL BE NUMERICAL TYPE OF APPROVED MAKES. METERING SHALL BE A PART OF NUMERICAL RELAY.
4. VA BURDEN OF CT & PT SHALL BE DECIDED BY THE SWITCHBOARD VENDOR CONSIDERING VA BURDEN REQUIREMENTS FOR OWNER'S EQUIPMENTS AS WELL.
5. TYPE OF RELAYS SHALL BE NUMERICAL RELAYS OR BAY CONTROL UNIT AS SPECIFIED IN DATASHEET.
6. MIMIC DIAGRAM FOR OPERATION AND STATUS INDICATION OF CIRCUIT BREAKER AND ASSOCIATED DISCONNECTORS & EARTH SWITCH SHALL BE PROVIDED ON LCC & CRP. THIS SHALL BE IN ADDITION TO MIMIC PROVIDED IN RELAY/BCU.
7. THE COMPONENTS & EQUIPMENTS TO BE LOCATED ON GIS, LCC & CRP RESPECTIVELY SHALL BE AS SPECIFIED IN THE STANDARD SPECIFICATION.

PROJECT: VRMP CLIENT: M/s HPCL	REV	DATE	PURPOSE	BY	CHKD	APPRV
	A	19.05.17	ISSUED WITH TENDER	NNB	AS	PG



R1
R2

EQUIPMENT DATA

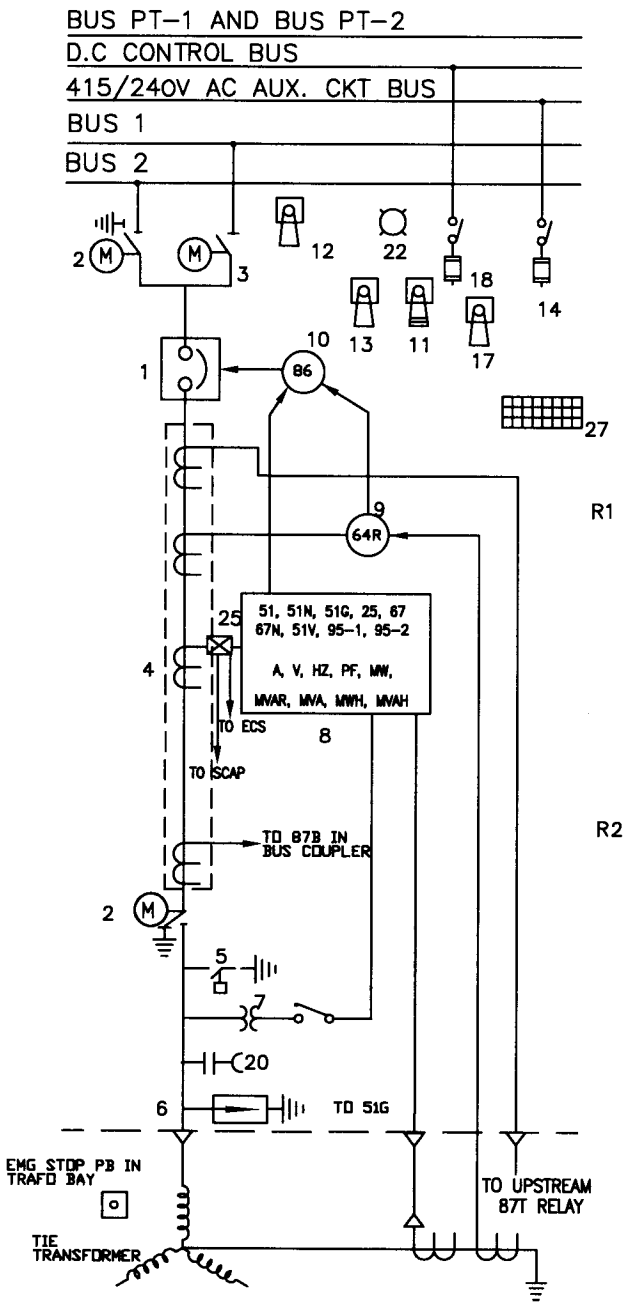
ITEM NO.	NEMA NO.	QTY	DESCRIPTION
1	52	1	SF6 CIRCUIT BREAKER
2	—	2	3 POSN. DISCONNECTOR EARTHING SWITCH- ON/ISOLATED/EARTHED
3	—	1	2 POSN. DISCONNECTOR SWITCH- ON/ISOLATED
4	—	3	CORE-1 C.T. FOR 87F CLASS PS
			CORE-2 C.T CLASS-5P10
0			CORE-3 C.T. FOR 87B CLASS PS
5		1	HIGH SPEED MAKE PROOF EARTHING SWITCH
6		1	SURGE ARRESTOR
7	51	1	IDMTL O/C RELAY (50-200%)
	51N		IDMTL E/F RELAY (10-40%)
	51V		VOLTAGE RESTRAINED OVERCURRENT RELAY
	96-1, 96-2		TRIP CIRCUIT SUPERSUPERVISION RELAY
			METERING AS INDICATED
8	87	AS REQD	FEEDER DIFFERENTIAL RELAY SUITABLE FOR FO CABLE (REFER NOTE-4)
9	86	1	TRIPPING RELAY
10	52 C/S	1	BREAKER CONTROL SWITCH (TNC) CLOSE-NEUTRAL-TRIP (LOCKABLE WITH SPRING RETURN TO NEUTRAL)
11	—	2	MV POWER SUPPLY SWITCH FUSE FOR LCC & CRP
12	—	2	CUBICLE LAMP WITH MCB, DOOR SWITCH FOR LCC & CRP
13	—	2	3 PIN SOCKET WITH TOGGLE SWITCH FOR LCC & CRP
14	—	1	LOCAL /OFF/REMOTE SELECTOR SWITCH
15	—	2	D.P. SWITCH 10 A WITH FUSE FOR D.C. CONTROL SUPPLY FOR LCC & CRP
16	—	1	SOCKET AT PANEL BACK FOR CABLE TESTING,CURRENT & VOLTAGE INJECTION
17	—	1	CAPACITIVE VOLTAGE DETECTOR
18	—	4	CONTROL SWITCH FOR DISCONNECTORS AND EARTHSWITCHES
19	—	AS REQD.	SF6 GAS MONITORING, ALARMS AND INDICATIONS
20	—	AS REQD.	CLUSTER LED TYPE INDICATION LAMP
21	—	AS REQD.	AUXILARY RELAY
23	—	AS REQD.	TRANSDUCERS, AS REQUIRED FOR ECS INTERFACE
24	—	AS REQD.	LIU FOR TERMINATION OF FO CABLE
25	—	2	PANEL SPACE HEATER WITH THERMOSTAT FOR LCC & CRP
26	—	AS REQD.	WINDOW ALARM ANNUNCIATIONS
27	—	AS REQD.	STARTERS FOR MOTORS OF CB, DISCONNECTOR & EARTH SWITCH
28	—	AS REQD.	INTERCONNECTING ARMOURED CABLE BETWEEN GIS, LCC & CRP

NOTES:
1. ANTIPUMPING RELAY USED, IF ANY, SHALL BE CONSIDERED AS PART OF BREAKER MECHANISM.
2. THE ONE LINE DIAGRAM SHOWN ABOVE IS ONLY INDICATIVE. ALL THE ITEMS SPECIFIED UNDER "EQUIPMENT DATA" AND IN JOB SPECIFICATION SHALL BE IN VENDOR'S SCOPE.
3. ALL PROTECTIVE RELAYS SHALL BE NUMERICAL TYPE OF APPROVED MAKES. METERING SHALL BE A PART OF NUMERICAL RELAY.
4. SCOPE OF SUPPLY OF 87F RELAYS FOR THIS FEEDER AND DOWNSTREAM FEEDER SHALL BE AS SPECIFIED IN JOB SPECIFICATION/DATASHEET.
5. VA BURDEN OF CT & PT SHALL BE DECIDED BY THE SWITCHGEAR VENDOR CONSIDERING VA BURDEN REQUIREMENTS FOR OWNER'S EQUIPMENTS AS WELL.
6. TYPE OF RELAYS SHALL BE NUMERICAL RELAY OR BAY CONTROL UNIT AS SPECIFIED IN DATASHEET.
7. MIMIC DIAGRAM FOR OPERATION AND STATUS INDICATION OF CIRCUIT BREAKER AND ASSOCIATED DISCONNECTORS & EARTH SWITCH SHALL BE PROVIDED ON LCC & CRP. THIS SHALL BE IN ADDITION TO MIMIC PROVIDED IN RELAY/BCU.
8. THE COMPONENTS & EQUIPMENTS TO BE LOCATED ON GIS, LCC & CRP RESPECTIVELY SHALL BE AS SPECIFIED IN THE STANDARD SPECIFICATION.

R1 ☐ PART OF NUMERICAL RELAY-1
R2 ☐ PART OF NUMERICAL RELAY-2

ENGINEERS INDIA LIMITED NEW DELHI	EHV GIS DATASHEET HARDWARE DATASHEET FOR OUTGOING PLANT FEEDER	DATA SHEET	REV
		B016-606-16-50-DS-1029 Sht.6 OF 6	A

PROJECT: VRMP CLIENT: M/s HPCL	REV	DATE	PURPOSE	BY	CHKD	APPRV
	A	19.05.17	ISSUED WITH TENDER	NNB	AS	PG



EQUIPMENT DATA

ITEM NO	NEMA NO.	QTY	DESCRIPTION	
1	52	1	SF6 CIRCUIT BREAKER	
2	---	2	3 POSN. DISCONNECTOR EARTHING SWITCH- ON/ISOLATED/EARTHED	
3	---	1	2 POSN. DISCONNECTOR SWITCH- ON/ISOLATED	
4	---	3	CORE-1 FOR 87T CLASS PS	R2
			CORE-2 FOR 64R CLASS PS	
			CORE-3 CLASS-5P10	
			CORE-4 FOR 87B CLASS PS	
5	---	1	HIGH SPEED MAKE PROOF EARTHING SWITCH	
6	---	1	SURGE ARRESTOR	
7	---	1	PT EHV/√3/110/√3, CL 1 WITH 4 POLE MCB	
8	67	1	DIRECTIONAL IDMTL O/C RELAY	R1
	51N		IDMTL E/F RELAY (10-40%)	
	51G		IDMTL E/F RELAY (BACK UP)(20-40%)	
	25		SYNCHRONISING CHECK RELAY	
	95-1, 95-2		TRIP CIRCUIT SUPERVISION RELAY	
	67N		DIRECTIONAL IDMTL E/F RELAY	
	51V		VOLTAGE RESTRAINED OVERCURRENT RELAY	
	51		IDMTL O/C RELAY (50-200%)	
			METERING AS INDICATED	
9	64R	1	RESTRICTED E/F RELAY	R2
10	86	1	TRIPPING RELAY	
11	---	4	CONTROL SWITCHES FOR DISCONNECTORS & EARTH SWITCHES	
12	52C/S	1	BREAKER CONTROL SWITCH (TNC) CLOSE-NEUTRAL-TRIP (LOCKABLE WITH SPRING RETURN TO NEUTRAL)	
13	---	1	UPSTREAM BREAKER TRIP SWITCH(2 POSITION)(STAYPUT & LOCKABLE)	
14	---	2	MV POWER SUPPLY SWITCH FUSE FOR LCC & CRP	
15	---	2	CUBICLE LAMP WITH MCB, DOOR SWITCH FOR LCC & CRP	
16	---	2	3 PIN SOCKET WITH TOGGLE SWITCH FOR LCC & CRP	
17	---	1	LOCAL/OFF/REMOTE SELECTOR SWITCH	
18	---	2	D.P. SWITCH 10 A WITH FUSE FOR D.C. CONTROL SUPPLY FOR LCC & CRP	
19	---	1	SOCKET AT PANEL BACK FOR CABLE TESTING,CURRENT & VOLTAGE INJECTION	
20	---	1	CAPACITIVE VOLTAGE DETECTOR	
21	---	AS REQD.	SF6 GAS MONITORING, ALARMS AND INDICATIONS	
22	---	AS REQD.	CLUSTER LED TYPE INDICATION LAMP	
23	---	AS REQD.	AUXILARY RELAY	
25	---	AS REQD.	TRANSDUCERS, AS REQUIRED FOR SCAP & ECS INTERFACE	
26	---	2	PANEL SPACE HEATER WITH THERMOSTAT FOR LCC & CRP	
27	---	AS REQD.	WINDOW ALARM ANNUNCIATIONS	
28	---	AS REQD.	STARTERS FOR MOTORS OF CB, DISCONNECTOR & EARTH SWITCH	
29	---	AS REQD.	INTERCONNECTING ARMOURED CABLE BETWEEN GIS, LCC & CRP	

NOTES:
1. ANTIPUMPING RELAY USED, IF ANY, SHALL BE CONSIDERED AS PART OF BREAKER MECHANISM.
2. THE ONE LINE DIAGRAM SHOWN ABOVE IS ONLY INDICATIVE. ALL THE ITEMS SPECIFIED UNDER "EQUIPMENT DATA" AND IN JOB SPECIFICATION SHALL BE IN VENDOR'S SCOPE.
3. ALL PROTECTIVE RELAYS SHALL BE NUMERICAL TYPE OF APPROVED MAKES. METERING SHALL BE A PART OF NUMERICAL RELAY.
4. VA BURDEN OF CT & PT SHALL BE DECIDED BY THE SWITCHGEAR VENDOR CONSIDERING VA BURDEN REQUIREMENTS FOR OWNER'S EQUIPMENTS AS WELL.
5. TYPE OF RELAYS SHALL BE NUMERICAL RELAYS OR BAY CONTROL UNIT AS SPECIFIED IN DATA SHEET.
6. MIMIC DIAGRAM FOR OPERATION AND STATUS INDICATION OF CIRCUIT BREAKER AND ASSOCIATED DISCONNECTORS & EARTH SWITCH SHALL BE PROVIDED ON LCC& CRP. THIS SHALL BE IN ADDITION TO MIMIC PROVIDED IN RELAY/BCU.
7. COMBINED FEEDER CUM TRANFORMER DIFFERENTIAL RELAY SHALL BE PROVIDED IF SPECIFIED IN JOB SPECIFICATION / DATASHEET.
8. THE COMPONENTS & EQUIPMENTS TO BE LOCATED ON GIS, LCC & CRP RESPECTIVELY SHALL BE AS SPECIFIED IN THE STANDARD SPECIFICATION.

R1 ☐ PART OF NUMERICAL RELAY-1
R2 ☐ PART OF NUMERICAL RELAY-2

ENGINEERS INDIA LIMITED NEW DELHI	EHV GIS DATA SHEET HARDWARE DATASHEET FOR INCOMER FROM TRANSFORMER	DATA SHEET	REV
		B016-000-16-50-DS-1029 Sht.5 OF 6	A

रिले तथा कन्ट्रोल पैनलो/डैस्कों के लिए निरीक्षण व परीक्षण योजना

INSPECTION AND TEST PLAN FOR RELAY & CONTROL PANEL/DESKS

Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
3	21.11.2013	Revised and Reissued	MJ	RS	SCG	SC
2	15.07.2011	Revised and Re-issued	GS	SA	AKC	DM
1	28.09.2007	Revised and Re-issued	AKG	PPM	MVKK	VC
0	25.07.2002	Issued for implementation	RG	AKC	AKB	GRR

Abbreviations

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

Inspection Standards Committee

Convenor : Mr. S C Gupta

Members:

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

1.0 SCOPE

This Inspection and Test Plan covers the minimum testing requirements of Relay & Control Panel/Desks.

2.0 REFERENCE DOCUMENTS

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

3.0 INSPECTION AND TEST REQUIREMENTS

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
1.0	**Procedures**	---	---	---	---	---	---
2.0	**Material Inspection**						
2.1	Incoming material like panel fabrication, PCBs, Lamps, Push Buttons, switches, Protective relays, Lockout relays, Indicating Meters, Terminals, cable wires(FR), PVC ducts, etc	Visual, Physical, Finish, Dimensions, Make of components, Manufacturer's test certificates for model, accuracy etc. as per relevant specifications	100%	Test records	H	H	R
3.0	**Inprocess Inspection**						

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
3.1	Wiring Checks	• Size, termination, ferruling, continuity • Check for correctness of wiring	100%	Test Records	---	H	R
4.0	**Final Inspection**						
4.1	Final Inspection	Acceptance Tests:- • Visual, Accessibility of operating devices • Dimensional • Name Plate & Inscription details • Paint shade and surface finish • Mimic diagram and color codes • Cable entry, Cable lugs, Cable Glands size, Lifting Hooks • Bill of material, Make of Components • Operation check of Alarm sequence/ Functional as per data sheet requirement / drawings • Operation/Calibration check of all relays, Meters and other components by current injection • Operation check for auxiliary contacts & auxiliary circuit • Earthing • Accuracy of digital clock • High voltage test • IR test before and after High voltage	100%	Inspection test record	-	H	H

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
5.0	**Painting**						
5.1	Painting and Packing	• Visual • Suitable protection to prevent entry of foreign material. • Proper packing to prevent any damage during transportation and storage.	100%	Packing list / Supplier's Records	-	H	-
6.0	**Documentation and IC**						
6.1	Documentation and IC	• Review of Internal Test Reports, Test reports for degree of protection • IC issuance	100%	Supplier's Test Records / Inspection Certificate	-	-	H
6.2	Final Document submission	Compilation of Inspection reports ,drawings, etc as per VDR / PR	100%	Final data folder /Completeness certificate	-	H	H

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

NOTES :-

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

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के लिए निरीक्षण एवं परीक्षण योजना

INSPECTION AND TEST PLAN
FOR
NUMERICAL RELAYS

Rev. No.	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
2.	21.11.2013	Revised and Reissued	MJ	RS	SCC	
1	29.06.2012	Revised and Reissued	RKP	RJD	AKC	DM
0	08.12.2008	Issued for implementation	RB	SKD	SKP	VC

Abbreviations

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

Inspection Standards Committee

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Mr. Mayank Jain
Mr. Rajeev Kumar
Mr. T Kamalakannan
Mr. Himangshu Pal
Mr. Deepak Gupta (Project)

1.0 SCOPE

This Inspection and Test Plan covers the minimum testing requirements of Numerical Relays, Data Concentrator and MMI Systems.

2.0 REFERENCE DOCUMENTS

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

3.0 INSPECTION AND TEST REQUIREMENTS

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
1.0	**Procedures**	--	--	--	--	--	--
2.0	**Material Inspection**						
2.1	Incoming Raw Material/Components like Princted circuit Boards, Link Interface unit, Relays, Ethernet Cards, Communication cables, Power Supplies, Transducers, CT/PT, GPS System, Enclosure, Printer, Laptops, UPS, Desktop etc	Manufacturers' TC / Compliance.	100%	Material Test Certificates	H	H	R
3.0	**In process Inspection**						

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
4.0	**Final Inspection**						
4.1	Final Inspection-Numerical Relays	• Visual checks and model verification • Self Diagnostics and communication integrity including time synchronization check, as per applicable standard • All functional characteristics checks as per job requirement.	100%	Supplier's Test Records and Inspection Witness Record	-	H	RW

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
4.2	Final Inspection- Data Concentrators/MMI (note -3)	• Physical, Dimensional and BoM Verification. • Schematic and Functional Checks. • Continuity Check of Control Wiring (Random). • High Voltage test and IR before and after HV. • Time Synchronization check with Job GPS system. • Redundancy checks of Processor, Communication and Power Supply • Data Logging, Alarm Generation, event Recording and Trends verification (with Time Stamping). • Verification of SLD Representation, Multi window Representation and Dynamic Graphics of MMI • Power Distribution Checks. • Input/ Output Tests • Verification of Scan time (if Applicable) • Verification of Communication with SCADA/ECS/DCS (As applicable). • Verification of Control Access Levels (Operator/ Engineer/ Administrator) • Software License Check.	100%	Test Report	-	H	H
4.3	Type Tests-Numerical Relays	Type test certificates as per relevant Indian /International standards. Type tests shall	Prototype for each model	Statutory Approval	-	R	R

SL NO.	STAGE/ ACTIVITY	CHARACTERISTICS	QUANTUM OF CHECK	RECORD	SCOPE OF INSPECTION		
					SUB SUPPLIER	SUPPLIER	EIL/TPIA
		include as minimum but not be limited to the following • Temperature withstand • Disturbance immunity • Electromagnetic compatibility (EMC) • HV withstands test for panel • Functional tests and Communication integrity • Relay characteristics verification • Degree of protection as per latest IS/IEC, for relays and Data Concentrator Panels (DCP). • Mechanical stress/ vibration test		Certificates / Type Test Certificates			
5.0	**Painting**						
5.1	Painting and Packing	• Visual • Suitable protection to prevent entry of foreign material. • Protection against damage during transportation.	100%	Packing list / Supplier's Records	-	H	-
6.0	**Documentation and IC**						
6.1	Documentation and IC	• Issuance of IC	-	Inspection Certificate Format	-	-	H
6.2	Final Document submission	Compilation of Inspection reports ,drawings, etc as per VDR / PR	100%	Final data folder /Completeness certificate	-	H	H

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

NOTES :-

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

Section 2:
Equipment Specification under scope of supplies

Section 2A:
Specific technical requirements for GIS & its Accessories

The Break-up for section is as follows,

1. Specification for Extra High Voltage Gas Insulated Switchgear
2. Datasheet for EHV Gas Insulated Switchgear

Section - 2A

अतिरिक्त उच्च वोल्टेज वाले गैस रोधित स्विचगियर के लिए विनिर्देश

SPECIFICATION FOR EXTRA HIGH VOLTAGE GAS INSULATED SWITCHGEAR

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
0	30.01.2014	ISSUED AS STANDARD SPECIFICATION	AS	PG	UAP	SC

Abbreviations:

A	:	Ampere
AC	:	Alternating Current
BCU	:	Bay Control Unit
BIL	:	Basic Insulation Level
BIS	:	Bureau of Indian Standards
CB	:	Circuit Breaker
CEA	:	Central Electricity Authority
CNT	:	Close-Neutral-Trip
CO	:	Close Open
CRP	:	Control Relay Panel
CT	:	Current Transformer
DC	:	Direct Current
EHV	:	Extra High Voltage
EIL	:	Engineers India Limited
FRLS	:	Flame Retardant Low Smoke
GIS	:	Gas Insulated Switchgear
GIBD	:	Gas Insulated Bus Duct
HV	:	High Voltage
Hz	:	Hertz
ICT	:	Interposing Current Transformer
IEC	:	International Electro technical Commission
IP	:	Ingress Protection
IS	:	Indian Standards
kV	:	Kilo Volt
kW	:	Kilo Watt
kWh	:	Kilo Watt Hour
LCC	:	Local Control Cabinet
LED	:	Light Emitting Diode
MCB	:	Miniature Circuit Breaker
NO	:	Normally Open
NC	:	Normally Close Contact
O	:	Open
PO	:	Purchase Order
p.u	:	per unit
RAL	:	Reichs-Ausschuss fur Lieferbedingungen
RIP	:	Resin Impregnated Paper
SF_6	:	Sulphur Hexafluoride
TRV	:	Transient Recovery Voltage
VT	:	Voltage Transformer
XLPE	:	Cross Linked Poly Ethylene

Electrical Standards Committee

Convenor: Mr. UA Patro

Members: Mr. BR Bhogal
Ms. S Anand
Mr. Parag Gupta
Mr. AK Chaudhary (Inspection)
Ms. NP Guha (Projects)

CONTENTS

1.0 SCOPE

This specification covers the design, engineering, manufacture, testing, packing and supply of Extra High Voltage Gas Insulated Switchgear (GIS) & Gas insulated Bus duct (GIBD) for working voltages from 66 kV up to and including 400 kV complete with Local Control Cabinet (LCC), Control Relay Panel (CRP) and interconnecting cabling amongst GIS, LCC & CRP.

2.0 CODES AND STANDARDS

2.1 The GIS equipments / components used shall comply with the requirements of latest revision of the following standards and also the other Indian and International Standards as applicable, unless otherwise specified:

IEC 60099 - 4	Metal-oxide surge arresters without gaps for a.c. systems
IEC 60137	Bushings for alternating voltages above 1000 V
IEC 60255	Electrical Relays
IEC 60270	High-voltage test techniques - Partial discharge measurements
IEC 60376	Specification of technical grade sulphur hexafluoride (SF_6) for use in electrical equipment
IEC 60480	Guidelines for the checking and treatment of sulphur hexafluoride (SF_6) taken from electrical equipment and specification for its re-use
IEC 60529	Degrees of protection provided by enclosures (IP Code)
IEC 60694	Common specifications for high-voltage switchgear and controlgear standards
IEC 61243-1	Live working Voltage detectors : Capacitive type to be used for voltages exceeding 1 kV a.c.
IEC 61639	Direct connection between Power Transformers and gas insulated metal enclosed switchgear for rated voltage 72.5 kV and above
IEC 61869-1	Instrument transformers – General requirements
IEC 61869-2	Additional requirements for current transformers
IEC 61869-3	Additional requirements for inductive voltage transformers
IEC 62271-4	Handling procedures for sulphur hexafluoride (SF_6) and its mixtures
IEC 62271-100	Alternating current circuit-breakers
IEC 62271-102	Alternating current disconnectors (isolators) and earthing switches
IEC 62271-104	Alternating current switches for rated voltages of 52 kV and above
IEC 62271-110	High-voltage switchgear and controlgear - Inductive load switching
IEC 62271-203	Gas Insulated metal-enclosed switchgear for rated Voltages above 52 kV
IEC 62271-209	Cable connections for gas-insulated metal-enclosed switchgear for rated voltages above 52kV-Fluid filled and extruded insulation cables-Fluid filled and dry type cable terminations

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

2.3 In case of any contradiction between various referred standard/ specification/ data sheet and statutory regulation, most stringent requirements shall prevail. However, Owner's decision in this regard will be final and binding.

3.0 GENERAL REQUIREMENT

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

3.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least 15 years from the date of supply.

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

4.0 SITE CONDITIONS

4.1 The EHV GIS & GIBD shall be suitable for installation and satisfactory operation in a pressurised substation or in a substation with restricted natural air ventilation in a tropical, humid and corrosive atmosphere.

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

4.3 All equipments are intended for continuous duty operation, as per nameplate rating under the specified ambient conditions, unless indicated otherwise.

5.0 DESIGN AND FABRICATION REQUIREMENTS

5.1 Enclosure and Protection

5.1.1 The switchgear shall be an indoor gas-insulated, metal enclosed design, assembled to form free standing, self supporting dead front structure. The degree of protection shall be at least IP65 for gas compartments and IP4X for low voltage and other compartments as specified in IEC-60529.

5.1.2 The switchgear assembly shall consist of completely separate, SF_6 gas filled pressurized sections housing various switchgear components. The switchgear gas enclosures shall be sectionalised, with gastight barriers between sections / compartments.

5.1.3 Each gas-filled compartment shall be equipped with static filters (e.g. molecular sieve or activated alumina or other absorbent), pressure switches, filling & draining valve with automatic shut off and safety diaphragm. The filters shall be capable of absorbing any water vapour which may penetrate into the enclosures as well as the by-products of SF_6 created during interruption. Each gas compartment shall be fitted with separate non-return valve connectors for evacuating & filling the gas and checking the gas pressure etc.

5.1.4 The enclosures may be three phase enclosure or single phase enclosure as per the standard design of the vendor.

5.1.5 The enclosure for the SF_6 gas and associated circuit elements of enclosure shall be made from non magnetic material e.g. AL/AL alloy. Enclosures of the same phase shall be electrically interconnected, and shall be earthed at appropriate places. At appropriate points single phase enclosures should be connected to other phases, thus ensuring a return current path.

5.1.6 The enclosure shall be designed to practically eliminate the external electromagnetic field and thereby electro-dynamic stresses even under short circuit conditions.

5.1.7 It should be impossible to unwillingly touch live parts of the switchgear or to perform operations that lead to arcing faults without the use of tools or brute force.

5.1.8 All interlocks that prevent potentially dangerous mal-operations shall be constructed such that they cannot be operated easily, i.e. the operator shall use tools or brute force to over-ride them.

5.1.9 The switchgear shall have provision earth bus for connection to the plant earth grid running in the vicinity of the equipment.

5.1.10 The ladders and walkways shall be provided wherever necessary for access to the equipment. A portable ladder with adjustable height shall also be supplied for access to the equipment.

5.1.11 Any paints or other coatings that may be used shall be such that they will not deteriorate when exposed to the SF_6 gas and other vapours, arc products, etc. that may be present in the enclosures. They shall also not contain any substances which could contaminate the enclosed SF_6 gas or affect its insulating properties over a period of time.

5.2 Accessibility & Maintenance

5.2.1 Checking and removal of components shall be possible without disturbing adjacent equipment. All equipments shall be easily accessible. It shall be possible to set all measuring relays and instruments in-situ without de-energising the switchgear. All mounted equipment shall have identification tags of self sticking tapes at the rear also. In addition, identification numbers shall be painted on the panel wall to give a permanent identification mark.

5.2.2 All terminals shall be shrouded with plastic covers to prevent accidental contact.

5.2.3 GIS components shall be installed and arranged to facilitate realistic access for maintenance and removal of equipment, with a minimum amount of disturbance to other equipment.

5.2.4 It shall be generally possible to remove a circuit element (breaker, disconnect switch etc), without removing another element.

5.2.5 For routine inspection and possible repairs, all elements shall be accessible without removing support structures. The removal of individual enclosure parts shall be possible without disturbing adjacent enclosures or entire breaker bays.

5.2.6 All special tools & tackles required for erection & maintenance of GIS & GIBD shall be provided by the vendor.

5.3 Bus Bar

5.3.1 EHV GIS Bus configuration **(Single Bus or Double Bus or One and half breaker scheme)** shall be provided as specified in the data sheets/ Job specification.

5.3.2 Bus bars shall be of high conductivity electrolytic aluminium or copper.

5.3.3 The 3-phase bus bars shall be either housed in single phase enclosures or 3-phase enclosure as per vendor's design. All phase bus bars shall be of uniform cross-section and shall be sized to carry continuously the rated current specified in data sheet.

5.3.4 Bus bars and the supports shall be adequately sized and braced to withstand the specified short-circuit current without any permanent deformation. All bus supports shall be of non-hygroscopic, non-inflammable, non-carbonising material, resistant to acids and alkalies.

5.3.5 Bus bar earthing facilities for each section of the bus bars, completely interlocked with associated disconnectors & CBs of that section of bus bars including bus coupler / bus sectionaliser shall be provided.

5.4 Expansion and Flexible Connection for Enclosure / Conductors

5.4.1 Expansion joints / flexible connections shall be provided in the metal enclosure and conductors to absorb the actual or relative thermal expansion and contraction of the bus bar & equipments as well as structures resulting from variations of temperature of the switchgear equipment.

5.4.2 The number and position of the expansion joints / flexible connections shall be decided by the vendor to ensure that complete installation is not subjected to any expansion stresses which could lead to failure of any piece of the GIS equipment, supporting structures.

5.4.3 The electrical connections for the conductor expansion joints / flexible connections shall be made by means of multiple contact connectors preferably same as that provided at the joints between the separate gas compartments.

5.4.4 Metallic bellows (preferably of stainless steel) shall be provided over expansion joints.

5.5 Cable Termination

5.5.1 All power cables and control cables will be connected from below through cut-outs in the floor or through cable trench. Plug in terminations (including plugs, sockets) and all accessories shall be provided for power cables for all feeders including spare feeders by vendor.

5.5.2 Suitable arrangements of test plug / socket shall be provided which will permit full dielectric testing for outgoing cable of all cable feeders including primary current injection test for current transformers.

5.5.3 Unless otherwise specified, all control cables shall enter from the bottom. Supporting facilities shall be provided for clamping of control cables.

5.5.4 Single compression nickel plated brass cable glands & tinned copper lugs shall be provided by vendor for all cables to GIS assembly, LCC & CRP.

5.6 Pressure Relief Device

5.6.1 Pressure relief devices shall be provided in the each gas sections/ compartment to protect the main gas enclosures from damage or distortion during the occurrence of abnormal pressure increase or shock waves generated by internal electrical fault arcs. Pressure relief shall be achieved either by means of diaphragms or plugs venting directly into the atmosphere in a controlled direction. If the pressure relief devices vent directly into the atmosphere, suitable guards and deflectors shall be provided to prevent pieces of the diaphragm or plug from flying out or any dangerous SF_6 arc product gases escaping, in a manner that could endanger personnel who may be present over there.

5.6.2 Pressure relief shall be provided for all EHV compartments including SF_6 gas & air insulated enclosures. Relief into cable cellar/ trench shall not be provided.

5.6.3 The set points for the pressure relief device shall be lower than pressure withstanding capability of the enclosure with sufficient margin.

5.7 Indication & Verification of Circuit Breaker, Disconnector & Earth Switch Position

5.7.1 Mechanical indicators mounted external to the equipment shall be provided on all circuit breakers, disconnectors and earth-switches, which shall clearly show whether the earth switches/ CBs / disconnectors etc. are open or closed. The indicators shall be mechanically coupled directly to the main contact operating drive rod or linkages and shall be mounted in a position where they are clearly visible from the floor or the platform in the vicinity of the equipment.

5.7.2 Viewing windows shall be provided for all disconnectors and earth switches so that the switch contact positions can be verified by direct visual inspection. Viewing windows shall be of type, whereby the open / close position can be checked without any danger to the eyes even when a flashover occurs at that time. Wherever the inspection windows are not accessible, sight glass endoscope shall be provided.

5.8 Foundation Channels & Supporting Frame Works

5.8.1 The panels shall be suitable for installation on base frame supplied by vendor along with foundation bolts. Amply dimensioned oblong holes shall be provided at the bottom of the panels for their installation on the base frame. The panels shall be suitable for tack welding and bolting directly to the base frame. The panels with base frame shall be suitable for installation on panel supporting frame through tack welding.

5.8.2 All supporting steel structures above grade level for switchgear bays and all panels including SF_6/Air Bushing support, GIDB support, inspection platform etc. shall be provided by vendor.

5.8.3 Details of suitable embedment in the foundation floor as required for supporting the switchgear assembly and panels, necessary supporting framework, levelling screws, inspection platforms etc. to fasten the switchgear base frames to the embedments in foundation floor shall be provided by vendor. Vendor shall provide drawing showing all details of the embedded parts and installation details required on the floor.

5.9 Nameplates

5.9.1 Engraved nameplates shall preferably be of 3-ply (Black-White-Black) lamicoid sheets or anodised aluminium. However back engraved perspex sheet nameplates are also acceptable. Nameplates shall be fastened by screws and not by adhesives. A weather proof and corrosion proof name plate shall be provided and shall conform to applicable standards.

5.9.2 A nameplate with the switchgear designation shall be fixed at the top of the central panel. A separate nameplate giving details of each feeder compartment of all panels shall be provided. Danger plate (Red) shall be provided at the front and rear for each panel.

5.9.3 Blank nameplates shall be provided for all spare feeders.

5.9.4 Each of the equipment devices including CB, Disconnector switch, Earthing switch, CT, VT and busbars etc. mounted inside the switchgear shall be provided with proper nameplate and rating plate. All information as per the latest edition of relevant IEC standards shall be included. Special warning plates shall be provided on removable covers or doors giving access to cable terminals and busbars.

5.9.5 Special warning labels shall be provided inside the switchgear also, wherever considered necessary. Identification tags shall be provided inside the panels matching with those shown on the circuit diagram.

5.10 Painting, Protective Finish / Corrosion Protection of Surfaces

5.10.1 The switchgear shall be treated and protected to withstand continuous operation under site conditions without sustaining corrosion or attacks from fungus or rodents. The protective finish shall prevent deterioration due to corrosion, humidity, temperature, ageing and weather etc. under site conditions.

5.10.2 All metal surfaces shall be thoroughly cleaned & degreased to remove mill scale, rust, grease and dirt. All exterior surfaces shall be cleaned and epoxy painted before leaving the factory with one coat of approved primer and two coats of approved equipment finish paint. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under surface shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc chromate primer. The underside of all surfaces bearing upon the concrete foundation shall be given two coats of approved primer. The under surface shall be made free from all imperfections before undertaking the finishing coat. Panel finish shall be free from imperfections like pinholes, orange peels, runoff paint etc.

5.10.3 The exterior surface finish of switchgear paint shade shall be RAL-7032 unless specified otherwise.

5.10.4 Supporting frame work shall be hot dip galvanised after fabrication.

5.10.5 Gas monitoring and service piping including all fittings and accessories shall be made of copper, brass or stainless steel.

5.10.6 Electrolytic corrosion shall be avoided in joints of different metals. Before the metal enclosed sections are joined together and charged with the SF_6 gas, they shall be thoroughly cleaned.

5.11 Auxiliary Cabling, Wiring and Terminals

5.11.1 Owner interface for remote control, metering, indication, alarm etc. of complete GIS equipment shall be at CRP only. Further external AC & DC control & auxiliary power supplies interface for complete GIS equipment shall be at designated LCC only.

5.11.2 All cables required amongst various components of GIS i.e. circuit breaker, disconnectors, earth switches, CT, PT, LCC, CRP etc. along with the cable glands & lugs shall be provided by the vendor. The cables shall be Cu conductor, FRLS, armoured type. These shall be suitable for directly laying in cable trays/ lined RCC trenches. Maximum distance between GIS/LCC and corresponding CRP shall be considered as 150 meters unless otherwise specified. Exact distances shall be informed during vendor drawing review based on the final locations of GIS/LCC and CRP.

5.11.3 Inside the cubicles, the wiring for control, signalling, protection and instrument circuits shall be done with FRLS type, copper conductor wire. The insulation grade shall be 660V. The wiring shall preferably be enclosed in plastic channels or neatly bunched together. Flexible conduits shall be provided for routing wiring between various compartments.

5.11.4 A minimum of 20% spare terminals shall be provided on each terminal block. Conductors shall be terminated with adequately sized compression-type lugs for connection to equipment terminals and strips. Stranded conductors shall be soldered at the ends before connections are made to the terminals. Sufficient terminals shall be provided on each terminal block to ensure that not more than one outgoing wire is connected per terminal. Terminal strips shall preferably be separated from power circuits by metal barriers or enclosures. All spare contacts of CB, switches, auxiliary relays etc shall be wired up to the terminals.

5.11.5 Each wire shall be identified at both ends by correctly sized ferrules. The CT terminal blocks shall have shorting, isolation and injection test facilities whereas VT terminals shall have isolation and injection test facilities.

5.11.6 Copper conductor of cross section 1.5 mm^2 may normally be used for control fuse rating 10 amps or less. For 16 amps control fuse circuit, 2.5 mm^2 copper conductors shall be used. CT Circuit wiring shall be done with 2.5 mm^2 copper conductors.

5.11.7 All inter-panel control wiring within each shipping section shall be done at vendor works. The inter-panel wiring shall be taken through sleeves or suitable grommets. For inter-panel wiring between the shipping sections, wires in rolls of the required length, connected at one point, shall be supplied with the panel by vendor for connection at site.

5.12 Earthing

5.12.1 Vendor shall provide copper earth bus of GIS and copper earth conductors & associated hardware material for connecting all GIS equipment, earthing switches, surge arrestors, enclosures, cabinets, marshalling boxes, supporting structure, platforms & hand rails, operating handles of disconnector & earth switches etc. to the earth bus of GIS.

5.12.2 The GIS shall be earthed at several points so that there shall be earthed cage around all the live parts. A minimum of two nos. of earthing connections should be provided for each enclosure. The earthing continuity between each enclosure shall be effectively interconnected with Cu bonds of suitable size to bridge the flanges.

5.12.3 LCC, CRP, power and control cable sheaths and other noncurrent carrying metallic structures shall be connected to the earthing grid. At least two earthing paths shall be provided to connect each point to the GIS earth bus.

5.12.4 Minimum earth bus size of 300 mm^2 copper for earthing of GIS equipment shall be provided.

5.12.5 All flexible earthing leads shall be of copper.

5.13 Interlocks

5.13.1 The interlock system shall positively prevent an Operator from reaching or creating unintentionally a dangerous or potentially dangerous condition.

5.13.2 All interlocks required between circuit breakers, disconnectors and earth switches shall be provided.

5.13.3 Specifically the following conditions shall be impossible to reach:

a) Electrically and manually closing or opening of the disconnector / earthing switch while the breaker is closed.

b) Electrical closing of disconnector switch, while the earthing switch at the remote end is closed.

c) Electrical closing of earthing switch while the remote end disconnector/circuit breaker is in closed position.

d) Electrical & manually closing of busbar disconnectors of any circuit while the busbar earthing switch is closed.

5.13.4 When the manual emergency cranks are used, it shall be impossible to control the devices electrically.

5.13.5 Bus VT Miniature Circuit Breaker (MCB) ON auxiliary contacts and under voltage relay contacts shall be monitored in the interlocking scheme to confirm the dead bus condition.

5.13.6 Bus-bar disconnectors of any circuit shall not close electrically or manually while a Bus-bar Earthing Switch is closed.

5.14 Space Heaters

5.14.1 CRP & LCC shall be provided with space heaters to prevent moisture condensation and maintain cubicle temperature 5°C above the ambient. The space heaters shall be controlled through a double pole MCB and thermostat. Space heaters shall be supplied from 240V AC auxiliary supply.

6.0 SWITCHGEAR COMPONENTS

6.1 Circuit Breakers

6.1.1 General

a) The circuit breakers shall be in 3 phase enclosure or single phase enclosure as per vendor standard design. They shall be electrically, mechanically, hydraulically trip free as applicable and anti-pumping with both of the trip circuits connected.

b) Pole discrepancy tripping shall be provided which shall detect discrepancy in opening of contacts. Local electrical operation shall be provided from the local control cabinet. An emergency manual trip device & mechanical operation counter shall be provided in the breaker kiosk. The breaker enclosure shall have provision for easy withdrawal of the interrupter assemblies.

6.1.2 Duty Cycle (Operating Mechanism)

a) Circuit breaker shall be C2 - M2 class as per IEC 62271-100.

b) Circuit breaker shall meet the duty requirements for any type of fault or fault location & also for line charging and dropping as applicable and perform make and break operations as per the stipulated duty cycles satisfactorily.

c) The CB shall be suitable for carrying out the duty cycle of O-3.0 minutes-CO-3.0 minutes – CO.

6.1.3 Pre-Insertion Resistor (if specified in job specification/ datasheet)

The circuit breakers for transmission line bay shall be provided with single step pre insertion closing resistors/Controlled switching devices to limit the switching surges to a value of less than 2.3 p.u. The value of the pre-insertion resistor and the duration of pre-insertion time shall be as designed by vendor.

6.1.4 Construction Features

a) The circuit breakers shall be SF_6 type. The circuit breakers shall be of single pressure type / self blast type and shall utilise puffer cylinder for arc interruption. Each SF6 CB pole shall preferably be with single interrupting chamber. Each SF_6 circuit breaker pole shall be provided with its own self-contained gas system.

b) The service connections for gas handling shall be located on each pole tank to facilitate servicing. The breaker shall be designed to ensure that condensation of moisture is controlled by proper selection of organic insulating materials having low moisture absorbing characteristics, complete drying of container and breaker, selection of 'O' ring, etc.

c) Materials such as activated alumina or molecular sieve shall be provided at appropriate locations as moisture absorbents. Also suitable absorbents for removing SF6 arc products shall be employed.

d) Breakers shall be so designed that when operated within their specified rating, the temperature of each part will be limited to values consistent with a long life for the material used. The temperature rise shall not exceed that indicated in IEC-62271-100 under specified ambient conditions.

6.1.5 Breaker Contacts

a) Main contacts shall be of copper with silver plating and have ample area & contact pressure for carrying the rated current and the short time rated current of the breaker without excessive temperature rise which may cause pitting or welding. Contacts shall have a minimum of movable parts and adjustments to accomplish these results. Main contacts shall be the first to open and the last to close so that there will be little contact burning and wear.

b) Arcing contacts, if provided, shall be the first to close and the last to open and shall be easily accessible for inspection and replacement. Tips of arcing and main contacts shall be silver faced or have tungsten alloy tipping. Provision shall be made for rapid dissipation of heat generated by the arc on opening.

c) If multi-break interrupters are used, they shall be so designed and augmented that a fairly uniform voltage distribution is developed across them.

6.1.6 Operating Mechanism

a) General Requirements

i. Circuit breaker shall be operated by spring charged mechanism or electro hydraulic mechanism or a combination of these.

ii. Main poles shall operate simultaneously. The design of the circuit breaker shall be such that contacts will not close automatically upon loss of gas / hydraulic pressure.

iii. The mechanism shall be such that the failure of any auxiliary spring will not prevent tripping and will not cause trip or closing operation of the power operating devices.

b) Operating Mechanism Control

i. The close and trip circuits shall be designed to permit use of momentary-contact switches and push buttons.

ii. Two (2) independent tripping circuits, valves, pressure switches, and coils shall be provided for each operating mechanism.

iii. For all HV Variable frequency drive feeders, breaker shall be additionally provided with under voltage release. However, in case it is not possible to provide under voltage release in the standard design, as an alternative, one shunt trip coil shall be suitable for DC control supply while second shunt trip coil shall be suitable for external AC control supply. The control supply voltage level shall be as specified in datasheet.

iv. A local manual closing device shall also be provided for maintenance purpose. Direction of motion of handle shall be clearly and indelibly marked.

v. Electrical tripping shall be performed by shunt trip coils. Provisions shall be made for electrical control from LCC & CRP.

vi. The trip coils shall be suitable for trip circuit supervision during both open and close position of breaker.

vii. Breaker tripping, closing and spring charging devices shall be fed with DC control power supply. Closing coil and associated circuits shall operate correctly at all values of control voltage between 85% and 110% of the rated voltage. Shunt trip and associated circuits shall operate correctly under all operating conditions of the circuit breaker upto the rated breaking capacity of the circuit breaker at all values of supply voltage between 70% and 110% of rated voltage.

viii. Pressure switch contacts shall be suitable for direct use as permissive in closing and tripping circuits. Separate contacts shall be used for each of tripping and closing circuits.

ix. The auxiliary switch of the breaker shall be positively driven by the breaker operating rod.

x. The breakers shall have at least 4 normally open (NO) and 4 normally closed (NC) spare auxiliary contacts for Owner's use. If these are not available, auxiliary relays shall be used to multiply the auxiliary contacts of the breakers.

c) Hydraulic Operated Mechanism

i. Hydraulic operated mechanism shall comprise self contained operating unit with power cylinder, control valves, high and low pressure reservoir, pressure gauge, necessary piping, compressor and motor, etc. A hand pump set shall also be provided for emergency operation.

ii. The piping shall be seamless type and of non-corrodible material such as SS or Brass. The joints shall be welded except at the equipment terminal ends.

iii. Oil required for initial filling including make up of usual losses during commissioning and leakages shall be supplied by vendor.

d) Hydraulic Monitoring Device:

i. Hydraulic pressure system shall be monitored as follows:

- "Hydraulic first level": this gives an alarm if, after a predetermined time interval, the hydraulic pressure is not returned to its nominal setting. Pressure switch contact to open for alarm.
- "Hydraulic second level": this will give an alarm indication if the pressure drops below the minimum operable pressure, i.e. mechanism locks out.
- Hydraulic motor Excessive start: alarm to be provided.
- Hydraulic motor: excessive running of motor alarm to be provided.

ii. 'Motor on overload' condition shall be tripped and 'trip' and 'supply failure' conditions shall be annunciated. In the event that non bio-degradable fluids are used, containment trays shall be provided to prevent a spillage.

e) Spring operated Mechanism

i. Spring operated mechanism shall be complete with motor. Opening spring and closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit shall also be provided.

ii. Breaker operation shall be independent of the motor which shall be used solely for compressing the closing spring. Facility for manual charging of the closing spring shall also be provided.

iii. Closing action of circuit breaker shall compress the opening spring ready for tripping.

iv. When closing springs are discharged after closing a breaker, closing springs shall automatically be charged for the next operation and an indication of this shall be provided in the LCC.

v. Provisions shall be made to prevent a closing operation of the breaker when the spring is in the partial charged condition.

vi. A mechanical indicator shall be provided to indicate the status of the spring.

vii. Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of closing springs when the breaker is in closed position.

viii. The spring operating mechanism shall have adequate energy stored in the operating spring to close and latch the circuit breaker against the rated making current and also to provide the required energy for the tripping mechanism in case the tripping energy is derived from the operating mechanism.

6.2 Disconnectors & Earthing Switches

6.2.1 General

a) Disconnectors and Earthing switches shall be of single-pole, group operated type, installed in the switchgear to provide electrical isolation with one motor operated mechanism per three poles. The disconnectors and earth switches shall conform to IEC- 62271-102.

b) The disconnector shall be M1 class operated.

c) High speed make proof earthing switches shall be E1 class operated. Safety earthing switches shall be E0 class operated.

d) Electric motor shall be suitable for DC control supply and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over current and short circuit. The associated circuits shall operate correctly under all values of supply voltage between 85% and 110% of rated voltage.

e) Disconnectors shall be suitable to make and break the charging currents during their opening and closing. The contact shielding shall also be designed to prevent restrikes and high local stresses caused by transient recovery voltages when these currents are interrupted.

6.2.2 Constructional Features

a) The disconnector shall be provided with high current carrying contact surfaces of silver faced copper/silver faced aluminium.

b) Arrangement shall be provided to permit manual operation of the disconnectors & earthing switches. Whenever the manual handle is inserted into the drive mechanism, it shall not be possible to control the device electrically. Manual operating handle shall be provided with pad lock. The contacts shall be both mechanically and electrically disconnected during the manual operation.

c) The disconnectors shall be arranged in such a way that all the three phases operate simultaneously. All the parts of the operating mechanism shall be able to withstand starting torque of the motor mechanism without damage until the motor overload protection operates.

d) The disconnectors and safety earthing switches shall have a mechanical key (pad locking key) and electrical inter-locks to prevent closing of the earthing switches when disconnectors are in the closed position and to prevent closing of the disconnector when the earthing switches are in the closed position.

e) The disconnectors & earth switches shall be capable of being padlocked in both fully open and fully closed positions with the operating motor automatically disengaged. The padlock shall be visible and directly lock the final output shaft of the operating mechanism. Integrally mounted lock instead of pad lock can also be provided.

f) One man shall be able to operate the disconnector/earthing switch (when manually operated) without undue effort.

6.2.3 Operating Mechanism Control

a) Disconnectors and earthing switches shall be motor operated, with limit switches and controlled from the LCC and CRP. Connections, interlocking requirements and auxiliary switches shall be provided as per the requirements.

b) The operating mechanism design shall be such that during the operation of the earth switch (especially manual operation), the moving blades once they reach the sparking distance, springs shall take over to give a quick, snap action closing so that the earth switch closing is independent of manual efforts. Similarly, the springs shall assist during the opening operation to give quick breaking feature.

c) Disconnectors and earthing switch shall be provided with a mechanism with stored energy to always ensure completed operations.

d) The disconnector operations shall be inter-locked electrically with the associated circuit breakers in such a way that the disconnector control is inoperative if the circuit breaker is closed.

e) Each disconnector, earth switch shall have at least 4 normally open (NO) and 4 normally closed (NC) spare auxiliary contacts for Owner's use.

6.2.4 Additional Requirements for Safety Earthing Switches

a) Earthing switch, whenever possible can form an integral part of each pole of the disconnector. Two independent earthing pads each with flexible copper braids and suitable connectors for the specified size of earth conductor lead shall be provided at the hinge end of the earthing switch.

b) Interlocks shall be provided so that manual operation of the earthing switches or insertion of the manual operating device will disable the electrical control circuits.

6.2.5 Additional Requirements for High Speed Make Proof Earthing Switches

a) High speed make proof earthing switch shall have make proof contacts and high speed stored energy operating mechanism to enable them suitable to close on to a fault.

b) High speed earth switches shall be motor driven stored energy operated. After removal of the earth initiated by a fault making earth switch, it shall be possible to re-energize the system without first carrying out the maintenance.

c) The short circuit making current rating of each earthing switch shall be at least equal to its peak withstand current rating as applicable. The switches shall have inductive/ capacitive current switching capacity as per IEC 62271-102.

d) All portions of the earthing switches and operating mechanism required for connection to earth shall be connected together utilizing copper conductor.

e) The main earthing connection on earthing switch shall be rated to carry the peak withstand current rating of the switch for 1 sec. and shall be equipped with a silver plated terminal connector suitable for steel strap of adequate design for connection to the earthing grid.

6.3 Surge Arrestors

6.3.1 The surge arrestors shall confirm in general to IEC 60099-4.

6.3.2 The surge arrester shall be of heavy duty station class and gapless (Metal oxide) type without any series or shunt gaps.

6.3.3 The surge arresters shall be capable of discharging over-voltages occurring during switching, lightning impulse etc.

6.3.4 The surge arresters shall be provided with a discharge counter located at an accessible position.

6.3.5 The nonlinear blocks shall be of inferred metal oxide material. These shall be provided in such a way so as to obtain robust construction, with excellent mechanical and electrical properties even after repeated operations.

6.3.6 The main earthing connection from the surge arrestor to the GIS earth bus shall be provided. The size of the connecting conductor shall be such that all the energy is dissipated to the earth without getting overheated.

6.4 Local Control Cabinet

6.4.1 Local Control Cabinet (LCC) for each bay shall be supplied. LCCs shall be either separate free-standing floor mounted type panel or mounted on GIS assembly as per vendor's standard design. If separate LCCs are provided, these will be located near GIS.

6.4.2 LCC shall be in dust and vermin proof hot dipped galvanised sheet steel construction. Hinged doors giving access to the components shall be provided.

6.4.3 Local control of all CBs, disconnectors & earthing switches shall be possible from LCC through control switches & selector switches with all associated interlocks. LCC panels shall house alarms and facia annunciation etc. of GIS including GIS gas pressure system. The LCC shall also be used for termination of CT and PT cables from GIS bay.

6.4.4 Two (2) numbers of 415V, TPN, 50 Hz, power supply feeders will be provided by Owner at one location in the LCC for complete switchgear. Further power supply distribution for each LCC and to CRP shall be done by vendor.

6.4.5 Two (2) numbers of DC supply feeders will be provided by Owner at one location in the LCC for complete switchgear. Further DC power supply to each LCC and to each CRP shall be done by vendor.

6.4.6 The incoming external control supplies (AC & DC) shall be monitored continuously and alarm shall be given on failure. Vendor shall supply all necessary equipment and control for automatic change over from one source of control supply to the other in the event of failure of one source / contactor drop out.

6.4.7 An isolating switch for disconnection of power supply, open/close push buttons, magnetic contactor with thermal overload relays and HRC link type fuses for short circuit protection shall be provided in LCC for each individual motor of CB, disconnector and earth switch.

6.4.8 **Local Alarm & Annunciation**

a) Alarm contacts shall be provided for monitoring of all vital systems of each circuit breaker and SF_6 gas system.

b) Window type alarm annunciation shall be provided on LCC of each bay for the various abnormal conditions.

c) Potential free electrical contacts shall be provided for remote alarm / indication of all alarm condition. These contacts shall be in addition to those required for local indication. These shall be wired to the terminal blocks in the LCC.

d) The following minimum number of abnormal conditions shall be annunciated.

i. Gas refill level for each gas compartment of the bay. (low gas pressure)

ii. Breaker Block level for each gas compartment of the bay. (low low gas pressure)

iii. Zone isolation level for each gas compartment of the bay.

iv. Over pressure for each gas compartment of the bay.

e) In addition to the minimum abnormal conditions listed above, any other abnormal condition as per the vendor shall also be annunciated.

f) Mimic diagram preferably shall be provided.

6.4.9 All current transformer leads shall be terminated on shorting type terminal blocks in the LCC and shall be accessible at all times. All potential transformer leads shall be terminated and protected by MCB.

6.4.10 All other devices shall be wired to terminal blocks provided in the LCC. The terminal blocks shall have minimum 20% spare terminals per cabinet.

6.5 Control Relay Panels

6.5.1 Separate Control Relay Panel (CRP) for each bay shall be supplied to facilitate control of circuit breakers, disconnectors, earth switches and metering, protection etc.

6.5.2 CRPs shall be free-standing floor mounted type panel to be located in separate room adjacent to GIS hall. CRP shall be in dust and vermin proof hot dipped galvanised sheet steel construction.

6.5.3 A mimic diagram shall be provided on the front of the panel with control switches and position indicators for CB, disconnector and earth switches. The panel shall be dead front type with front door having clear glass cut-out of adequate size so that mimic diagram, annunciator windows, indicating lamps are clearly visible from outside.

6.5.4 CRP shall house bay control units (BCUs) and protection relays. These panels shall also house the various selector switches, auxiliary relays, timers, local indications, alarms and facia annunciation window etc. to realise various interlocks as per requirement among circuit breakers, disconnectors and earth switches and for breaker pole discrepancy, anti-pumping etc. It shall include the following as minimum:

a) Local / off / remote selection switch

b) CNT control switch for breaker

c) Breaker ON, OFF, Trip-1, Trip-2, Trip circuit healthy indications

d) Disconnector & earth switches ON, OFF control switches & indications

e) DC supply healthy indication

f) Spring charging devices status

g) Aux. relays / other devices as required by the design.

6.5.5 Completely separate and isolated circuits shall be used for each operating mechanism control, trip-1, trip-2, close, alarms and auxiliary devices. Close and trip circuits shall be kept isolated to their final mechanical or electrical actuators from the CRP terminals.

6.5.6 Trip circuit-1 & trip circuit-2 shall be individually monitored for continuity under open and closed condition of breaker. Close circuit shall be monitored under open condition of breaker.

6.5.7 The contacts and signals originating from/going to the GIS, associated auxiliary and monitoring equipment shall be wired up to the CRP, for external use.

6.5.8 **Measuring Instruments**

All analogue instruments shall be of square pattern, 96 x 96 mm, flush-mounted type. Measuring instruments, shunts, transducers, CTs, VTs, etc, shall be provided, as specified in data sheet. The accuracy class for all instruments shall be 1.0 unless otherwise specified.
Digital meters shall also be acceptable, provided specific approval of EIL/Owner for make and model is obtained. All digital meters shall be highly reliable, accurate, and compact and self powered. Digital meter data shall be saved in case of power failure. Field programming from front of the meter shall be possible and shall have RS232/485 port in case specified in the job specification/data sheet.

a) Ammeters and Voltmeters

Analogue meters shall be of moving-iron type. The range shall be indicated on the drawings.

b) kW / kWh Meters

The kW / kWh meters shall be suitable to measure unbalanced loads on a 3-phase, 3-wire system. The kW meters shall operate on a VT secondary voltage of 110 V.

c) Frequency Meters

These shall be of direct-reading or digital type and shall operate on a VT secondary voltage of 110V. The standard range shall be 45-50-55 Hz.

d) Power Factor Meters

Power factor meters shall operate on a VT secondary voltage of 110 V. The standard range shall be 0.5 lead-1.0-0.5 lag.

6.5.9 **Relays**

a) Type of relay i.e. electromechanical, static or numerical / bay control unit shall be as defined in datasheet / job specification.

b) All electromechanical protective relays shall be back-connected, of drawout type, suitable for flush mounting, and fitted with dust-tight covers. Alternatively, "plug-in" type relays will also be acceptable. Auxiliary relays are acceptable in fixed execution.

c) The protective relay cases shall have a provision for insertion of a test plug at the front for testing and calibration using an external power supply without disconnecting the permanent

wiring. The insertions of the test plug shall automatically short circuit the CTs and permit extension of external power supply to the relay.

d) All protective relays shall have hand reset facility and clear operating indication, e.g. flags for electro-mechanical type relays or light emitting diodes for static/numerical type relays. It shall be possible to reset the flag without opening the relay case.

e) All tripping relays shall be of lockout type with hand-reset contacts, and shall be suitable to operate on the specified voltage. These relays shall have self coil cut off contacts, and shall be provided with hand-reset operation indicators. Tripping relays will be acceptable in non-drawout cases.

f) The tripping relay shall be suitable for satisfactory operation from 50% to 110% of the specified control supply voltage.

g) Numerical relays /bay control unit shall be equipped with communication port to work as an integrated part of the substation automation system. Multifunctional device (bay control and protection unit) shall be with control, indication, metering, protection, mimic, communication/ interface functions.

6.5.10 **Alarm & Annunciation**

a) Potential free electrical contacts shall be provided for remote alarm / indication of all alarm/trip condition. These contacts shall be in addition to those required for local indication at LCC. These shall be wired to the terminal blocks in the CRP.

b) The following minimum no of abnormal conditions shall be annunciated.

i. Hydraulic motor overload / circuit trouble

ii. Hydraulic first level (low hydraulic pressure)

iii. Hydraulic second level (Low-Low Hydraulic pressure)

iv. Disconnector / earth switch motor overload (one per each bay)

v. Circuit breaker motor overload (one per each bay)

vi. DC control supply failure

vii. Common gas alarm for the bay

c) In addition to the minimum abnormal conditions listed above, any other abnormal condition as per the vendor shall also be annunciated.

6.5.11 Clustered LED type indicating light with minimum 8mm diameter size shall be provided for indications. The LED shall have a low glow voltage protection and shall not glow on voltage leakage.

6.5.12 All other devices shall be wired to terminal blocks provided in the CRP. The terminal blocks shall have no less than 20% spare terminals per panel.

6.6 Current Transformers

6.6.1 The current transformers and accessories shall conform to IEC: 61869-1&2 and other relevant standards.

6.6.2 The short time rating shall be equal to that of the switchgear. The CT ratings shall be as shown in the data sheet. Protective CTs shall have an accuracy class of 5P and an accuracy limit factor greater than 10. CTs for instruments shall have an accuracy class of 1.0 and an accuracy limit factor less than 5.0. For numerical relays having protection and metering functions, dual rated CT

shall be provided suitable for protection class and metering class. Separate CTs shall be provided for Differential and Restricted Earth Fault protection. One leg of CTs shall be earthed.

6.6.3 The current transformers shall be of metal- enclosed and epoxy cast resin type and shall be given tropicalised treatment for satisfactory operation in hot and humid climate. The current transformers shall have effective electromagnetic shields to protect against high frequency transients.

6.6.4 The CT secondary terminals shall be brought outside the EHV enclosures through a bushing of 1.1 kV class and mounted in accessible terminal box. All secondary leads shall be wired to shorting type terminals on the terminal strip in the local control cabinet of each breaker bay. All terminals shall be shrouded with plastic covers to prevent accidental contact.

6.6.5 All CTs shall be star connected. Interposing CT (ICT) shall be provided (if required) for differential protection of transformers having star-delta connection.

6.7 Voltage Transformers

6.7.1 The voltage transformers shall conform to IEC 61869-1&3.

6.7.2 The voltage transformers shall be of inductive type, non-resistant and shall be contained in their own compartment. The voltage transformers shall be effectively shielded against high frequency electromagnetic transients.

6.7.3 Voltage transformer secondary shall be protected by 4 pole MCB for all the windings. The secondary terminals of the VT's shall be terminated to the stud type non-disconnecting terminal blocks in the secondary boxes.

6.7.4 The terminals of the secondary winding shall be brought out of the enclosure through 1.1kV class bushing. Secondary terminals of each phase shall be located in accessible earthed terminal box on the VT enclosure itself. Neutral side of HV winding shall be brought out through a bushing rated for at least 1.1kV class and located in a terminal box.

6.8 Auxiliary equipment

6.8.1 Auxiliary Relays and Contactors

a) Auxiliary relays and contactors shall generally be used for inter-locking and multiplying contacts. Auxiliary contacts shall be capable of carrying the maximum anticipated current.

6.8.2 Control Switches

a) All control switches shall be rotary type, having a cam-operated contact mechanism. Circuit breaker control switches shall be 3-position CNT, spring return to neutral from both Close and Trip positions. They shall have pistol-grip handles.

b) The Local/off/remote switch shall be three positions type, lockable, key free in remote positions only with the following functions:

i. Local position (the breaker, disconnector and earthing switches can only be operated locally by its control switches).

ii. Off position (the breaker, disconnector and earthing switches cannot be operated electrically).

iii. Remote position (the breaker and disconnector can only be operated from Remote).

c) Ammeter selector switches shall have a make-before-break feature on its contacts. The selector switch shall generally have four positions, three positions for reading 3-phase currents and the fourth position for OFF. The voltmeter selector switch shall also have four positions, three positions shall be used to measure phase-to-phase voltages and the fourth position shall be for OFF.

6.9 SF_6 Gas Supply

6.9.1 SF_6 gas shall comply with the requirements of IEC 60376, 60376A & 60376B, at the time of the first charging & shall be suitable in all respects for use in the switchgear under all operating conditions.

6.9.2 SF_6 gas necessary for initial filling (including entire losses, if any, during HV testing, Pre-commissioning / commissioning) and make-up gas for leakages of the complete switchgear shall be supplied by vendor.

6.9.3 The initial gas pressure or density at the time of charging the equipment shall provide a 10% margin above the allowable operating pressure for the plant to be safely operated for a reasonably long period before recharging is necessary.

6.9.4 In addition 10% of total gas requirement shall be supplied in separate cylinders as spare requirement by vendor.

6.10 SF_6 Gas Monitoring Devices and Alarm Circuits

6.10.1 All gas compartments shall have their own independent gas supervision and alarm systems. There shall not be any interconnection between different gas compartments for the purpose of gas monitoring.

6.10.2 Individual temperature compensated gas pressure gauge(s)/ density device(s) shall be provided in each of the gas compartments which will continuously & automatically monitor and indicate the state of gas density as follows:

a) Compartments except circuit breaker

i. 'Gas Refill' level
This will be used to annunciate on the LCC and CRP the need for the gas refilling.

ii. 'Zone Trip' level
This is the minimum level at which the vendor will guarantee the insulation rating of the assembly (i.e. one minute power frequency voltage, BIL specified). At this pressure level it will be annunciated on the LCC/ CRP so that manual tripping of the circuit should be done.

b) Circuit Breaker

i. 'Gas Refill' level
This will be used to annunciate on the LCC and CRP the need for the gas refilling.

ii. 'Breaker Block' level
This is the minimum gas density at which the vendor will guarantee the rated fault interrupting capability of the breaker. Beyond this level the device contacts lock out the breaker (trip and close operation) circuits and annunciate the condition on the LCC and CRP.

c) High pressure interlock and monitoring device shall be provided.

d) Necessary contacts for remote annunciation shall be provided.

6.10.3 Vendor shall provide an independent pressure switch for isolation of the particular zone. This alarm level shall be provided to indicate abnormal pressure rise in the gas compartment.

6.10.4 Pressure switches and pressure gauges / density devices shall be located at accessible location suitable for viewing.

6.10.5 It shall be possible to test all gas monitoring devices without de-energising the primary equipment and without reducing pressure in the main section.

6.10.6 **Gas Leakage Loss**

a) Maximum guaranteed gas leakage loss of the switchgear shall be in no case be more than **0.5% per year over the life time of the switchgear**. Initial filling of equipment shall guarantee gas service period of not less than 10 years.

b) All gas seals shall be designed to ensure that leakage rates are kept to an absolute minimum under all normal pressure, temperature, electrical load and fault conditions. All gas seals located in the flanges of the equipment enclosures shall be of the O -ring type.

6.11 SF_6 Gas Handling Plant / Service Cart

6.11.1 Portable SF_6 gas handling & processing unit suitable for evacuating, liquefying, evaporating, filling, drying and purifying SF_6 gas during the initial installation, subsequent maintenance and future extension of GIS shall be provided. The cart shall be equipped with rubber wheels and shall be easily manoeuvrable within the building.

6.11.2 The unit shall be self-contained suitable for 415 V AC, 3-phase, 50 Hz power supply and fully equipped with an electric vacuum pump, gas compressor, gas drier, gas filter, refrigeration unit, evaporator, gas storage tank, full instrumentation for measuring vacuum, compressor inlet temperature, tank pressure and temperature, valving and piping to perform the following operations as a minimum requirement:

- Evacuation from a gas filled compartment using the vacuum pump,
- Transfer of SF_6 gas from a system at some positive or negative pressure to the storage tank via the gas drier and filter;
- Recirculation of SF_6 gas in the storage tank through the drier,
- Recirculation of SF_6 gas in any Switchgear or bus duct compartment through the drier and filter;
- Evaporating and filling SF_6 gas,
- Drawing off and liquefying SF_6 gas,
- A combination operation of filling SF_6 gas into a gas system and evacuating a second, gas system using the vacuum pump.

6.11.3 The unit shall be complete with all necessary instrumentation and control which may include instruments such as decomposition tester, hygrometer, test unit for the density monitors, precision pressure / density gauge and vacuum gauge.

6.11.4 The unit shall include necessary gas cylinders for replenishment and for temporary storage of the evacuated SF_6 gas. The capacity of the storage facilities shall at least be sufficient for storing the

maximum quantity of gas that could be removed from the largest compartment of GIS + 10% extra SF_6 gas when carrying out maintenance or repair work on the switchgear and associated equipment.

6.11.5 Adequate length of hoses shall be provided for filling of SF_6 gas in any of the gas compartment with the help of gas cart.

6.12 Insulators & Gas Seals

6.12.1 The support insulators and section barriers/ insulators shall be of solid moulded composite epoxy resin. They shall be free from all voids and with smooth surface and the design shall be such so as to reduce the electrical stresses in the insulators to a minimum.

6.12.2 Gas section barriers including seals to the conductor and enclosure wall shall be gas-tight and shall be capable of withstanding the maximum differential pressure that could occur across the barrier, i.e. with a vacuum drawn on one side of the barrier and on the other side, at least twice the rated gas service pressure that can exist under normal operating and maintenance conditions or the maximum gas over-pressure, equal to the operating pressure of the relief devices, that could be attained with internal arc fault.

6.12.3 All gas seals shall be designed to ensure that leakage rates are kept to specified minimum under all pressure, temperature, electrical load and fault conditions. Double gas seals with provision to monitor the failure of first seal shall be preferred to single gas seal leakage.

6.13 Voltage Detectors

Each outgoing & incoming bays and main busbars shall include capacitive type voltage detectors for each phase to indicate phases "ALIVE". The unit shall also be suitable for interlocking of earthing switches (voltage free condition).

6.14 Outdoor SF_6 – Air Bushings

6.14.1 Outdoor SF_6 – Air bushings, for the connection of conventional external conductors to the GIS shall generally be in accordance with the requirements of IEC 60137 as applicable.

6.14.2 Bushing type shall be any of the following:

a) Condenser type bushings, liquid filled with liquid level gauges clearly visible from ground level, preferably of the direct reading prismatic type or the magnetic type. Other types of liquid level gauges will be accepted if specifically approved.

b) The bushings with composite insulators (Silicone rubber) or with porcelain insulators with all surfaces free from imperfections. The internal insulation of the bushings shall be resin impregnated paper winding (RIP body) or compressed SF_6 gas. The internal and external electrical field of the bushings shall be controlled by a capacitive grading body /grading shields. The RIP body shall consist of resin impregnated paper insulation with concentric aluminium layers. The space between the RIP body and the insulator shall be filled with insulating foam compound or compressed SF_6 gas. Air bushings shall comply with the relevant IEC standards.

6.14.3 Bushings shall be designed to have ample mechanical strength and rigidity for the conditions under which they will be used. Outdoor bushings shall be capable of withstanding a cantilever force applied to the terminal.

6.14.4 All current carrying parts shall be of Copper. Hardware used for current carrying parts (such as nuts, bolts etc.) shall be 304 Grade or brass. All current carrying contact surfaces shall be silver faced.

6.14.5 The flange shall be made of weather resistant, corrosion proof material. Suitable arrangement for connection of flange to earth shall be provided. If required, corona ring shall be provided which will be of Copper / Brass.

6.14.6 Porcelain shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture. Glazing of the porcelain shall be of uniform brown colour free from blisters, burns and similar other defects.

6.14.7 The parameters characterising the SF_6- Air bushing profile shall be such that it is suitable for "Very heavy" pollution level (salt contamination) prevailing at the site and also suitable for fixed type hot line washing. The creepage distance over the external surface of outdoor bushings shall not be less than 31 mm/kV.

6.14.8 Puncture strength of bushings shall be greater than the dry flash-over value. When operating at normal rated voltage, there shall be no electric discharge between the conductors and bushing which would cause corrosion / errosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action.

6.14.9 All joints shall be air-tight. Surface of the joints shall be trued-up; porcelain parts by grinding and metal parts by machining. Bushing design shall be so as to ensure uniform compressive pressure on the joints.

6.15 Gas Insulated Bus Duct

6.15.1 The Gas insulated bus duct shall be 3 phase enclosure or single phase enclosure as per vendor standard design comprising of straight lengths, bends, elbows, gas seals and accessories such as flanges, gaskets, fixing hardware etc.

6.15.2 Bus bars shall be of high conductivity electrolytic aluminium or copper.

6.15.3 The enclosure for the bus duct shall be made from non-magnetic material e.g., AL/AL Alloy.

6.15.4 The busduct shall be capable to withstand the mechanical and thermal stresses due to short circuit currents, as well as thermal expansion and contraction created by temperature cycling.

6.15.5 The busduct shall be suitable for outdoor installation.

6.15.6 The bus duct shall not be supported from the wall when crossing from indoor to outdoor. Necessary accessories supports etc. including wall frame assemblies shall form part of supply. Necessary bellows with sealing arrangements shall be provided.

7.0 INSPECTION, TESTING AND ACCEPTANCE

7.1 General

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

7.1.2 All the equipments should have been successfully type tested as per the relevant standards. Type tests shall not have been conducted earlier than five years. In case the type tests were conducted earlier than 5 years, such type tests shall be carried out by the vendor free of cost before commencement of supply.

7.1.3 Test certificates of bought out components shall be shown to the inspection agency on demand during inspection.

7.2 Type Tests

Type test should have been carried out as per relevant IEC standards at a recognized and well-reputed test laboratory. The following type test certificates shall be available for verification as evidence of successful completion of type tests.

a) Test to verify the insulation level of the equipment including partial discharge test and dielectric tests viz (i) Lightning impulse test (ii) Switching impulse test iii) One min, p.f. test (iv) Partial discharge test.
b) Test to prove the temperature rise of any part of the equipment and measurement of the resistance of the main circuit.
c) Test to prove the ability of the main and the earthing circuits to carry the rated peak and the rated short time withstand current.
d) Test to verify the making and breaking capacity of circuit breaker.
e) Test to prove the satisfactory operation of switching devices i.e., circuit breaker, disconnector, earth switch.
f) Tests to prove the strength of enclosures.
g) Test for degree of protection of the enclosure.
h) Tests to assess the effects of arcing due to an internal fault (internal arc test).
i) Gas tightness tests.
j) Type tests on Circuit breakers, disconnectors, earth switches, surge arrestors, CT, PT etc as per the relevant standards.

7.3 Routine Tests

Switchgears and their components including LCC & CRP shall be subjected to routine tests as per the relevant IEC standards not limited to the following in the presence of EIL/Owner's representatives. Testing of GIS with LCC shall be done at vendor's works.

a) Power frequency voltage test
b) Partial discharge measurement tests.
c) Voltage test on auxiliary and control circuits
d) Test to verify the resistance of the Main Circuit
e) Enclosure pressure test on each gas compartment.
f) Insulation resistance test with 2 kV on all auxiliary circuits.
g) Complete mechanical operation tests.
h) Complete test of inter locking devices.
i) Check of wiring
j) Functional tests of all auxiliary devices including all protective relays, alarm, control and trip circuits.
k) Visual and dimensional checks.
l) Gas tightness test

m) Pressure test on partitions

n) Acceptance test on SF_6 gas

o) Any other tests as per vendor's recommendation.

8.0 PACKING AND DESPATCH

8.1 The equipment shall be carefully packed for transport by sea, rail and road in such a manner that it is protected against the climatic conditions and for any damage during transportation, transit and storage.

8.2 The SF_6 equipment shall be shipped in the largest factory assembled units within transport and loading limitations and considering handling facilities on site to reduce the erection and installation work on site to a minimum. Where possible all items of equipment or factory assembled units shall be boxed in substantial crates or containers to facilitate handling in a safe and secure manner.

8.3 Each individual piece to be shipped, whether crate, container or large unit, shall be marked special notations such as 'Fragile', 'This side up', 'Center of gravity', 'Weight', 'Owner's particulars', 'PO no.' etc., and other details as per purchase order.

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

8.5 Special precautions shall be taken to protect any parts containing electrical insulation against the ingress of moisture. This applies particularly to the equipment of which each gas section shall be sealed and pressurized prior to shipping. Either dry nitrogen/air or dry SF_6 gas shall be used and the pressure shall be such as to ensure that, allowing for reasonable leakage, it will always be greater than the atmospheric pressure for all variations in ambient temperature and the atmospheric pressure encountered during shipment to site and calculating the pressure to which the sections shall be filled to ensure positive pressure at all times during shipment.

8.6 All blanking plates, caps, seals, etc., necessary for sealing the gas sections during shipment to site shall be provided. Any seals, gaskets, 'O' rings, etc. that will be used as part of the arrangement for sealing off gas sections for shipment of site, shall not be used in the final installation of the equipment at site. Vendor to provide quantity of components accordingly considering permanent installation.

Project Project Management Consultancy (PMC) Services for execution of VRMP **Client** HPCL

Unit CAPTIVE POWER PLANT (CPP) **Location** VIZAG **Job No.** B016 **Unit No.** 606

PURCHASER'S DATA

Site Conditions		
Maximum Ambient Temperature	°C	45
Minimum Ambient Temperature	°C	12.5
Design Ambient Temperature	°C	45
Relative Humidity	%	95
Altitude Above MSL	m	< 5.56
Environment		Humid & highly corrosive
Operating Conditions		
System Voltage		
Frequency		50 Hz ± 3 %
Number of Phases		Three
System Fault Level	kA(for 1 sec)	40
System Earthing		Solidly Earthed
Auxilliary Power Suppy		
- for space heaters,cubicle lamps etc		240 V AC TPN 10 %
- for protection metering and control		110 V DC- 15/+ 10 %
- circuit breaker spring charging motor		110 V DC- 15/+ 10 %
- Motor drive for disconnectors and earth switches		110 V DC- 15/+ 10 %
- gas handling and filling unit / cart		415 V AC TPN ± 10%
Installation		
GIS		Airconditioned
LCC		Airconditioned
CRP		Airconditioned
Electrical Data		
Bus Bar System		Single
Bus bar rated current	A	
1 sec short circuit withstand capacity	kA	40
Rated peak withstand current	kA	
Internal arc rating		
Circuit Breaker		
Type of circuit breaker		SF6
Duty cycle of Circuit Breaker		O-3 min-CO-3 min-CO
Breaking capacity	kA	
Making capacity	kA	
CB Operating Mechanism		
Shunt trip coil-1	V DC	110V DC
Shunt trip coil -2	V DC	110V DC
Mechanical indicator for breaker status		Required
Pre-insertion resistor		Not Required
Dissconnector & Earthing Switch		
Operating Machanism		Motorised
Mechanical indicator for disconnector & earthswitch status		Required
Viewing windows for disconnector and earthswitch		Required
Mechanical interlock for disconnector & earthswitch		Required
Electrical interlock with associated circuit breaker		Required
High speed make-proof Earthing switch		

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Project Project Management Consultancy (PMC) Services for execution of VRMP **Client** HPCL

Unit CAPTIVE POWER PLANT (CPP) **Location** VIZAG **Job No.** B016 **Unit No.** 606

	Operating Machanism		Motorised
	Mechanical indicator for High speed earthswitch status		Required
	Electrical interlock with associated circuit breaker		Required
	Miscellaneous		
	Paint Shade		Epoxy and shade RAL 7032
	Interface with ECS		Required
	SF6 Gas monitoring system		Required
	SF6 Gas Handling /filling unit		Required
	Spare SF6 gas		Required
	Quantity of spare gas	%	10
	Mimic on LV compartment		Required
	Voltage Detectors		Required

MANUFACTURER'S DATA

	General		
	Name of manufacture		
	Place of manufacture		
	Type designation		
	LCC		
	Degree of protection		
	Gas compartment		
	LCC		
	CRP		
	Enclosure		
	Enclosure material		
	Gas compartment		
	LCC		
	CRP		
	Rated Voltage	kV	
	1 min. power frequency withstand (rms)	kV	
	Lighting impulse withstand voltage	kV	
	Switching impulse withstand voltage		
	Rated current		
	Busbar	A	
	Incomers and outgoing feeders	A	
	1 sec short ckt. withstand capacity	kA	
	Peak dynamic withstand capacity	kA	
	Bus bar material		
	Main Busbar size		
	Bus bar size for incomers and outgoing feeders	sqmm	
	Insulating material (busbar support)		
	Eath busbar material / size	sqmm	
	SF6 Gas		
	Average leakage rate of SF6 gas	% / year	
	Gas monitoring devices (density guages/pressure switch		
	Gas handling and filling arrangement /cart		
	- maximum power requirement	kW	
	Whether GIS are dispatched filled with SF6 gas		

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Project Project Management Consultancy (PMC) Services for execution of VRMP **Client** HPCL

Unit CAPTIVE POWER PLANT (CPP) **Location** VIZAG **Job No.** B016 **Unit No.** 606

SF6 gas pressure for each gas compartment		
Design Pressure		
Operating Pressure		
Alarm Pressure		
Lockout Pressure		
Pressure of relief device		
Spare gas (no. of cylinders,volume/pressure of cylinder)		
Circuit Breaker		
Type of circuit breaker		SF6
Make		
Place of manufacture		
Type designation		
Encloser		
Number of poles per phase		
Number of interrupting chambers per pole		
Number of trip coils		
Rated continuous current for I/C and O/G fdrs		
Duty cycle		
CB Operating mechanism		
Short circuit withstand capacity	kA	
Breaking capacity	kA	
Peak making capacity	kA	
% DC component		
First pole to clear factor		
Power required for opening	W	
Power required for closing	W	
Power required for spring charging motor	W	
Closing time	sec	
Opening time	sec	
Provision of manual spring charging		
Manual trip device		
Mechanical ON/OFF indicator for breaker		
Mechanical indication for spring status		
Operation counter		
Number of auxiliary contacts and their rating		
Breaker is trip free		
Disconnector / Earthing switch		
Make		
Place of manufacture		
Type designation		
Rated continuous current of dissconnector/earth switch for I/C and O/G fdr		
Short circuit withstand capacity		
Short circuit making capacity of high speed earth switch		
Operating mechanism		
Type of motor drive		

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Project Project Management Consultancy (PMC) Services for execution of VRMP **Client** HPCL

Unit CAPTIVE POWER PLANT (CPP) **Location** VIZAG **Job No.** B016 **Unit No.** 606

Number of auxiliary contacts and their rating		
Mechanical ON/OFF indicator		
Manual operation handle		
Manual spring charging		
Power required for spring charging motor		
Instrument Transformers		
Current Transformer		
Make		
Place of manufacture		
Type designation		
CT ratio,accuracy & VA burden		
Knee point voltage / secondary voltage,accuracy & VA burden		
Voltage Transformer		
Make		
Place of manufacture		
Type designation		
Primary Voltage / Secondary Voltage ,accuracy & VA burden		
Surge Arrestors		
Make		
Type designation		
Place of manufacture		
Rated Voltage	kV	
MCOV(Max. Continuous voltage, accuracy & VA burden	kV	
Line discharge class	kA	
Nominal discharge current	kA	
High current withstand capacity	kA	
Temporary overvoltage for 1 sec		
Temporary overvoltage for 10 sec		
Mechanical		
Feeder / Bay		
Max. overall weight		
overall Dimensions(Width X Depth X Height)		
LCC		
overall Dimensions(Width X Depth X Height)		
CRP		
overall Dimensions(Width X Depth X Height)		
Largest shipping section		
Max overall weight		
overall Dimensions(Width X Depth X Height)		
Gas handling & filling plant / service cart		
Overall dimensions(Width X Depth X Height)		
Recommended clearances		
GIS (Front / rear / above)	mm	
LCC (Front / rear / above)	mm	
CRP (Front / rear / above)	mm	

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Project	Project Management Consultancy (PMC) Services for execution of VRMP			**Client**	HPCL
Unit	CAPTIVE POWER PLANT (CPP)	**Location**	VIZAG	**Job No.**	B016 **Unit No.** 606

Shock loading on foundation	
Requirement of EOT crane for GIS	
Capacity of EOT crane required	
Clear height recommended for EOT crane	
Dispatch for each feeder / bay	
Copies of following test certificates enclo	
For each type of offered feeder/bay with circuit breaker, dissconnector and earthswitch	
Short circuit tests(peak and 1 sec withstand)	
Making and breaking tests	
Temperature rise test	
Internal arc test	
Dielectric tests	
Operation and mechanical endurance tests	

Notes

1 Offered switchboard shall be of type tested design and type test certificate of identical design shall be furnished alongwith the bid. In case any of the above tests have not been conducted on the offered design of switchboards or there has been a change in the design after the type tests the requisite tests shall be conducted by the successful bidder on the offered design of switchboards after order finalization without any extra cost and delivery impact.

2 Complete plugs/socket for cable termination shall be part of GIS

3 The degree of protection shall be at least IP65 for gas compartments and IP4X for the supporting frames, low voltage and other compartments.

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Project Project Management Consultancy (PMC) Services for execution of VRMP **Client** M/s HPCL

Unit CPP PACKAGE **Location** Vizag **Job No.** B016 **Unit No.** 606

PURCHASER'S DATA

Site Conditions			
Maximum Ambient Temperature	°C	45
Minimum Ambient Temperature	°C	12.5
Design Ambient Temperature	°C	45
Relative Humidity	%	95
Altitude Above MSL	mm	Less than 5.56
Environment		Humid Highly corrosive
Operating Conditions		
System Voltage		33 kV ± 10 %
Frequency		50 Hz ± 3 %
Number of Phases		Three
System Fault Level	kA(for 1 sec)	40
System Earthing		Solidly Earthed
Auxilliary Power Suppy		
- for space heaters,cubicle lamps etc		240 V AC SPN ± 10
- for protection metering and control		110 V DC - 15/+ 10 %
- circuit breaker spring charging motor		110 V DC - 15/+ 10 %
- Motor drive for disconnectors and earth switches		110 V DC - 15/+ 10 %
- gas handling and filling unit / cart		415 V AC TPN ± 10
Installation		Airconditioned
Electrical Data		
Bus Bar System		Single
Bus bar rated current	A	2500 (min)
1 sec short circuit withstand capacity	kA	Other
Rated peak withstand current	kA	100
Internal arc rating		
Circuit Breaker		
Type of circuit breaker		VCB
Duty cycle of Circuit Breaker		0-3 min-co-3 min-co
Breaking capacity	kA	40
Making capacity	kA	100
CB Operating Mechanism		Stored energy (type Motorized)
Shunt trip coil-1	V DC	110
Shunt trip coil -2 (see note-1)	V DC	110
Mechanical indicator for breaker status		Required
Dissconnector & Earthing Switch		
Operating Machanism		Motorised
Mechanical indicator for disconnector & earthswitch status		Required
Mechanical interlock for disconnector & earthswitch		Required
Electrical interlock with associated circuit breaker		Required
Miscellaneous		
Interface with ECS		Required
Paint Shade		Epoxy & RAL 7032
Cable Entry		Bottom
Gland Plate		Non-Magnetic
SF6 Gas monitoring system		Required
SF6 Gas Handling /filling unit		Required

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Section 2:
Equipment Specification under scope of supplies

Section 2B:
Specific technical requirements for CRP & its Accessories

The Break-up for section is as follows,

1. Specification for Control & Relay Panels
2. Datasheet for Control & Relay Panels
2. Specification for Numerical Relays & Station Automation System
3. Datasheet for Numerical Relays
4. Specification for Electrical Control System
   (For reference and compliance to ECS/RTU interface requirement)
5. Typical ECS I/O List for Different Type of Feeders ECS System
6. Scope Division for ECS Interface
7. System Architecture-SAS
8. Overall Single Line Diagram
9. 33kV GIS Single Line Diagram
10. 415V PMCC & 415V EPMCC Single Line Diagram

Section - 2B

रिले तथा कन्ट्रोल पैनलों के लिए विनिर्देश

SPECIFICATION FOR RELAY & CONTROL PANELS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	31.05.16	REVISED & ISSUED AS STANDARD SPECIFICATION	RAHUL	PG	BRB	RN
4	07.04.11	REVISED & ISSUED AS STANDARD SPECIFICATION	RKS	SA	UAP/JMS	DM
3	21.04.06	REVISED & ISSUED AS STANDARD SPECIFICATION	AK	NS	JMS	VJN
2	27.11.02	REVISED & ISSUED AS STANDARD SPECIFICATION.	AK	RPG/AAN	VPS	GRR
1	22.04.97	REVISED & ISSUED AS STANDARD SPECIFICATION.	AK/AAN	VPS	SG	AS

Abbreviations:

AC	Alternating Current
AVR	Automatic Voltage Regulator
BIS	Bureau of Indian Standards
BS	British Standards
CEA	Central Electricity Authority
CRCA	Cold Rolled Cold Annealed
CT	Current Transformer
DC	Direct Current
EIL	Engineers India Limited
EPDM	Ethylene Propylene Diene Monomer
FRLS	Flame Retardant Low Smoke
HDPE	High Density Poly Ethylene
HRC	High Rupture Capacity
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IP	Ingress Protection
IS	Indian Standards
ISA	Instrument Society of America
LED	Light Emitting Diode
MCB	Miniature Circuit Breaker
MSL	Mean Sea Level
NEMA	National Electrical Manufacturers Association
PCB	Printed Circuit Board
PF	Power Factor
PVC	Poly Vinyl Chloride
SWG	Standard Wire Gauge
VDE	Verband Der Electrotechnik, Elecktronik und Information Stechnik
VT	Voltage Transformer

Electrical Standards Committee

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CONTENTS

1.0 SCOPE

The scope of this specification is to define the requirements of design, engineering, manufacture, testing, packing and supply of relay and control panels.

2.0 CODES AND STANDARDS

2.1 The equipment shall comply with the requirements of latest revision of following standards issued by BIS & IEC, unless otherwise specified.

IS: 5	:	Colours for Ready Mixed Paints & Enamels.
IS: 694	:	PVC Insulated Cables for Working Voltages upto & including 1100V
IS: 1248	:	Direct Acting Electrical Indicating Instruments.
IS: 2419	:	Dimensions for Panel Mounted Indicating and Recording Electrical Instruments.
IS: 2705	:	Current Transformers.
IS: 3156	:	Voltage Transformers.
IS: 3231	:	Electrical Relays for Power System Protection.
IS: 3842	:	Application Guide for Electrical Relays for AC Systems.
IS: 4794	:	Push Button Switches: General Requirements and Tests.
IS: 5578	:	Marking of Insulated Conductors.
IS: 5786	:	Fixed resistors, general purpose low power.
IS: 5834	:	Electrical Timer Relays for Industrial Purposes.
IS: 6236	:	Direct Recording Electrical Measuring Instruments.
IS: 6553	:	Environmental Requirements for Semiconductor Devices and Integrated Circuits.
IS: 8530	:	Maximum Demand Indicators.
IS: 8686	:	Static Protective Relays.
IS: 9124	:	Guide for Maintenance and Field Testing of Electrical Relays.
IS: 9347	:	Charts for Recording Instruments.
IS: 11353	:	Uniform System of Marking and Identification of Conductors and Apparatus Terminals.
IS: 11954	:	Guide for Colour Coding of Electrical Mimic Diagrams.
IS: 12021	:	Specifications for Control Transformers for Switchgear and Control gear for Voltages not exceeding 1000V AC.
IS: 12083	:	Electrical Relays.
IS: 13010	:	AC Watt-hour Meters, Class 0.5,1 and 2
IS: 13703	:	Low Voltage Fuses.
IS: 13779	:	AC Static Watt-hour Meters, Class 1 and 2
IS: 14372	:	Volt-Ampere-Hour Meters for Full Power Factor Range.
IS: 14415	:	Volt-Ampere-Hour Meters for Restricted Power Factor Range.
IS: 14901	:	Semiconductor Devices: Discrete Devices & Integrated Circuits.
IS/IEC: 60529	:	Degrees of Protection Provided by Enclosures (IP Code).
IS/IEC: 60947	:	LV Switchgear and Control gear.
IEC: 60255	:	Measuring relays and protection equipment.
IEC: 60688	:	Electrical measuring transducers for converting AC and DC electrical quantities to analogue or digital signals.

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

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

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

2.5 In case of any conflict between various referred standards/specifications/data sheets and statutory regulations, the most stringent requirement shall govern and the decision of Owner/EIL in this regard shall be final and binding.

3.0 SITE CONDITIONS

The relay & control panels shall be suitable for installation in a closed room with restricted natural air ventilation in tropical, humid and corrosive atmosphere. The equipment shall be designed to operate under site conditions as specified in the data sheet. If not specifically indicated, design ambient temperature of 40^0 C and altitude not exceeding 1000m above MSL shall be considered.

4.0 GENERAL REQUIREMENTS

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

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

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

5.0 TECHNICAL REQUIREMENTS

5.1 Constructional Features

5.1.1 The panels shall be Simplex, Duplex, Control Desk or Console type as specified in data sheet.

5.1.2 The panels shall be sheet steel enclosed, dust and vermin proof having minimum degree of protection as IP-41. The panels shall be floor mounting, free standing type mounted on a supporting structure so as to form a rigid enclosure suitable for the application. The frames shall be fabricated by using minimum 2mm thick CRCA sheet steel while the doors and covers shall be made from 1.6 mm thick CRCA sheet steel. Wherever, required suitable stiffeners shall be provided. All openings, covers and doors shall be provided with gaskets of Neoprene/HDPE/EPDM or equivalent around the perimeter to make the panel dust and vermin proof. Hinged doors shall be complete with door handles, lock and latching facility. Ventilating covers, if provided shall have screens and filters.

5.1.3 The panels shall be provided with integral base frame, suitable for tack welding to floor embedded insert plate/flat/channel.

5.1.4 The height of control panels shall not exceed 2400 mm. In case more than one panel is used, all the panels shall be arranged to form a continuous line up of uniform height and depth.

5.1.5 The bottom of all panels shall have a 100 mm kick plate all around.

5.1.6 Cable entry shall be from bottom unless specified otherwise. A suitable removable undrilled gland plate shall be provided for cable entry.

5.1.7 Suitable hooks shall be provided for lifting the panels.

5.2 Types of Panels

5.2.1 **Simplex Panel**

Simplex type panels shall be with equipment mounted on the vertical front and access door to wiring from rear.

5.2.2 **Duplex Panel**

Duplex panel shall consist of a front and a rear panel connected back to back with a 750 mm (minimum) walk way in central corridor. There shall be complete access through the corridor to terminal blocks, internal wiring and components mounted on the panel. Separate cable entries shall be provided for front and rear panels. Interconnection between front and rear panels shall be by interpanel wiring (through the corridor) at the top, inside the panel. Adequately sized hinged type access doors shall be provided at both ends of panel line up.

5.2.3 **Control Desk**

Control desk shall consist of an enclosure having inclined horizontal surface. The horizontal surface shall have a minimum height of 800 mm. The layout shall be such that various control devices are within convenient reach of the operator. All necessary switches, push buttons and indicating lamps etc. shall be mounted on the horizontal inclined surface. Control desk shall have a removable front cover and rear hinged door.

5.2.4 **Control Desk Console**

Control desk console shall have one horizontal inclined surface and one vertical inclined surface. The horizontal inclined surface shall have a minimum height of 800 mm. The height of vertical surface shall be limited to 1500 mm. Control switches, push buttons and indicating lamps etc. shall be mounted on horizontal face and all instruments shall be on vertical face, all within the full view of the operator. The Control desk Console shall have a removable front door and rear hinged door.

5.3 Mounting of Components

5.3.1 All controls, indications, meters, annunciations, mimic diagram, protective relays having flags/operations indicators and lock out relays requiring hand reset shall be mounted on panel front without overcrowding & cramping. The auxiliary relays can be mounted inside. In case of duplex panels, controls, indications, meters, annunciations and mimic diagram shall be mounted on the front panel and the relays shall be mounted on the rear panel.

All equipment mounted on front/rear panels shall be flush mounting type. All meters/components shall be suitable for vertical/horizontal mounting position in which they are to be installed. Test blocks for devices as required shall be provided.

5.3.2 The centre line of switches, push buttons etc. shall be not less than 750 mm & shall not be more than 1800 mm from the bottom of the panel. Centre line of relays, meters, recorders etc. shall be not less than 450 mm from the panel bottom. Alarm facia shall be located at a minimum height of 900 mm from panel bottom.

The centre line of switches, push buttons & indicating lamps shall be matched to give a neat & uniform appearance. Likewise the top of all meters, relays & recorders etc. shall be in one line.

5.3.3 Provisions for cut-outs and their wiring for items to be supplied by Purchaser shall be as per respective manufacturer's drawings. Cut-outs for equipments that are to be mounted in future shall be blanked.

5.3.4 Checking, removal & replacement of individual components shall be possible without disturbing the adjacent equipment. It shall be possible to test all the protective relays 'in-situ'. The internally mounted components, auxiliary equipment such as transducers, interposing CTs etc. shall be mounted in such a way as to be readily accessible, without impeding the access to internal wiring and other components.

5.4 Wiring & Terminals

5.4.1 All wiring inside the panel shall be done with adequately sized, BIS approved, PVC insulated, FRLS type, 660V grade, single-core, stranded, annealed copper conductor wires. For CT circuits the cross section of the wires shall be 2.5-mm^2 minimum.

5.4.2 Each wire shall be identified at both ends with wire numbers by means of PVC ferrules.

5.4.3 All external connections shall be through terminal block. The terminal blocks shall be mounted minimum 300 mm above the gland plate. Each wire shall be terminated at a separate terminal. Shorting links shall be provided for all CT terminals and wherever necessary.

5.4.4 All spare contacts of relays, timers, etc shall be wired up to the terminal block.

5.4.5 Terminal block shall be moulded piece made of non-inflammable plastic and complete with insulating barriers, stud type terminals, washers, nuts, lock nuts, inserts etc. Marking on the terminal strip shall correspond to wire number and terminal numbers on the wiring diagram. Minimum 20 % spare terminals shall be provided in each terminal block.

5.4.6 Clamp type terminals suitable for termination of crimped type lugs shall be provided for all control cable connections. Suitable power terminals shall be provided for incoming power cables.

5.4.7 All terminals shall be properly shrouded against accidental contact.

5.4.8 Wiring between panels shall be routed through PVC sleeves or rubber grommets. All inter panel wiring within each shipping section shall be done at Vendor's works. For wiring between shipping section, Vendor shall provide terminal blocks on adjacent shipping sections and supply suitable jumpering wires. Alternatively, rolled up wires with necessary ferruling for inter panel wiring shall be provided.

5.5 Earthing

5.5.1 All panels shall be connected to an earth bus bar of suitable size having continuity throughout the length of the panel line-up. All doors and movable parts shall be connected to the earth bus with flexible copper connections. Provision shall be made to connect the earthing bus bar to the plant earthing grid at two ends. All non current-carrying metallic parts of the equipment and components shall be earthed.

5.6 Panel Illumination and Space Heaters

5.6.1 LED lamps working on 240 V AC, operated by door switches shall be provided for internal panel illumination of each panel and corridor.

5.6.2 A 240 V, single phase, 5 A, 3 pin socket shall be provided in the panel corridor or interior of each cubicle with on-off switch for connection of hand lamps.

5.6.3 The panels shall be provided with space heaters, controlled through MCB and thermostat with an adjustable setting.

5.7 Painting

5.7.1 All metal surfaces shall undergo manufacturer's standard cleaning/painting cycle.

5.7.2 After preparation of the under surface, the panels shall be painted with two coats of epoxy based final paint. Colour shade of final paint shall be 631 of IS: 5/RAL-7032.

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

5.8 Mimic

5.8.1 Mimic diagram shall be provided on panels when specified in data sheet. Mimic diagram shall be screwed on to the panels and shall be made of anodised aluminium or plastic of approved fast colour. The mimic shall be 10 mm wide for horizontal run and 5 mm wide for vertical run.

5.8.2 When semaphore indicators are used for indicating isolator/ breaker position, they shall be automatic type and shall be so mounted in the mimic such that isolator (or breaker) closed position shall complete the continuity of the mimic. The mimic diagram shall incorporate red and green lamps for position indication and controlling switches for breakers. Alternatively if specified in data sheet, discrepancy switches having built in hand operated semaphore and position indicating lamps for breaker control & indication shall be provided. The discrepancy switch shall perform the following functions:

a) The breaker on-off control shall be through this switch.
b) The lamp will remain steady when the semaphore position corresponds with the breaker position.
c) The lamp shall flicker if the semaphore position does not correspond with the breaker position.

5.8.3 The colour code for various voltages in the mimic diagram shall be as per IS: 11954 as detailed below:

Voltage Level	Mimic Colour	Shade as per IS: 5
400 KV AC	Signal Red	537
220 KV AC	Light Orange	557
132 KV AC or 110 KV AC	Lemon	355
66 KV AC	Golden Brown	414
33 KV AC or 22 KV AC	Olive Green	220
11 KV AC	Sea Green	217
6.6 KV AC	Air Craft Blue	108
3.3 KV AC	Sky Blue	101

415 V AC or 240 V AC	Dark Violet	796
220 V DC or 110 V DC	Black	-

5.8.4 In general all colours shall be so chosen as to be distinguishable from others appearing in the mimic diagram. These shall be subject to review by Owner/EIL during detailed engineering.

5.8.5 Actual value of voltage, Bus Number and other details shall be indicated in alpha-numeric characters, suitably on the mimic.

5.9 Equipment Specifications

5.9.1 **Instruments**

All instruments shall be switchboard type, flush mounted, dust tight and tropicalised. The instruments shall be digital/analogue type. The analogue indicating meters shall be in square shape of size 96x96 mm². These shall be taut band type having a scale covering 0-240°. The instruments shall have minimum accuracy class of 1.0.

Zero adjustment for pointers shall be accessible from the front of the instruments. All auxiliary equipment such as shunts and transducers etc as required shall be provided.

5.9.1.1 **Frequency Meters**

These shall be of direct-reading or digital type, and shall operate on a VT secondary voltage of 110V. The standard range shall be 45-50-55 Hz.

5.9.1.2 **Ammeters, Voltmeters, kW/kVA/kVAR meters, kWh/kVAh/kVARh meters**

Meters shall be suitable for the specified CT ratios and VT secondary voltage of 110V or directly from 415/240V circuit, as the case may be. The kW/kVA/kVAR meters and kWh/kVAh/kVARh meters shall be suitable for measuring unbalanced loads on a 3-phase, 3 wire system. If specified, bi-directional type kW/kVA/kVAR meters shall be provided.

5.9.1.3 **Power Factor Meters**

The range of PF meters shall be 0.5 lag - 1.0 - 0.5 lead. If specified, four-quadrant type power factor meters shall be provided, suitable for bi-directional flow of power. The PF meters shall be suitable for 110V VT secondary.

5.9.1.4 **Recording Instruments**

The recording instruments shall be continuous recording type. These shall be suitable for the Current / Voltage signals as applicable for the specified parameters to be recorded The recording instrument shall be complete with automatic chart feed control mechanism, isolating switch for chart drive, necessary transducers etc. as required. Each recorder shall be supplied with chart rolls and inking system for minimum 6 months continuous operation.

5.9.2 **Indicating Lamps**

The indicating lamps shall be of cluster LED type having minimum outer dia of 10 mm. All lamps shall be interchangeable, panel mounting type with rear terminal connection and shall afford easy replacement from front of the panel. The lamp cover shall be screwed type, unbreakable.

5.9.3 **Control Switches**

All control switches shall be rotary type. Circuit breaker control switches shall be 3-position Close-Neutral-Trip, spring return to neutral from both Close and Trip positions. They shall have pistol-grip handles. Minimum one spare way shall be provided on these switches for each position.

Ammeter selector switches shall have a make-before-break feature on its contacts. The selector switch shall generally have four positions: three for reading 3-phase currents and the fourth for the OFF position. The voltmeter selector switch shall also have four positions: three shall be used to measure phase-to-phase voltages, and the fourth shall be for the OFF position.

5.9.4 **Control Fuses**

All control fuses shall be of HRC cartridge link type.

5.9.5 **Annunciator / Annunciation Scheme**

5.9.5.1 Facia window type annunciators shall be provided on the control panels. These shall be of solid state type, with modular construction.

5.9.5.2 Visual indication shall be flush mounted, back lighted type, consisting of translucent facia of unbreakable acrylic material. Trip and non-trip alarms shall be segregated. The colour of windows shall be 'Red' for trip alarms and 'White' for all other alarms.

5.9.5.3 Annunciation facia shall be suitable for accommodating at least 15 standard capital size letters / numerals in Gothic form per line with 4 lines. Minimum size of the letter shall be 4 mm. Spacing between the 2 lines shall be minimum 2 mm. The facia window shall have a minimum display area of 1500 mm^2.

5.9.5.4 Each facia window shall be provided with at least two sets of super bright cluster LEDs in parallel to ensure highly reliable visual annunciation of adequate light intensity.

5.9.5.5 On occurrence of fault (s) one of the alarm sequences, as per Figure A (Sequence M of ISA S 18.1) or as per Figure B(Sequence F2M-1 of ISA S 18.1) shall be provided, as stated in the data sheet. If not specified therein, sequence as Figure A (Sequence M of ISA S 18.1) shall be provided.

5.9.5.6 Static control circuits shall be used for alarm logics incorporating audible and visual alarms. These shall be mounted on PCBs. The PCBs for identical logic units shall be interchangeable

5.9.5.7 All requisite accessories including separate push buttons for ACKNOWLEDGE/ ACCEPT, RESET, SILENCE, and TEST functions shall be provided common for all annunciator windows. These shall be located on front of the panel.

5.9.5.8 Annunciator shall be designed to lock in even during TEST mode if the field contacts get actuated at that instant.

5.9.5.9 The annunciator circuit design shall ensure that momentary short circuits in lamp circuit do not affect it. Visual and audible alarm circuits shall be independent i.e. the failure of one shall not affect the other.

5.9.5.10 The annunciators shall be suitable for operation with normally open fault contact which closes on a fault. It shall be possible to make them suitable for normally closed fault contact by field modification.

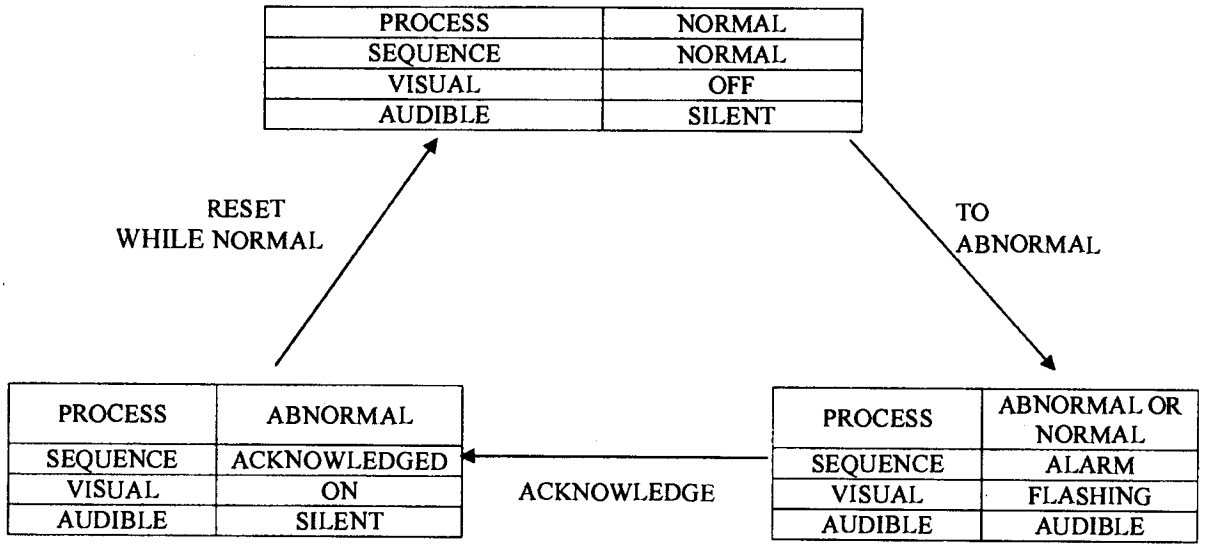
5.9.5.11 Annunciator shall be able to lock in for momentary actuation of field contacts.

5.9.5.12 The system shall have protection against malfunctioning due to voltage spikes.

5.9.5.13 DC Control supply, at the specified voltage, shall be provided by the Purchaser, as indicated in the data sheet. Necessary power supply module(s), if required, to generate different voltages for various annunciator elements shall be included in Vendor's scope. DC supply failure indication shall be provided separately with DC under voltage relays. On failure of DC supply to the panel, a lamp and an audio buzzer fed from AC supply shall operate. There shall be provision for silencing / acknowledging the buzzer. The buzzer shall have distinctly separate tone from other audible alarms.

FIGURE A: SEQUENCE-M, MANUAL RESET

SEQUENCE DIAGRAM



SEQUENCE TABLE

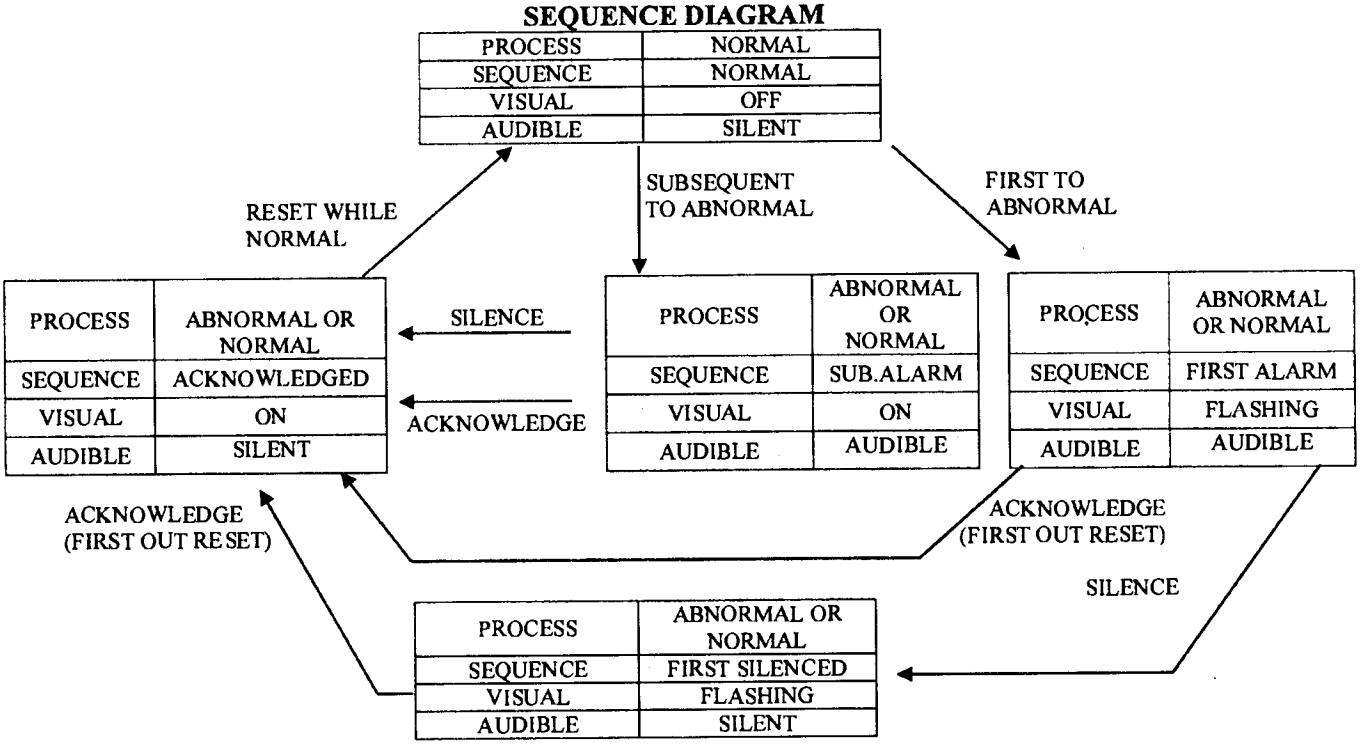
LINE	PROCESS CONDITION	PUSHBUTTON OPERATION	SEQUENCE STATE	VISUAL DISPLAY	ALARM AUDIBLE DEVICE	REMARKS
1	NORMAL	-	NORMAL	OFF	SILENT	
2	ABNORMAL	-	ALARM	FLASHING	AUDIBLE	LOCK-IN
3	ABNORMAL OR NORMAL	ACKNOWLEDGE	ACKNOWLEDGED	ON	SILENT	MANUAL RESET REQUIRED
4A	ABNORMAL	RESET	TO LINE 3			
4B	NORMAL		NORMAL	OFF	SILENT	MANUAL RESET

SEQUENCE FEATURES :

1. ACKNOWLEDGE, RESET AND TEST PUSHBUTTONS.
2. ALARM AUDIBLE DEVICE.
3. LOCK-IN OF MOMENTARY ALARMS UNTIL ACKNOWLEDGED.
4. THE AUDIBLE DEVICE IS SILENCED & FLASHING STOPS WHEN ACKNOWLEDGED.
5. MANUAL RESET OF ACKNOWLEDGED ALARM INDICATIONS AFTER PROCESS CONDITIONS RETURN TO NORMAL.
6. OPERATIONAL TEST.

FIGURE B: SEQUENCE-F2M 1, MANUAL RESET FIRST OUT WITH NO SUBSEQUENT ALARM FLASHING AND SILENCE PUSH BUTTON

SEQUENCE DIAGRAM



SEQUENCE TABLE

LINE	PROCESS CONDITION		PUSHBUTTON OPERATION	SEQUENCE STATE	VISUAL DISPLAY	ALARM AUDIBLE DEVICE	REMARKS
1	NORMAL		-	NORMAL	OFF	SILENT	
2	FIRST	ABNORMAL	-	FIRST ALARM	FLASHING	AUDIBLE	LOCK-IN
3	SUB			SUB ALARM	ON	AUDIBLE	LOCK-IN
4	FIRST	ABNORMAL OR NORMAL	ACKNOWLEDGE BEFORE SILENCE	TO LINE-7			FIRST OUT RESET
5	SUB	ABNORMAL OR NORMAL					
6	FIRST	ABNORMAL OR NORMAL	SILENCE	FIRST SILENCED	FLASHING	SILENT	
7	SUB	ABNORMAL OR NORMAL		ACKNOWLEDGED	ON	SILENT	MANUAL RESET REQUIRED
8	FIRST	ABNORMAL OR NORMAL	ACKNOWLEDGE AFTER SILENCE	TO LINE-7			FIRST OUT RESET
9	NORMAL		RESET	NORMAL	OFF	SILENT	MANUAL RESET

SEQUENCE FEATURES:

1. SILENCE, ACKNOWLEDGE, RESET AND TEST PUSHBUTTONS.
2. ALARM AUDIBLE DEVICE.
3. LOCK-IN OF MOMENTARY ALARMS UNTIL ACKNOWLEDGED.
4. OPTION-1: SILENCE PUSHBUTTON TO SILENCE THE ALARM AUDIBLE DEVICE WHILE RETAINING FIRST OUT FLASHING INDICATION.
5. FLASHING INDICATION FOR FIRST ALARMS ONLY. NEW SUBSEQUENT ALARMS HAVE THE SAME VISUAL INDICATION AS ACKNOWLEDGED ALARMS.
6. FIRST OUT INDICATION IS RESET WHEN ACKNOWLEDGED.
7. MANUAL RESET OF ACKNOWLEDGED ALARM INDICATIONS AFTER PROCESS CONDITIONS RETURN TO NORMAL.
8. OPERATIONAL TEST.

5.9.6 **Relays**

5.9.6.1 **Protective Relays**

i) Type of relay i.e. electromechanical, static or numerical shall be as defined in data sheet/ job specification.

ii) All electromagnetic protective relays shall be back-connected, of drawout type, suitable for flush mounting, and fitted with dust-tight covers. Auxiliary relays and tripping relays are acceptable in fixed execution.

iii) The relay cases shall have a provision for insertion of a test plug at the front for testing and calibration using an external power supply without disconnecting the permanent wiring. The insertion of the test plug shall automatically short circuit the CTs and permit extension of external power supply to the relay.

iv) All protective relays shall have hand reset facility and clear operating indication, e.g. flags for mechanical type relays or light emitting diodes for static/numerical type relays. It shall be possible to reset the flag without opening the relay case.

v) All tripping relays shall be of lockout type with hand-reset contacts, and shall be suitable to operate on the specified voltage. These relays shall have self coil cut off contacts, and shall be provided with hand-reset operation indicators.

vi) The tripping relay shall be suitable for satisfactory operation from 50% to 110% of the specified control supply voltage.

vii) Stabilising resistors, interposing CTs /VTs, metrosils etc., wherever required, shall be part of the relay.

5.9.6.2 **Auxiliary relays and contactors**

Auxiliary relays and contactors shall generally be used for inter-locking and multiplying contacts. Auxiliary contacts shall be capable of carrying the maximum anticipated current.

5.9.7 **Clock**

5.9.7.1 An electronic digital clock having 7 segment LED display (Red Colour) shall be provided on the top of the panel line up. The display shall have date, hour and minute display with blinking dots. The AM/PM or 24 hour mode shall be field selectable. The display shall be visible from a distance of 7 metre arc covering an angle of 120^0. The numeral height of the digit shall be minimum 5 cm. The intensity of the display shall be sufficient to view in broad day light. The accuracy of the clock shall be better than $\pm$ 10 sec. per month.

5.9.7.2 Power supply for the clock shall be derived from the incoming main supply to the panel and shall be backed by lithium batteries.

5.9.8 **Transducers**

Transducers designed for 4-20mA output signal shall be provided as specified in data sheets/as per requirements of approved schemes. Transducers shall be suitable for accuracy class 0.5 (max.). Galvanic isolation shall be provided between input and output circuits. The isolation insulation shall withstand minimum 2 kV, 50 Hz for 1 minute. The transducers shall be protected against input and output voltage surges. The transducers shall be suitable for driving 600 ohms load impedance located min. 500 m away and connected through 0.5 mm^2 copper conductor cables. The transducers shall be suitable for minimum 125 % continuous overload in input voltage/ current parameters.
The transducer characteristics shall be linear throughout the measuring range and its output shall be load independent. The transducer shall also have a low AC ripple on output less than the 1%.

5.9.9 **Nameplates**

5.9.9.1 Engraved nameplates indicating the panel designation shall be provided at the top (on front and back) of each panel. These shall be fixed in such a way that these can be removed and refitted when desired.

5.9.9.2 Nameplate or polyester adhesive 'identification tags' shall be fixed on each panel mounted equipment inside the panel and shall be provided on panel walls, to indicate permanent location of the components. Labels shall be provided for every component on the cards, connecting wires, as well as, for the terminals in the terminal strip inside the panel.

5.9.9.3 Nameplates shall also be fixed on the exterior of the panels at appropriate places to indicate the description/function of various relays, meters, control switches, push buttons, lamps and other equipment.

5.9.9.4 Special warning plates shall be provided on all removable covers or doors giving access to energised metallic parts above 24 volts.

5.9.10 **Auxiliary VTs and CTs**

Necessary auxiliary voltage transformers for open delta and auxiliary current transformers, wherever required, shall be included in Vendor's scope of supply.

Auxiliary CT required for summation of two or more feeders and auxiliary VT's required for galvanic isolation of different synchronising inputs shall be included in Vendor's scope of supply.

5.9.11 **Tariff Metering**

Wherever called for, integrating meters of the trivector or equivalent types capable of indicating kWh, kVARh and kVAh directly, along with maximum kVA and kW demand shall be provided.

These shall be suitable for 3 phase, 3 wire with unbalanced loading and with two sets of elements connected to current and potential transformers of specified ratio, and shall be fitted with reverse stop and impulse contacts to operate printo-maxigraphs where required. The printomaxigraph shall be operated from the impulses received from the Trivector meter and shall print the maximum demand in figures as well as record the shape of the load curve. The recording shall be inkless type.

5.10 Synchronisation Panel/Trolley

Whenever called for, swinging type synchronising panel / synchronisation trolley complete with running and incoming voltmeters, running and incoming frequency meters, synchroscope, synchronising check and guard relays, synchronising switches, lamps etc. shall be provided. Automatic synchronsing device with inputs to governor control and excitation panel shall be provided if specifically asked for. The synchronising switches shall be lockable type. One common key shall be provided for all synchronising switches to ensure that only one incoming source (from only one synchronising switch) is selected at a time.

The swing type panel shall be mounted on one side of the main panel with hinges and shall be so located as to enable easy operation of all breakers provided with synchronisation facility. Synchronising trolley shall be on wheels and shall be complete with multipin plug and flexible lead. Matching sockets shall be provided on main panels wherever required for synchronising.

5.11 Mounting of Loose Equipment/Components

Purchaser may buy loose equipment to be mounted on the control panel from different Vendors, e.g. On Load Tap-Changer controls, AVR equipment, transformer fan and temperature control, special relays etc. as specified in data sheets. The cutout and wiring details for such items shall be supplied to the successful Vendor. The panels shall be supplied duly drilled, wired etc. for mounting & wiring of the loose items.

6.0 INSPECTION, TESTING AND ACCEPTANCE

6.1 During fabrication, the panels shall be subject to inspection by EIL / Owner, or by an agency authorised by the Owner, to assess the progress of work, as well as to ascertain that only quality raw material is used. The manufacturer shall furnish all necessary information concerning the supply to EIL / Owner's inspectors. Minimum three weeks notice shall be given to EIL/owner for witnessing the final testing of the complete equipment.

6.2 For testing requirements, refer Inspection & Test Plan No. 6-81-1004. Prior notice of minimum 4 weeks shall be given to EIL/owner for witnessing the final testing of panel to ensure satisfactory operation of all components. Tests shall be carried out at manufacturer's works under his care and expense.

7.0 PACKING AND DESPATCH

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

The equipment may be stored outdoors for long periods before erection. The packing shall be completely suitable for outdoor storage in areas with heavy rains / high ambient temperature, unless otherwise agreed. A set of instruction manuals for installation, testing and commissioning, a set of operation & maintenance manuals and a set of final drawing shall be enclosed in a waterproof cover along with the shipment.

Project Project Management Consultancy (PMC) Services for execution of VRMP **Client** M/s HPCL

Unit CPP PACKAGE **Location** Vizag **Job No.** B016 **Unit No.** 606

PURCHASER'S DATA

Site Conditions		
Maximum Ambient Temperature	°C	45
Minimum Ambient Temperature	°C	12.5
Design Ambient Temperature	°C	45
Relative Humidity	%	95
Altitude Above MSL	m	Less than 5.56
Environment		
Operating Condition		
Voltage	kV	
Frequency		50 Hz ± 3 %
System earthing		
Control voltage		
Control		110 V DC ± 10 %
Protection		110 V DC ± 10 %
Annunciation		110 V AC ± 10 %
Aux. Supply		240 V AC ± 10 %
Space heater		240 V AC ± 10 %
Type of panel		MOSAIC
Dimension matching with exist/other panels		Required
Colour matching with exist/other panels		Required
Colour of the panel		RAL-7032
Cable entry		Bottom
Component requirements		
Meters		
Type of mounting		Flush
Type of indicating meters		Analogue
Type of scale (Analogue)		Taut Band
Angle of scale		0-240 drgree
Rated CT secondary	Amps	1
Rated PT secondary		110 V AC(L-L)
Suitability for		
Unbalanced load		Required
Bidirectional power flow		Required
Max. Demand Indicator		Required
Recorders		
Type of mounting		Flush
Type of recorder		Direct wiring type
Mounting of mechanism		Draw out
Relays		
General prot. relays		Numerical
Generator prot. relays		Numerical
Motor protective relays		Numerical
Tripping relays		Numerical
Aux. Relays		Electro mechanical
Timers		Solid State

Rev. No.	Date	Purpose	Prepared By	Reviewed By	Approved By
A	18-MAY-2017	ISSUED WITH TENDER	GAURAV KATYAL	ACHUTUNI SAI	GUPTA PARAG

Project Project Management Consultancy (PMC) Services for execution of VRMP **Client** M/s HPCL

Unit CPP PACKAGE **Location** Vizag **Job No.** B016 **Unit No.** 606

Type of case	
Protective relays	Draw out
Tripping relays	Draw out
Aux. Relays	Non-Draw out
Timers	Non-Draw out
Rated CT secondary	1
Rated PT secondary	110 V AC(L-L)
Control switches	
No. of ways	As required
Locking arrangement	As required
Indicating lamps	
Type	LED Type
Rating	As required
Push buttons	
Type	LED Type
Contactor type	Momentary
Locking arrangement	As required
Mimic diagram	Required
Annunciator	Required
No. of windows	as required
Annunciation sequence	Type A
Interface with ECS	Required
Applicable standard	6-51-0004

MANUFACTURER'S DATA

Make of panel	
Type & designation	
Control switches	
Make	
Type/ Model no.	
Rating of contacts	
Make & Carry continuously	
Make & Carry momentarily	
Break resistive load	
Dimensions	
Mounting details	
Detailed technical literature	
Indicating lamps	
Make	
Type/ Model no.	
Dimensions	
Ratings	
Series resistor	
Life in burning hours	
Push buttons	
Make	
Type/ Model no.	
Rating of contacts	

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Project Project Management Consultancy (PMC) Services for execution of VRMP **Client** M/s HPCL

Unit CPP PACKAGE **Location** Vizag **Job No.** A921 **Unit No.** 606

Make & Carry continuously	
Make & Carry momentarily	
Break resistive load	
Dimensions	
Mounting details	
Detailed technical literature	
Annunciators	
Make	
Type/ Model no.	
Dimension of window	
Letter/ line size	
No.of letters & lines/window	
No.of lamps/window	
Lamp burning hours	
Auxiliary supply/loading	
Rating of contacts	
Make & Carry continuously	
Make & Carry momentarily	
Break resistive load	
Field changeover possible	
Detailed writeup furnished	
Overall dimensions	
Mounting details	
Detailed technical literature	
Mimic diagram	
Type	
Any other component	
Furnish details	
Auxiliary supply/loading	
Overall dimensions	
Cut out dimensions	
Weight	
Detailed technical literature	
O/C & E/F relays	
Current tap setting range	
Time dial setting range	
Type of characteristics	
Current-time characteristics	
Time of operation at max. time dia setting at 10 times current	
Series/shunt seal in units	
High set instantaneous unit	
Current setting range	
VA burden	
Directional relay	
MTA for directional unit	

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Project	Project Management Consultancy (PMC) Services for execution of VRMP			**Client**	M/s HPCL
Unit	CPP PACKAGE	**Location**	Vizag	**Job No.**	B016
Unit No.	606				

Polarisation-potential	
Connection scheme for polarising potential	
Diffential relays	
Current setting range	
No. of taps	
Harmonic restraint range	
Bias setting range	
No. of taps	
VA burden at various setting	
Operating time	
Voltage relays	
Voltage setting range	
No. of taps	
Time voltage characteristics	
Motor protection relays	
Thermal over load element	
Setting range	
Charateristics	
over current element	
Current setting range	
Time setting range	
Earth fault element	
Current setting range	
Time setting range	
Negative sequence element	
Pickup current setting	
Time delay setting range	
Locked rotor protection	
Current setting range	
Time delay setting range	
Hot & Cold starts/hour range	
Any other detiails	
Relays	
Relay function/NEMA code	
Make & Model no.	
VA burden/Power consumption	
Any other relay type	
Furnish details	
Technical particulars-Meters	
Meter designation	
Make and Model no.	
VA burden/ Power consumption	
Current Coil	
Potential Coil	
Auxiliary supply/ loading	

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Project	Project Management Consultancy (PMC) Services for execution of VRMP			**Client**	M/s HPCL
Unit	CPP PACKAGE	**Location**	Vizag	**Job No.** B016	**Unit No.** 606

Overall dimensions	
Cut out dimensions	
Weight	
Detailed literature	
Other details, if any	
To be filled seperately for each type of meter	
Technical particulars-Recorders	
Type	
Make and Model no.	
VA burden/ Power consumption	
Current Coil	
Potential Coil	
Auxiliary supply/ loading	
Chart width	
Chart speed	
Type of marking/inking system	
Colour of amrking/ ink	
Type of chart driving mechanism	
Chart driving mechanism	
Hours of spring reserve	
Hours of spring reserve	
Facility of variation of recording speed	
Visible range of recording	
Overall dimensions	
Cut out dimensions	
Weight	
Detailed literature	
Other details, if any	
To be filled seperately for each type of recorder	

Notes
1

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न्यूमेरिकल रिलेय व सबस्टेशन स्वचालन प्रणाली के लिए विनिर्देश

SPECIFICATION FOR NUMERICAL RELAYS & SUBSTATION AUTOMATION SYSTEM

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
2	12-06-14	REVISED AND ISSUED AS STANDARD SPECIFICATION	AS	SV	BRB	SC
1	24-03-09	REVISED AND ISSUED AS STANDARD SPECIFICATION	SKM	AK	JMS	ND
0	12-08-02	ISSUED AS STANDARD SPECIFICATION	RCS	AAN	VPS	GRR

Abbreviations:

AC	:	Alternating Current
BS	:	British Standard
BTD	:	Bearing Temperature Detector
CBCT	:	Core Balance Current Transformer
CPU	:	Central Processing Unit
CT	:	Current Transformer
DC	:	Direct Current
DCS	:	Distributed Control System
ECS	:	Electrical Control Station
EMI	:	Electromagnetic Interference
FIFO	:	First in first out
FO	:	Fibre Optic
GPS	:	Global Positioning System
HV	:	High Voltage
I/O	:	Input/output
ICT	:	Intermediate Current Transformer
IDMTL	:	Inverse Definite Minimum Time Lag
IEC	:	International Electrotechnical Commission
IEEE	:	Institute of Electrical and Electronics Engineers
IP	:	Ingress Protection
IRIG- B	:	Inter-Range Instrumentation Group Subcarrier Channel-B
KEMA	:	Keuring Electrotechnisch Materieel Arnhem
LAN	:	Local Area Network
LCD	:	Liquid Crystal Display
LED	:	Light Emitting Diode
HMI	:	Human Machine Interface
TCP-IP	:	Transmission Control Protocol-Internet Protocol
MOG	:	Magnetic Oil Gauge
NEMA	:	National Electrical Manufacturers Association
NO	:	Normally Open
OTI	:	Oil Temperature Indicator
PC	:	Personal Computer
PCB	:	Printed Circuit Boards
PLC	:	Programmable Logic Controller
PT	:	Potential Transformer
PVC	:	Poly Vinyl Chloride
REF	:	Restricted Earth Fault
RSTP	:	Rapid Spanning Tree Protocol
RTD	:	Resistance Temperature Detector
RTU	:	Remote Terminal Unit
SNTP	:	Simple Network Time Protocol
SOE	:	Sequence of event
VDE	:	Verband Deutscher Elecktrotechniker
WTI	:	Winding Temperature Indicator

Electrical Standards Committee

Convenor : Mr. BR Bhogal

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

CONTENTS

1.0 SCOPE

The intent of this specification is to define the minimum requirement of design, manufacture, testing, packing and dispatch of numerical relays. The specification also defines the requirement of communication and integration for Substation Automation System.

2.0 CODES AND STANDARDS

2.1 The equipment shall comply with the requirements of latest revision of following IEC standards / equivalent Indian Standards, unless otherwise specified:

IEC 60068 : Environmental Testing

IEC 60073 : Basic safety principles for man machine interface, marking & identification – Coding principles for indicators and actuators

IS/IEC 60529 : Degree of protection provided by enclosure (IP Code)

IEC 60255 : Electrical relays

IEC 61000 : Electromagnetic compatibility (EMC)

IEC 61850 : Communication networks & systems in substations

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

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

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

2.5 In case of any contradiction between various referred standard/ specification/ data sheet and statutory regulation, most stringent requirements shall prevail. However, Owner's decision in this regard will be final and binding.

3.0 SITE CONDITIONS

3.1 The relay shall be tropicalised, for satisfactory operation when installed in a panel located in a pressurised substation with restricted natural air ventilation, in tropical humid and corrosive atmosphere. Relay shall be designed to perform all its functions and operate under site conditions specified in numerical relay data sheet. If not specifically mentioned there in, a design ambient temperature of 40°C and an altitude not exceeding 1000M above the mean sea level shall be considered.

4.0 GENERAL REQUIREMENTS

4.1 The equipment offered shall be brand new with state of the art technology with proven field track record of similar type and model or model in same series with additional features. No prototype equipment shall be offered.

4.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment at least for 15 years from the date of supply.

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

4.4 In case of relays manufactured outside India, the relay manufacturer through his Indian establishment or associate in India shall provide application, testing, commissioning, after sales service and other necessary support for minimum of 15 years to customer. Their Indian establishment or associate company in India shall also maintain adequate inventory of each type of relay or spares to meet the requirement arising during project execution and plant operation. Relay manufacturer shall possess a signed Memorandum of Understanding with their Indian associate for providing customer support

5.0 TECHNICAL REQUIREMENTS

5.1 Auxiliary Power Supply

Unless otherwise specified, numerical relays, data concentrator, Ethernet switches, gateway & HMI shall be suitable to accept both AC/DC supplies with range 110V to 240V with tolerance of ± 15%. The auxiliary power supply shall preferably be site-selectable requiring no additional hardware.

5.2 Basic Requirement and Construction Details

5.2.1 Relay shall be suitable for flush mounting. The relay enclosure front shall be dust tight having degree of protection minimum as IP5X.

5.2.2 Relay terminals shall be suitable for termination of 1.5/2.5/4 sq mm wires, for all hardwired connections.

5.2.3 Relay shall be modular with plug in type PCB for easy replacement. The relay terminals shall be easily accessible for testing and commissioning.

5.2.4 Current operated relay shall have provision for minimum 3 number phase CT inputs and 1 number CBCT input. Voltage operated relay shall have provision of minimum 3 numbers PT inputs. The exact number of CT and PT inputs shall be based on the schematic requirements, relays shall be selected accordingly.

5.2.5 CT shorting link shall be provided at terminal block as required.

5.2.6 All numerical relays shall have key pad/ keys to allow relay setting from relay front. All hand-reset relays shall also have reset button on relay front. Self reset or hand reset feature of the relay shall be software selectable and password protected.

5.2.7 Relay shall be suitable for 1 A or 5A CT secondary. CT secondary 1A or 5A shall either be software selectable or by providing suitable link. Selection between 1A or 5A should be possible at site.

5.2.8 Relays shall have self-diagnostic feature with indication of relay failure on relay front. Relay faults (Self- diagnostic) shall be communicated and annunciated to substation automation system.

5.2.9 Relays shall, as a minimum, have protection functions as per feeder equipment data sheets. Other functions such as metering and control shall be provided, if specified in data sheets/job specifications.

5.3 Software Security

The relays shall be provided with suitable security (pass word protection) against unauthorized WRITE ACCESS for change in relay setting. However it should be possible to view metering, protection settings, status and event data as READ ONLY without password protection.

5.4 Display and Indication

5.4.1 All relays shall have LCD display along with LED indications for display of settings, status, faults and events. Relays for generator protection, switchyard and GIS shall be provided with medium size LCD display having facility for graphical display of mimic with upto 15 objects on each page.

5.4.2 LCD display shall be backlit and temperature compensated up to 55°C for contrast and legibility.

5.4.3 Relays shall have 3 fixed LEDs for Relay ON/Control supply ON, fault trip & relay unhealthy apart from freely configured LEDs.

5.5 Protection Functions

5.5.1 Over Current/Earth Fault Protection

i) This section describes over current & earth fault protection function, which mainly include different setting stages such as low set, high set and high set instantaneous (51, 50, 51N,

50N). Over current protection function provided should have IDMTL characteristic for low set and high set stages and definite time delay for high set instantaneous stage.

ii) Over current relay shall be three phase type with 4 elements; 3 elements for inverse and definite time delay over current and one element for inverse and definite time delay earth fault current. Selection of inverse or definite time feature shall be user selectable.

iii) The IDMTL characteristic (for 51 and 51N) shall be as per IEC. The inverse characteristics shall include normal inverse, very inverse, extremely inverse, long inverse and shall be soft ware selectable. Inverse element shall have two or more stages (low and high set) for selection of required inverse characteristic to achieve close protection as required.

Definite time characteristic shall have minimum 2 stages with adjustable current and time setting.

iv) Relay shall also have separate current input from CBCT for measured earth fault current element. It shall be possible to connect earth fault element either through CBCT or to be connected residually. Minimum setting current for sensitive earth fault element shall be 1%.

v) Directional overcurrent & earth fault element shall be provided, wherever required.

vi) Voltage biased overcurrent / earth fault element shall be provided wherever required.

5.5.2 **Motor Protection**

i) Motor protection relay shall have all protection function such as over current, thermal (over load), locked rotor current, zero sequence, negative sequence, maximum number of start, motor overload pre-alarm, motor re-acceleration, lock out, inhibit of over current protection during motor starting through contactor feeders, hour run count, inhibit start after elapse of maximum number of starts etc.

ii) The relay shall be provided with 6 Nos. RTD and 2 Nos. BTD analog inputs, if specified in the data sheet / job specification. Alternatively, external RTD/BTD module having interface with numerical relay can be provided. The numerical relay with RTD / BTD inputs shall be suitable for shielded triad cable of conductor size 1.5sqmm copper, unless otherwise specified.

iii) Separate motor differential protection shall be provided, wherever specified.

5.5.3 **Transformer Protection**

i) In addition to overcurrent & earth fault function, wherever required, the main numerical relay shall also include standby earth fault protection function (51G) for the transformer. The standby earth fault shall operate from a separate neutral CT input and shall have definite time / IDMTL characteristics as per IEC.

ii) Wherever the transformer requires restricted earth fault protection (64R), separate numerical relay shall be provided. 64R function can be included as a part of main differential protection relay (87T), unless otherwise specified. For details of transformer differential protection relay refer Cl. 5.5.6.

iii) Transformer auxiliary protection (OTI/WTI/Buchholz/MOG etc) shall be included as a part of numerical relay.

iv) Transformer differential protection shall be provided, wherever specified.

5.5.4 **Generator Protection**

i) Medium Voltage Generators (415V) shall have all protection functions such as voltage restrained overcurrent (51V), standby earth fault (51G), negative sequence (46), Reverse power (32), under voltage (27), overvoltage (59), thermal overload (49), PT fuse failure monitoring function (60), generator differential (87G) as a minimum.

ii) In addition to the above, HV generators (turbine / diesel engine driven) shall have additional protection functions such as rotor back up earth fault (64R)-1st and 2nd stage, low forward

power flow (37), loss of excitation (40), under frequency (81U), rate of change of frequency (df/dt) unless otherwise specified.

iii) If specified in the datasheet, additional protection functions such as field overcurrent, over frequency (81O), back up impedance (21), over fluxing (99), out of step shall be provided as a part of generator protection numerical relay.

iv) The generator protection functions can be included as a part of one numerical relay or a separate numerical relays can be provided.

5.5.5 **Voltage Operated Protection Functions**

i) These functions include under voltage (27), over voltage (59), ON delay and OFF delay timers, phase sequence voltage, neutral displacement and Synchro-check functions etc.

ii) The under voltage and overvoltage protective function shall have different stages with IDMTL and definite time characteristics.

iii) If specified in datasheet, the relay shall have under and over frequency function along with frequency supervised Rate of change or average rate of change of frequency function.

5.5.6 **Differential Protection**

Suitable differential protection shall be provided as required as per data sheet / job specification for the specific application such as for generator, transformer, overall generator & transformer, motor, feeder, bus section etc. The following requirements, as applicable, shall be complied:

i) Differential protection shall be either high impedance or low impedance type. In case of high impedance type, suitable non linear resistor shall be provided to limit the peak overvoltage.

ii) Transformer differential protection shall have suitable harmonic restraint feature to avoid maltripping during switching.

iii) For transformer differential protection, necessary correction for ratio error and for transformer primary and secondary vector grouping shall be taken care in the relay itself without additional ICTs. The required relay setting for this shall be programmable.

iv) Bus differential relay shall have feature for CT supervision and check differential.

v) In case separate hard-wired relay is used for check differential, the status/ event of same shall be communicated through the numerical relay provided for main differential application.

vi) Unless otherwise specified, the differential relays such as generator differential, transformer differential, overall generator transformer differential, motor differential, feeder differential etc. shall be suitable for cable connection between CTs and relay using 2.5 sq.mm., Cu conductor, PVC insulated, armoured cable. However for differential protections provided for feeders having long lengths, armoured FO cable may be considered. In cases where FO cable is not suitable, shielded twisted pair cable of conductor size 1.5sqmm copper shall be specifically mentioned by the bidder in the offer for EIL/Owner's acceptance on case to case basis.

5.6 Metering Functions

The metering function shall be provided as required and same shall be built inside the numerical relays.

5.7 Control Functions

5.7.1 The control function shall be built inside the numerical relays. For this purpose relays shall have all graphical PLC/Boolean logic functions such that complete control logic of the feeder along with all necessary interlocks as required can be developed inside the relay.

5.7.2 Relays for motor feeder shall be equipped with all control functions and interlocks related to motor feeder. If reacceleration is a part of motor feeder, the control function shall also cover reacceleration logic.

5.7.3 Relays shall have sufficient integral I/Os to take care of complete feeder logic. External I/O module for implementation of logics is not acceptable.

5.8 Lock Out (86), Trip Circuit Supervision (95), Auxiliary Relays and Timer Functions

5.8.1 Unless otherwise specified the numerical relays shall have built in lock out function. For motor feeders additional built-in lockout element shall be provided to receive process trip signals. Lock out elements shall be self reset or hand reset and shall be software selectable.

5.8.2 The numerical relays shall have built in trip circuit supervision function, unless otherwise specified.

5.8.3 Auxiliary relays/ Timers function etc as required for control schematics shall be programmable as a part of numerical relay. The number of such elements as required for schematic shall be considered.

5.8.4 Timer function shall be programmable for both ON/OFF delays.

5.9 Disturbance/ Event Recording and Data Storage

5.9.1 Breaker trip/ close status, relay faults, trip values, event data and disturbance record data shall be stored in the relay in non-erasable memory or memory backed up by lithium battery. Under no circumstances such as withdrawal of power to the relays shall the status, data and events in the memory get erased. Unless otherwise specified, it should be possible to store total 10 seconds of disturbance recording and 200 sequence of event records. Subsequent events shall be overwritten following principle of FIFO.

5.9.2 All disturbances/ events shall be time stamped within the relay.

5.10 Input/ Output Interface, Filters and Galvanic Isolation

5.10.1 Voltage (through PT) input to relay, shall be 110V +/- 10%, unless otherwise specified.

5.10.2 Out put relays shall have 4 numbers spare NO contacts; each shall separately be programmable for either hand reset or self- reset.

5.10.3 Contacts of pushbuttons from field, interlocks from DCS/ other switchboards shall be wired to the relay as binary input using 1.5/2.5sqmm, multi core, copper conductor cables. The distance between push buttons/ interlock to switchboard may be considered as 1000m, unless otherwise specified. The pick-up voltage for BIs/BOs shall be site selectable. The additional components as required to overcome the cable capacitance effect shall be considered as a part of supply of relay. The binary input to relay from field contacts and interlocks shall be momentary type. Logic to latch the momentary contact, as required shall be built as a part of protection relay.

5.10.4 All I/Os shall have galvanic isolation. Analog inputs shall be protected against switching surges, harmonics etc.

5.11 Relay Communication

5.11.1 All numerical relay shall have RS232/RJ45/USB port on the front for hooking laptop.

5.11.2 At the rear numerical relays shall have suitable communication port for communication with data concentrator/ HMI/ Station bus. The type of port shall be selected based on method of communication (Serial or Ethernet) and type of physical transmission medium (twisted pair copper or fiber optic). For serial communication, the relay port shall be RS485 or FO (fiber optic) and for Ethernet (IEC 61850 based) communication same shall be RJ45or FO.

5.11.3 The communication protocol shall be selected to transfer all information including time stamp data from relay to data concentrator/ substation HMI. The relays shall communicate on industry open protocol such as IEC 60870-5-103/IEC 61850/ Modbus-RTU / Modbus TCP-IP or any other open protocol.

5.11.4 For IEC 61850 based communication, each relay shall be suitable for communicating with minimum three numbers client devices.

6.0 SUBSTATION AUTOMATION SYSTEM

Substation automation system broadly comprises of numerical relays, data concentrator panels (as required), HMI, laptop, printers and their associated software for monitoring of the electrical system.

6.1 Communication

Communication is the backbone of any substation automation system. It is through this medium, the monitoring of various parameters takes place effectively.

6.1.1 Serial Communication

i) Data concentrator shall have two serial ports (1 no. in each CPU module) for simultaneous remote communication on relay LAN. The relays shall be multi-dropped on RS485 through single drop from LAN to each relay. In the event of either failure of any relay or break in LAN cable or failure of port at data concentrator, the redundant hardware shall ensure healthy communication between relay and data concentrator (refer Figure-1).

ii) Alternatively, relays shall communicate in star topology using star coupler. Communication from relays to star coupler shall be through single communication port. Communication from star coupler to data concentrator shall be through redundant communication link (each link part of separate star coupler unit). RS485 to FO converters wherever required shall be part of offered relay/ other hardware. Star coupler shall be provided with dual power supply module

iii) The maximum number of relays in one loop shall be decided so as to achieve maximum scan time as 500 ms for status input and maximum 6 sec for analog and historical data considering total number of serial loop and star coupler as a total integration. The above scan time does not include screen refresh rate at HMI.

iv) For sequence of event recording, time discrimination between two events shall be maintained to 1 m sec or better.

6.1.2 IEC-61850 based Communication

i) Ethernet switches shall provide error free communication in harsh substation environment and shall be immune to EMI. The Ethernet switches shall comply to IEC 61850-3 and shall be KEMA approved or equivalent.

ii) For real time deterministic performance, managed Ethernet switch shall be considered in the Ethernet network. The switch shall support following features:

- Full duplex operation
- Priority Queuing
- Virtual LAN (VLAN)
- Rapid Spanning tree
- Multicast filtering

iii) Dedicated Ethernet switches shall be provided for each switchboard. 20% spare ports shall be provided in each Ethernet switch.

iv) Ethernet switch shall have dual DC power supply facility.

v) Communication between relay and HMI shall be provided as follows:

Redundant Ethernet communication architecture shall have RSTP topology. Numerical relays shall be hooked up to Ethernet switch in star topology and the switches (within the switchboard) shall be further connected in ring (refer Figure 2).

Alternatively, from each switch (within the switchboard) redundant communication link shall be extended to two number backbone switches to be located within the switchboard (refer Figure 3).

For hooking up to HMI/gateway for upper level connectivity, redundant communication link either from any two switches within the ring or from back bone switches shall be further extended and hooked up to two numbers master Ethernet switches dedicated for hooking HMI/gateway/printers/GPS etc. From HMI redundant communication link shall be extended to the master Ethernet switches.

6.2 Data Concentrator

6.2.1 Data concentrator shall be supplied to facilitate communication with relays on open protocol.

6.2.2 As a minimum data concentrator shall have separate power supply module, CPU module and I/O module. To achieve redundant architecture, either separate data concentrator shall be considered or data concentrator shall have redundant power supply module and redundant CPU module. The CPU module shall have sufficient communication ports depending on relay LAN requirement.

6.2.3 Data concentrator shall provide gateway to upper level control system on Ethernet/ IEC61850 protocol/Modbus-RTU protocol or protocol as specified in the data sheet. The communication to upper level control system shall be redundant as per data sheet/ system architecture.

6.2.4 Data concentrator shall have binary and analog (4 to 20mA) I/O cards suitable for interface requirement specified in data sheet. Unless otherwise specified, 20% I/Os shall be considered as spare. Alternatively, a separate Data Acquisition Unit may be supplied for binary and analog interface.

6.2.5 Data concentrator shall have required number of ports for relay LAN/ star couplers. Number of relay LAN/ star couplers shall be as per project requirement. 20% or minimum 2 Nos. spare ports whichever is maximum shall be provided for future extensions.

6.2.6 Data concentrator shall have required number of RS232/ RS422/RJ45 ports for connection to Laptop PC and substation HMI having operator's work station and engineering station PC.

6.2.7 Data concentrator shall have redundant RS485/ FO/ Ethernet port for communication to substation HMI and upper level ECS-RTU. Hook up to upper level system shall be carried out by extending serial connectivity from each communication ports in two CPU modules.

6.3 Gateway

6.3.1 Gateway for upper level connectivity if separately provided shall have redundancy in power supply module, CPU module. Alternatively, redundant gateways can be provided.

6.3.2 In case of IEC-61850 based communication, if gateway is envisaged, gateway shall have binary and analog (4 to 20mA) I/O cards suitable for interface requirement specified in datasheet. Unless otherwise specified, 20% I/Os shall be considered as spare. Alternatively, a separate Data Acquisition Unit may be supplied for binary and analog interface with communicates to ethernet switch on IEC-61850 protocol.

6.4 Human Machine Interface (HMI)

6.4.1 Following functions as a minimum shall be a part of HMI:

- Display of Single Line Diagram
- Feeder status monitoring
- Data logging
- Relay parameterization
- Event recording
- Historical data & trending
- Annunciation

6.4.2 Human machine interface shall include engineering and operator function. Engineering and operator workstations shall be separate.

6.4.3 HMI shall be of industrial grade suitable for continuous operation at design ambient temperature with restricted natural ventilation.

6.4.4 HMI shall be of latest version of industrial grade PC and the same shall be provided with 21" color monitor (TFT flat screen) with non glare glass filters to minimize glare from external lighting.

6.4.5 Operator workstation shall have user friendly software for interactive display of substation data in multiwindow feature. Software shall have capability to display substation single line diagrams, display of electrical system parameters, reports, alarm annunciation, daily and monthly data logging, continuous polling, relay monitoring, relay supervision, fault disturbance record of each relay, graphic representation and trending of data etc. The offered system shall comply with requirements of IEC for basic and safety requirements for Human-machine interface.

6.4.6 Engineering workstation shall have software for engineering, detailed self diagnostic for maintenance, trouble shooting and changing parameters. Further, it shall also have facility to program and configure numerical relays, data concentrator and other intelligent devices. In addition engineering work station shall have all the facilities as provided for operator workstation.

6.4.7 The HMI system shall be provided with color laser jet A3 printer for generating hardcopy of alarm, event and logging report. The printing shall be on demand, unless otherwise agreed.

6.4.8 If specified, separate laptop shall be provided. The laptop shall include all functionalities as specified for HMI system and the same shall be provided with required licensed software, hardware, accessories and material. System configuration shall be latest proven model and upgradable.

6.4.9 HMI system shall be provided with all associated furniture for PC, printer etc.

6.5 Time Synchronization

6.5.1 All internal clocks of numerical relay, data concentrator, SOE modules, HMI etc. shall always work in synchronism such that there is one and only one system-wide time. GPS shall be considered to synchronize with an external satellite clock. The time synchronization accuracy shall be ± 1.0 msec or better.

6.5.2 The GPS system shall consist of GPS antenna, lightning arrestor, GPS receiver/server and associated cables.

6.5.3 The time synchronization shall be carried out either through communication over substation relay LAN or by considering dedicated time synchronization channel. In case of synchronization through relay LAN, the communication protocol shall support to carry time synchronization message to the relays/data concentrator/HMI and maintain the desired accuracy. In case of time synchronization through dedicated time synchronization channel, relays, data concentrator and HMI shall be provided with IRIG- B port and the same shall be directly hooked up to GPS receiver.

6.5.4 In Ethernet based communication network, GPS receiver shall be directly hooked up to Ethernet LAN and all internal clocks of HMI and numerical relays shall be updated using SNTP protocol.

7.0 INSPECTION, TESTING AND ACCEPTANCE

7.1 During assembly, EIL / Owner or his authorized representative shall be permitted to assess the progress of work as well as to ascertain that quality raw material is used for the same. All assistance as required during inspection shall be given to inspector.

7.2 For testing requirements refer Inspection & Test Plan No. 6-81-1055.

8.0 PACKING AND DESPATCH

The equipment shall be properly packed for transportation by ship/rail or trailer. All equipments shall be wrapped in polyethylene sheets before being placed in wooden crates/ cases with fillers to prevent damage to the finish. Crates/cases shall have skid bottoms for handling. Special notations such as 'Fragile', 'This side up', 'centre of gravity', 'weight', 'Owner's particulars', 'PO nos.' etc. shall be clearly marked on the package together with other details as per purchase order.

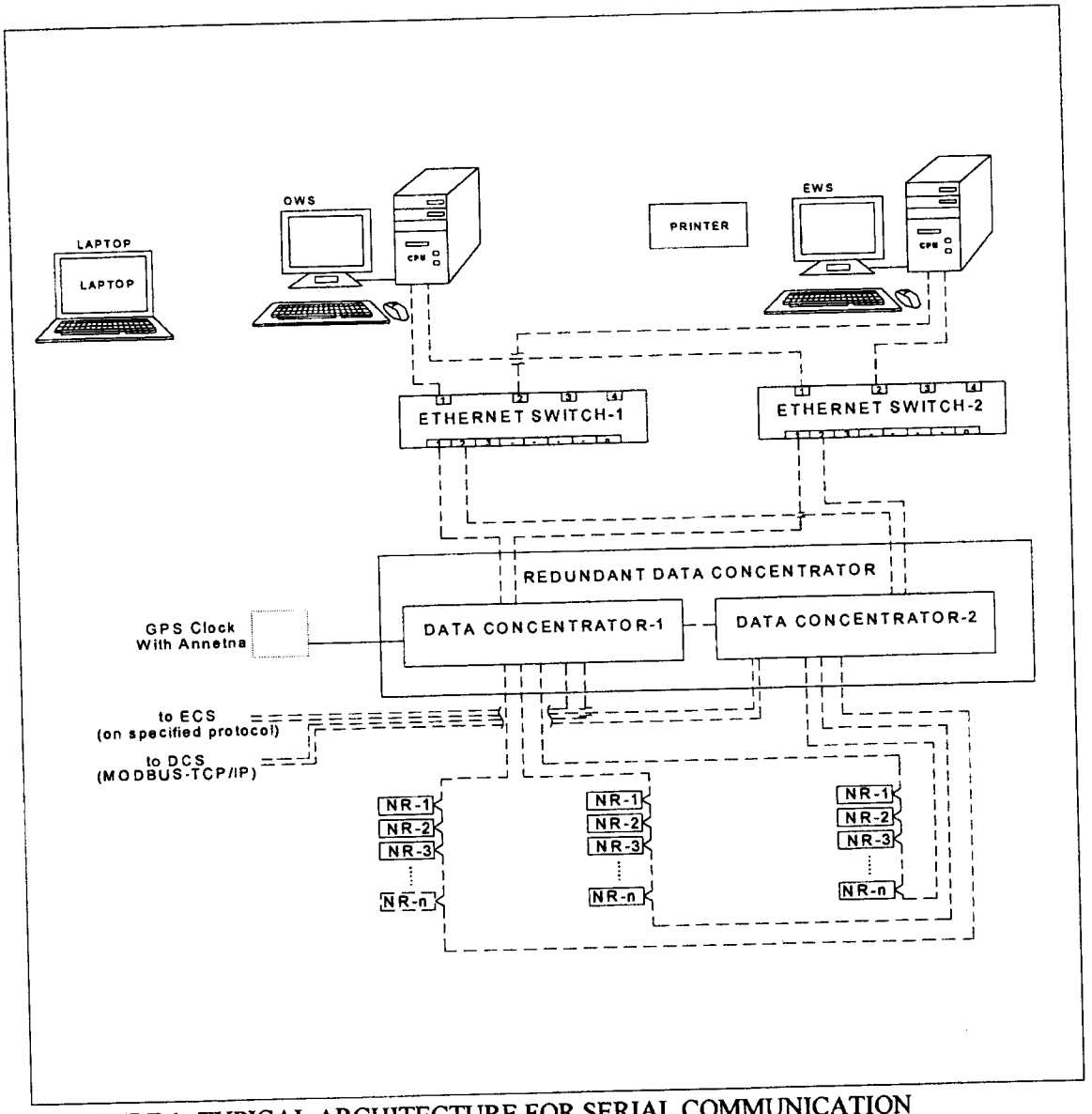

FIGURE 1: TYPICAL ARCHITECTURE FOR SERIAL COMMUNICATION

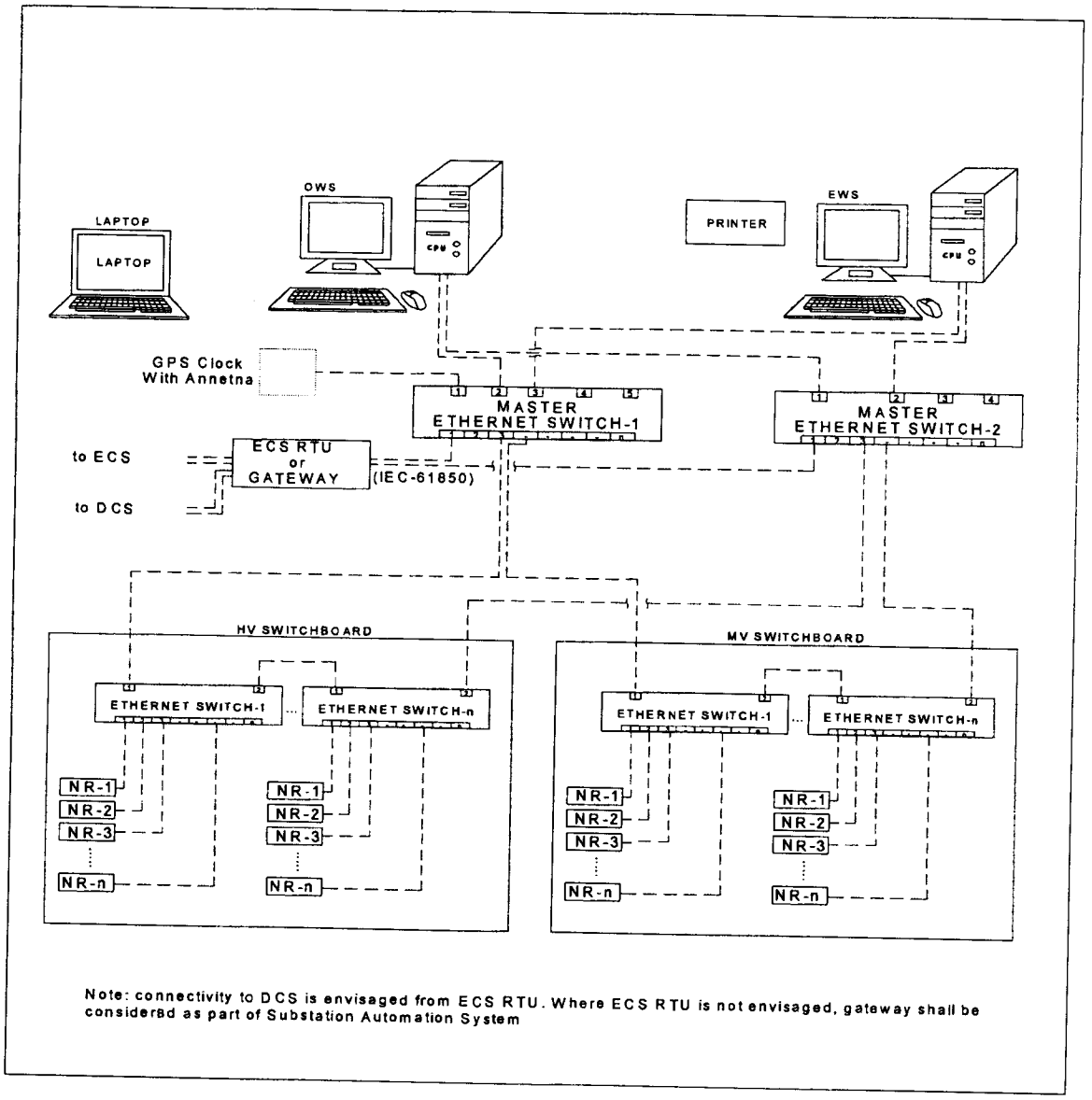

FIGURE 2: TYPICAL ARCHITECTURE FOR IEC-61850 COMMUNICATION

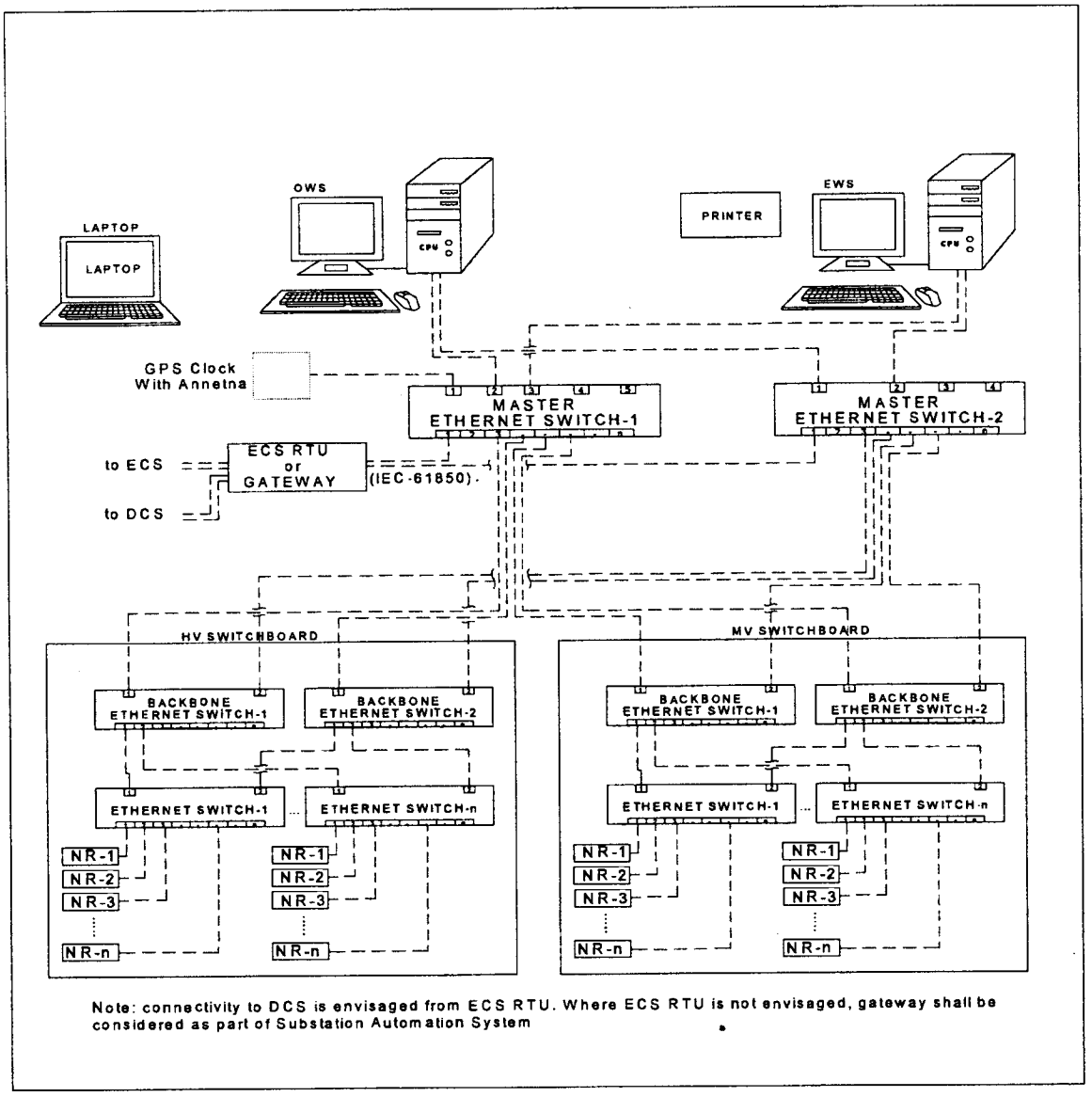

FIGURE 3: TYPICAL ARCHITECTURE FOR IEC-61850 COMMUNICATION

Project Project Management Consultancy (PMC) Services for execution of VRMP **Client** HPCL

Unit CAPTIVE POWER PLANT (CPP) **Location** VIZAG **Job No.** B016 **Unit No.** 606

PURCHASER'S DATA

Site Conditions		
Maximum Ambient Temperature	°C	45
Minimum Ambient Temperature	°C	12.5
Design Ambient Temperature	°C	45
Relative Humidity	%	95
Altitude Above MSL	m	≤5.56
Environment		Humid & highly corrosive
RELAY SELECTION		
RELAY FUNCTION		
Only Protection		☐
Protection and metering		☐
Protection and metering and control		☑
Ethernet communication		☑
Password protection		
a. For write		☐
b. For both read and write		☑
CONTRUCTION FEATURE		
Enclosure type		IP5X
Terminal size-sqmm for external wires		2.5 for control, 4 for CT/PT
Mounting		flush
Drawout feature		as per 6-51-0055
Display type		Alpha Numeric LCD + LED indication
SPECIAL REQUIREMENT IF ANY		
Applicable standards		IEC
Distance for cable capacitance for application where field		
contacts are directly wired to relay e.g. Motor start/ stop, intertrip	m	1000
INPUT POWER SUPPLY		
Site selectable feature		☑
Input supply	V	110 DC
CT/ PT INPUT TO RELAY		
Current operated relays		☐
a1 Main CT input		
a2 CT for sensitive EF or back up EF		
Voltage operated relays		☐
b1 PT input		
Comprehensive relay		☑
c1 Main CT input		3 CTs, 4 wire
c2 PT input		3 Phase, 4 Wire
c3 CT for sensitive EF or back up EF		1 CT, 2 wire input (Yes for I/C & TR fdr)
CT Secondary current		1
RELAY PROTECTION/ METERING FUNCTIONS		
CURRENT OPERATED RELAYS		
3 phase O/C element (50, 51)		* I> ☑ * I>> ☑ * I>>> ☑
Characteristics as per IEC		
* Inverse (normal, very, extremely, long) and definite time for I > and I >>		

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Project	Project Management Consultancy (PMC) Services for execution of VRMP			**Client**	HPCL
Unit	CAPTIVE POWER PLANT (CPP)	**Location**	VIZAG	**Job No.** B016	**Unit No.** 606

	* Definite time for I >>>		
	E/F relay (50N, 51N, 51G)	* I> ☑	* I>> ☑ * I>>> ☑
	Characteristics as per IEC		
	* Inverse (normal, very, extremely, long) and definite time for IO >, IO >>		
	* Definite time for IO>>>		
	Metering/ event recording		
	3 phase/ line currents	☑	
	Disturbance record	☑	
	Breaker trip/ close status	☑	
	Relay faults	☑	
	Trip Values	☑	
	VOLTAGE OPERATED RELAYS		
	3 phase O/V element with time delay (59+2)	* OV> ☑	* OV>> ☑
	3 phase U/V element with time delay (27+2)	* UV> ☑	* UV>> ☑
	Characteristics as per IEC		
	* Inverse (normal, very, extremely, long) and definite time for UV> ,UV>>		
	Under/ Over Frequency element with time delay (81U/ 81O)		
	Settable under voltage restraint	☐	
	df/dt element	☐	
	Number of stages with u/f		
	Number of stages with df/dt		
	Synchrocheck function	☑	
	Metering/ event recording		
	3 phase/ line Voltages	☑	
	Disturbance record	☑	
	Breaker trip/ close status	☑	
	Relay faults	☑	
	Trip Values	☑	
	MOTOR PROTECTION RELAY		
	Protection elements		
	Thermal overload (49)	☑	
	OC protection with doubling feature (50)	☑	
	EF protection (50N)	☑	
	Locked Rotor protection	☑	
	Maximum start time	☑	
	Maximum number of starts	☑	
	Negative phase sequence	☑	
	Under voltage delayed trip	☑	
	EF Through CBCT	☐	
	Single phasing	☑	
	Metering/ events		
	3 phase/ line current	☑	
	Hour run	☑	
	KW, KWH, pf	☑	
	Disturbance record	☑	
	Plot start characteristic	☑	

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Unit	CAPTIVE POWER PLANT (CPP)	**Location**	VIZAG	**Job No.** B016	**Unit No.** 606

Trip values	☑
Start time	☑
Start current	☑
Control	
Breaker close in test mode	☑
Reacceleartion logic	☑
Breaker trip	☑
RTD/BTD input	☑
COMPREHENSIVE NUMERICAL RELAY	
Current op elements (51, 50, 51N, 50N, 51G)	
Voltage op elements (59, 27, 2, 81U, 81O)	
Control function	
Breaker close/ trip from relay	
Breaker close/ trip on serial	
PLC logic function for control scheme	
Digital I/P & Digital O/P:	
Motor Feeder control function	
SPECIAL PROTECTION RELAYS (Refer Job Spec)	
Part of main relay	☐
Separate relay	☑
Differential relays	☑
BUS	Applicable
Feeder	Required
Trafo	as per Engineering Desgn Basis
Machine	as per Engineering Design Basis
Directional relays (67, 67N)	☑
Restricted EF (64R)	☑
Generator protection	☑
Distance protection	☑
Reverse power relay	☑
OTHER RELAY FEATURES	
Analog inputs 4-20mA	
RTD/ BTD-GPR	Required
WTI/ OTI-Trafo relay	Required
WTI= Winding temperature indicator	
OTI= Oil temperature indicator	
Out put relays	
Number of relays	As per 6-51-055
Contact rating	
Reset	
FUNCTIONS part of numerical relay	
Lock out function (86)	☑
Trip circuit supervision(95)	☑
Watch dog	☑
Time stamp	☑
Modular construction for easy and quick replacement of faulty PCB/circuit	☑
ETHERNET COMMUNICATION AND RELAY INTEGRATION	

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Unit	CAPTIVE POWER PLANT (CPP)	**Location**	VIZAG	**Job No.** B016	**Unit No.** 606

RELAY INTEGRATION	
Communication ports at Relay	
Relay front	RS 232/ RJ45/USB
Relay back	RJ45/FO
Protocol of relay LAN	IEC 61850
Requirment of Integration	
Integratori with DC	☑
Directly to MMI	☐
Topology	as per 6-51-0055
Data concentrators	YES
REDUNDANCY	
Relay LAN / serial	☑
Redundant (serial)	☑
Non redundant (star)	☑
From DC to MMI	☑
Redundant	☑
Non redundant	☐
From DC to ECS-RTU	☑
Redundant	☑
Non redundant	☐
REDUNDANCY REQUIREMENT FOR DC/ETHERNET SWITCH/MMI	
Ports at STAR coupler	
For each relay	Applicable
For DC/Ethernet Switch	Applicable
Data concentrator / Ethernet Switch	
Power supply card	Applicable
Communication port for each relay LAN	Applicable
Communication Processor	Dual redundant
SERIAL COMMUNICATION FROM DC/ETHERNWT SWITCH ONWARDS	
DC/Ethernet Switch to MMI	
Topology	as per 6-51-0055
Protocol	IEC 61850
DC to DCS	YES
DC/Ethernet Switch to ECS-RTU	YES
Scan time	as per 6-51-0055
OTHER REQUIREMENT	
Time synchronization	☑
Remote relay parameterization	☑
Annunciation at MMI	☑

MANUFACTURER'S DATA

NUMERICAL RELAY TYPES

Relay Make/Model	Serial Ports	Analouge Inputs	No of DI/DO	Protocal	Any Other Data	Remarks
Incomer						
Buscoupler						

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Project	Project Management Consultancy (PMC) Services for execution of VRMP	**Client**	HPCL		
Unit	CAPTIVE POWER PLANT (CPP)	**Location**	VIZAG	**Job No.**	B016	**Unit No.**	606

Generator							
Transformer							

DATA CONCENTRATOR / ETHERNET SWITCH AND RELAY INTEGRATION

Model no.	
Make	
Input power supply	
Voltage	
Power reqt	
Redundancy	
Power supply	
Communication processor	
Communication port	
Relay LAN/ Serial communication	
ECS-RTU interface	
MMI interface	
Serial interface/ Relay LAN	
Topology	
Protocol	
Nos of relay in each	
Topology	
Type of port	
Cable type	
Serial interface- MMI	
Topology	
Protocol	
Type of Port	
Cable type	
Serial Interface -ECS-RTU	
Topology	
Protocol	
Type of Port	
Cable type	
Number of Digital Input/ Aanalog Input (4-20mA)	
DI for substation eqpt	
Spare DI	
AI as per project data sht	
Spare AI	
Maximum Scan Time	
Status	

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Project	Project Management Consultancy (PMC) Services for execution of VRMP			**Client**	HPCL
Unit	CAPTIVE POWER PLANT (CPP)	**Location**	VIZAG	**Job No.** B016	**Unit No.** 606

events	
Data acqusition (analog)	
Disturbance record download time	
Other features	
Spare capacity for additional devices for relay LAN	
Time synchronization options	
Power walk in time	
Restoration time of communication of DC with NR & MMI	
STANDARD FEATURES OF RELAY / SYSTEM ARCHITECTURE	

Notes

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FOR REFERENCE AND COMPLIANCE TO ECS/RTU INTERFACE REQUIREMENT

FOR REFERENCE AND COMPLIANCE TO ECS/RTU INTERFACE REQUIREMENT

PART – I

GENERAL SPECIFICATIONS

OF

ELECTRICAL CONTROL SYSTEM

CONTENTS (PART-I)

1.0 SCOPE

1.1 The intent of this specification is to define the minimum functional and design requirements of a microprocessor-based data acquisition and control system called Electrical Control System (ECS). This specification covers the requirements for selection, design, hardware, software and firmware specifications, engineering, manufacture, testing at vendor's works, supply, installation, testing at site and commissioning of the system.

1.2 ECS is intended for the control and information system of the electrical system of the complex. ECS shall have requisite control computing support with appropriate number of consoles for control and information management activity. The system architecture, hardware and software of the offered system shall be proven, reliable and of industry standard.

2.0 CODES AND STANDARDS

2.1 The system and equipment shall comply with relevant BIS and other Indian / International standards, as applicable. In case Indian standards are not available for any equipment, standards issued by IEC/ BS/ VDE/ IEEE/ NEMA or equivalent agency shall be applicable. In case of imported equipment, the standards of the country of origin shall be applicable if these standards are equivalent or more stringent than the applicable Indian standards.

2.2 The equipment shall also conform to the special requirement/ provision of applicable statutory regulations currently in force in the country.

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

2.4 The ECS system & equipments / components used shall conform to the latest edition of the following and also the other Indian and International Standards as applicable:

IEC 60068-2-1/2/30/48	:	Basic environmental testing procedure (Part 1-cold, Part 2-dry heat, Part 30-damp heat, cyclic, Part 48-storage temperature)
IEC 60255	:	Electrical relays
IEC 60255 –3	:	General performance requirement
IEC 60255-5	:	Insulation tests for electrical relays (Voltage withstand test, insulation resistance test, Dielectric test, Impulse voltage withstand test, clearance and creepage distance)
IEC 60255-6	:	Measuring relays & protection equipment (Measurement of accuracy, rated burden, thermal requirement, dynamic value, limits and dependency of frequency, ambient temperature and auxiliary voltage range, marking and data, mechanical durability)
IEC 60255-11	:	Interruption to and alternating component (ripple) in dc auxiliary energizing quantity of measuring relays.
IEC 60255-21-1/2/3	:	Vibration tests/ Shock and bump test/ Seismic test
IEC 60255-22-1	:	1 MHz burst disturbance test
IEC 60255-22-2	:	Electrostatic discharge test
IEC 60255-22-3	:	Radiated electromagnetic field disturbance tests
IEC 60255-22-4	:	Fast transient disturbance test
IEC 60255-22-25	:	Conducted and radiated radio frequency emission tests
IEC 60255-23	:	Contact performance requirement
IEC 60529	:	Degree of protection provided by enclosure
IEC 61000	:	Electromagnetic compatibility (EMC)
IEC 61000-4-2	:	Electrostatic discharge immunity test
IEC 61000-4-3	:	Radiated, radio frequency and electromagnetic field immunity
IEC 61000-4-4	:	Electrical fast transient/ burst immunity test
IEC 61000-4-5	:	Surge immunity test
IEC 61000-4-6	:	Immunity to conducted disturbance induced by radio frequency field

IEC 61000-4-8	:	Power frequency magnetic field immunity test
IEC 61000-4-9	:	Pulse magnetic field immunity test
IEC 61000-4-10	:	Damped oscillatory magnetic field immunity test
IEC 61000-4-11	:	Voltage dips, short interruption and voltage variation immunity test
IEC 61000-4-16	:	Immunity to conducted, common mode disturbances in the frequency range 0 Hz to 150Hz
IEC 61158	:	Field Bus Standard for use of Industrial Control System
IEC 61508	:	Functional Safety of Electrical/ Electronic/ Programmable Electronic Safety-related systems
ENV 50204	:	Radiated electromagnetic field disturbance test
EN 55022 class A	:	Radio interference test
ISA		
S 71.04	:	Environmental Conditions for Process Measurement and control System: Airborne Contaminants
S 5.2	:	Binary Logic Diagrams for Process Operations
S 5.3	:	Graphic Symbols for Distributed Control System Display Instrumentation, Logic and Computer System
S 5.4	:	Instrument Loop Diagram
S 5.5	:	Graphic Symbols for Process Display
S 18.1	:	Annunciator Sequences and Specifications
IEEE 472	:	Electrical Surge protection
IEEE 802.3	:	Telecommunication and Information Exchange between Systems- Local and Metropolitan Area Networks- specific Requirements-Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA / CD) Access Method and Physical Layer Specifications
DIN 43760	:	Electrical Temperature – Measuring Resistance Instrument

3.0 DEFINITIONS

The various terms used in this specification are defined as below:

3.1 Electrical Control System

The term refers to a large-scale distributed measurement and control system used to monitor and control electric power generation and distribution network through a central system that monitors and controls a complete site on a real time basis. The entire ECS system is networked for communication, monitoring & control.

3.2 Configurable

A system feature that permits selection through entry of key board commands of basic structure and characteristics of a device or system, such as control algorithm, display format or I/O termination.

3.3 I/O

Input/Output with respect to process/operator

3.4 Operator Console

Operator console is the main operator's interface device via which operator can view the system and can give instructions to peripherals to execute commands and can configure & maintain the system

3.5 Engineering Console

Engineering console shall be the engineer's main interface device via which the engineer can view the system, give instructions to peripherals to execute commands and can configure & maintain the system

3.6 Redundancy

A system component shall be termed as redundant if it takes over the operation automatically on the failure of the main component without causing any interruption in the system and upsetting the process. The repaired or replaced device shall be brought in-line only through operator station.

3.7 Scan Rate

Scan rate is defined as the time cycle taken by controller / device to read & process input, perform control calculations and update control output if required.

3.8 Data Base

Data base shall be defined as the information stored temporarily or permanently in the system to meet all its functional requirements.

3.9 Event

An event shall be defined as any automatic change of state or action taken by the operator via operator keyboard and switches on hardwired console like change of set point, change of control mode, ON/OFF of circuit breaker, alarm acknowledge etc.

3.10 Sequence of Event (SOE)

Arranging events in the sequence of their occurrence in time with a specified time resolution by a program is defined as sequence of events.

3.11 Sequence of Event Recorder (SER)

System or sub-system which presents and/or records the events in the sequence of their occurrence in time with a specified time resolution utilising its hardware and software capabilities is termed as sequence of event recorder.

3.12 Real Time Trend

Real time trend shall be defined as a continuously progressing graphical record showing continuously updated parameter with most recent value and a past record of minimum 10 minutes without pressing any additional key for moving backward in time.

3.13 Display Update Rate

Display update rate shall be defined as the rate at which the information present at the system input terminal is getting updated on the current display on the screen.

3.14 Local Level

All those sub-systems which directly interface with field devices shall be referred to as local level.

4.0 SITE CONDITIONS

4.1 The equipment located in the control rooms shall be in air-conditioned environment and shall operate satisfactorily under the following conditions:

FOR	TEMPERATURE	HUMIDITY
Operation	10-35°C	20-80% RH
Storage & transportation	- 30 to + 60°C	5-95% RH

4.2 All the other equipments e.g. RTUs, Interfacing Panels etc. shall be designed for operation, storage and transportation under the following environment with the limits given below. These shall be suitable for satisfactory operation when installed in a pressurized substation with restricted natural air ventilation, in tropical humid and corrosive atmosphere. These shall be designed suitable for the site conditions specified in the data sheets. If not specifically mentioned there in, a design ambient temperature of 40°C and an altitude not exceeding 1000M above the mean sea level shall be considered.

FOR	TEMPERATURE	HUMIDITY
Operation	0-40°C	10-95% RH
Storage & transportation	- 30 to + 60°C	5-95% RH

4.3 The equipments shall withstand transportation and handling by air, sea and road under packed conditions. The equipments shall also be resistant to termite, fungus, rodents and salty environment.

5.0 GENERAL REQUIREMENT

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

5.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least for 15 years from the date of supply.

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

5.4 The ECS system manufacturer through his Indian partner or subsidiary company in India shall provide application, testing, commissioning and other necessary support for minimum of 15 years to customer. Their Indian partner or subsidiary company in India shall also maintain adequate inventory of each type of equipment / components or spares to meet the requirement arising during project execution and plant operation. ECS system manufacturer shall possess a signed MOU with their Indian partner/ subsidiary company for providing customer support

6.0 TECHNICAL REQUIREMENT

6.1 Extent of Coverage

6.1.1 Within the above geographical coverage, following electrical equipments shall be specifically covered within the domain of the ECS system:

- Turbine Generators i.e. STGs / GTGs
- Grid supply, Switchyard, EHV system
- HV switchboards of CPP and other plant substations
- MV switchboards, as applicable
- Transformers
- AC UPS, DC System
- Outdoor lighting

6.1.2 The minimum extent of coverage and functionalities for the ECS system shall be as given in the engineering design basis document.

6.1.3 The single-line diagrams of sub-stations shall be guidelines for I/O counts, displays and diagrams for control and supervision. Certified copies of these shall be released for ECS design. A tentative estimate of feeders and a feeder-wise list of I/Os shall be as specified in the data sheets.

All I/O points shall be interface-able to the Owner's switchgear or control gear as specified. Necessary transducers and its housing shall be provided wherever required, to receive signal from CT and PT. One set of CT and PT signals shall be given for MW, MVAR, frequency, current and voltage measurements. All digital output points shall be through interposing relays in sealed unit of proper voltage and current contact ratings directly interface-able in switchgear control circuits. Transducers and interposing relays shall be housed in panels and placed in the RTU panel line-up.

6.2 Basic Functionalities of the ECS System

Basic functionalities of the system shall be provided as described below:

6.2.1 Monitoring and Control of the Electrical Plant

a. The ECS system shall achieve the following functions related to control and information generation system:

i. Electrical plant's data acquisition and display
ii. Routine log report generation and energy balance reports
iii. Detection and reporting of alarms
iv. Sequence of event recording
v. Controls as per the required extent of coverage

b. The information system shall cover the acquisition and display of voltage and frequency of each line and bus; the real power, reactive power and current of feeders; computed or acquired variables like power factor.

c. The system shall facilitate monitoring and control with electrical diagrams (graphic displays).

6.2.2 **Sequence of Event (SOE) Recording**

a. For sequence of event recording for the power plant block, following hand reset contact signals shall be considered:

i. Protective relay trips of generators (To the extent available from the relay)
ii. Lockout relay (86) contact for all HV feeders
iii. Lockout relay (86) contact for all MV feeders, as applicable

b. For sequence of event recording for areas except power plant block, "Circuit Breaker OFF" contact for all HV feeders and MV feeders, as applicable, shall be considered.

c. The sequence of event recording shall be with a resolution of 1 msec or better and shall be recorded in ECS only for the hardwired potential free contact inputs.

6.3 Advanced Functionalities of the ECS System

The ECS system shall achieve certain application-software-aided advanced functions for integrated control and monitoring of the electrical plant . These functions are customer need based and beyond the basic functions described in previous sections. This is to achieve software based advanced level control and supervision of the electrical plant with the data and information acquired through the base level functions. The software shall be reliable and proven with appropriate configuration tools for building and modifying the configuration. The advanced level functions envisaged are:

6.3.1 Load Control and Tie Line Control

Total load of the plant at any given time is dependent on the number of process units on line and their production. Load control software shall be aimed at managing the power requirement of the plant by generating set points for the TGs. This software shall have provision to load a generator within a minimum and maximum loading regime and load ramping rates recommended by machine manufacturer.

When the plant is running isolated from grid, this software shall dictate the load sharing between generators and isochronous/ droop mode of operation of the machines. When the plant is running parallel with the grid, the software shall also ensure import/ export to/ from grid within predetermined limits. This tie limit shall be operator settable and shall be fixed in such a manner as to maximise power plant capacity utilisation.

6.3.2 Load Shedding including Maximum Demand Limit Control

Electric load shedding shall consist of fast and slow load shedding as described below.

6.3.2.1 Contingency based fast load shedding

a. This load-shedding software shall operate based on contingency analysis procedure as applicable in industrial power system for emergency control. The program shall determine all possible islands which may arise due to breaker trip, and shall try to save the island from collapsing due to generation deficiency by shedding appropriate amount of load while taking into account the machine dynamics and the spinning reserve available on various generators. The software shall be equipped to handle cases of running generator trip in an island mode.

b. To calculate power deficiency, the import from grid, wherever applicable, shall be generally limited by the maximum demand limit. The loads shall be selected based on their current magnitude, and based on the priority from a predefined table. The program shall update each pre-calculated table on every scan. Status of critical circuit-breakers, opening or closing of which change the island configurations of the power system, are to be actually acquired and read by the load shedding program every 0.05 second (or less) in order to permit immediate corrective action due to islanding based on the contingency analysis already done. This load shedding (fast shed) is required to take place within a specified time from the instant of island formation. Thus a two-level execution of the full functionality can be adopted. The system shall allow updating of the priority table, and also inhibiting any breaker from load shed out of the assigned loads for shed. The program shall also allow saving emergency power from tripping. Loads shall be earmarked for shedding in the event of a generator trip within an island. A minimum of 100 load groupings and priority settings should be possible, however the actual number of load grouping shall be decided during detail engineering & can be in excess of 100 load groupings.

c. Load shedding reset shall be done through global reset command or invidual feeder reset, which shall be field settable.

6.3.2.2 **Slow load shedding**

a. In case of generator over-load or due to decrease in frequency, the load-shedding program shall shed the load of least priority. Such load shedding shall take place after the occurrence of the overload / under frequency has been detected by ECS (real time shed).

b. The real time shed program will continue to shed next available least priority loads till overload / under frequency condition is mitigated.

c. Real time load shed shall also act as a back up to fast load shedding described above. Hence, real time load shed action shall be comparatively slow.

d. Real time load shed based on under frequency shall be blocked for an island that has grid support.

e. Slow load shedding shall also take place on sustained overloading of grid transformer, tie transformer and / or generator(s)

f. Minimum four stages of under frequency shall be considered for slow load shedding scheme

6.3.2.3 **General**

a. For each shed-able load, there shall be a bus assignment. This shall pertain to the source bus to which it is connected. If due to a bus transfer or isolator switch transfer, the bus assignment of a load changes, the same shall be dynamically updated based on the monitored status of network. The ECS supplier shall carefully weigh this requirement after a thorough analysis is made, and shall include this feature in his software.

b. The load shedding program shall carry out extensive check and cross-check routines. A typical example of cross-check routines for a circuit breaker open condition shall check that the relevant power measurement turns zero, circuit breaker status is OPEN and NOT CLOSED. Further, the trip-circuit healthy status of the concerned circuit breaker shall also be taken into account while selecting a feeder for load shedding. The above and similar checks and cross checks on correctness of input signals under certain circumstances may eliminate a circuit breaker from load shedding. In other cases, it may detect only an abnormality. This should lead to a system-generated alarm aimed at reconstruction of missing information.

c. Remote I/O communication, if proposed, shall not be a bottleneck for time-critical controls such as load shedding.

d. Load shedding shall be applicable for feeders upto HV level unless otherwise specified.

e. Load shedding operated annunciation from ECS, is to be provided at all locations in the plant. Hence, 1 no. potential free DO contact (latched) shall be kept reserved at every ECS location for load shedding operated annunciation. This contact shall be wired to their respective process DCS / annunciation panel to annunciate load shedding operated condition. The contact shall be reset by the ECS operator once conditions are mitigated.

6.3.2.4 **Maximum demand limit control**

a. This software shall calculate a demand limit error when the generators are connected to the tie line, to predict the error that would be experienced at the end of the preset 15 minutes (or a user defined set period) if nothing were to be changed. The maximum demand limit shall be an operator-entered value.

b. The method of calculation is

- Time into the present period
- The integrated energy consumed during the period, expressed as MWh / h= MW
- The present tie-line power is MW, i.e. the slope of the line to the right chosen point

1. From this information, the predicted overshoot of maximum demand at the end of the period shall be computed. Load shedding shall be initiated at an appropriate instant within the demand interval whenever warranted so as to limit the power exchange with grid within stipulated limits. The ECS supplier shall offer the above scheme, or a suitable modified scheme, to satisfy the above requirement.
2. The software shall have to work under situations where the demand limit start period is defined by others (fixed window), as well as when the demand limit start period is not defined (sliding window)

6.3.3 **Synchronisation**

a. The synchronizing facility for synchronization of circuit breakers shall be provided in the ECS.

b. List of circuit breakers where synchronization facility is to be provided shall be as specified elsewhere. Unless otherwise specified, synchronisation of DG set is excluded from ECS scope.

c. ECS supplier shall provide full software based synchronisation scheme. If this is not possible, the ECS supplier shall use a software-cum-hardwired combination to achieve the objective. Synchronising facility shall be LCD monitor screen based and user friendly.

d. In the part hardware and part software based scheme, the hardware shall mainly consist of dual-redundant autosynchroniser and check-synchronising relay. With this facility, it shall be possible to synchronise all sources from a centralised location without the necessity of moving around with a synchronising trolley.

e. The ECS supplier shall provide appropriate graphics displays with standard keyboard functions for synchronising manually and automatically all sources of unsynchronised power that are likely to be synchronised. Plant operator shall be required to carry out coarse control of the voltage and frequency of the controlled source. Once the voltage and frequency of controlled source is brought within a reasonable band of that reference source, the autosynchroniser shall get activated and synchronise the circuit breaker without further operator intervention.

f. Graphic displays shall be user-friendly and shall assist the plant operator in proper selection of control source and reference source once a circuit breaker has been selected for synchronisation.

g. The ECS supplier shall note that the control voltages of various machine controllers and circuit breakers could be different and shall design the scheme accordingly.

h. It shall be possible for operator to select circuit breaker synchronization in "11 o clock" and "1 o clock" positions and monitor the same in real time during synchronisation.

6.3.4 **Capacitor feeder switching for power factor improvement**

ECS supplier shall supply software that will advise the plant operator to Switch ON / Switch OFF the capacitor banks provided in HV switchboards. The software, while advising switching ON of a capacitor bank, shall check that none of the other circuit breakers in the network is likely to be subjected to leading power factor interruption duty. If a capacitor feeder has been switched ON and subsequently, due to load change, the same is found likely to be subjected to leading power factor interruption duty, then the software shall advise the operator to switch OFF the capacitor bank. The software shall take into account the changes in power flow arising out of automatic bus transfers in the switchboards.

6.3.5 Proper Data validation and data reconciliation packages shall be provided to enable proper working of the software (s).

7.0 TYPICAL PERFORMANCE MEASURES OF ECS

7.1 The ECS supplier shall guarantee following typical performance measures for ECS:

Performance	Time
Hardwired analogue input acquisition	1 s
Analogue input acquisition from relay LAN	2 s
Digital input acquisition from relay LAN	2 s
Hardwired digital input acquisition	1 s
Fast load shed operation time	100-200 ms
Operator initiated control command execution time	2 s
Display recall time on monitor	10 s

7.2 Data acquisition time in the above context shall mean the time elapsed from the instant of change taking place at field to the instant it is reported on the system console. Similarly control command execution time shall mean the time elapsed form the instant of command issued at the console to the instant of corresponding output relay actuation at I/O rack assembly in the field including overheads for check before execute feature. Load shed operation time shall mean the time elapsed from the instant of island formation / generator trip to the instant of corresponding output relay actuation for load feeder shedding at I/O rack assembly in the field.

8.0 CONFIGURATION OF CONTROL AND MONITORING SYSTEM

8.1 The ECS system shall have a suitable open architecture configuration to allow distributed data acquisition, control and information generation for the plant with application software aids.

8.2 Configuration

8.2.1 General

i. The system shall be configured with distributed data acquisition and control units (hereinafter referred as RTUs i.e. remote terminal units) with required I/O interfaces in various sub-stations and control rooms. These units should be capable of carrying out local control functions for a faster action in plant control and shall have capability for data acquisition of all data types, sequence and logic execution and all standard control algorithm. If all these capabilities are not available at local level, the ECS supplier shall justify the selection of the system offered with respect to response requirements of various functions spelt out in clause 7.0 above.

ii. These units shall bi-directionally transmit and receive data and commands from the central station equipment and consoles. These transmissions shall take place through

data highway and data channels of suitable physical media (henceforth called "data highway"). The remote units shall be connected (multi-dropped or otherwise) on the data highway. The central station(s) shall have operator consoles, computers and other sub-systems, as may be required. The central station and its associated equipment shall be connected to the data highway and the complete system, thus configured, shall control bi-directional transmission of data with error detection and suitable retransmissions and recovery schemes. If the processing load appears more, then the system can be configured suitably with intermediate or front-end processors.

iii. The computer, consoles and other devices exchanging bulk data can either be placed directly on the data highway segment coming from the plant and/or be placed on a separate information highway having a high transmission rate. The information highway should also be a metal free fibre optic cable network and shall have suitable communication link or gateway to the data highway.

iv. System control shall be possible from various locations as described in clause 8.011.1.11.5.4. Therefore, alarms and graphics shall be grouped and available to the relevant task area. The offered system shall have adequate password security measures to safeguard against unauthorised operation

8.2.2 Time Synchronisation

Internal clocks of all controllers, concentrators, SOE modules, work-stations and remote I/O drops, shall always work in synchronism such that there is one and only one system-wide time. GPS shall be provided to synchronise with an external satellite clock.

The system shall have capability to synchronize the time of all the sub-systems/ nodes within the system using the GPS time reference provided by GPS clock. This shall ensure that data acquired by all sub-systems will have the same and common global time reference.

In general, the system shall be provided with external GPS antenna connected to GPS clock. The primary server internal clock shall be designated as "Master Clock" for the overall system Date and Time Facility utilizing time reference from GPS clock and all the sub-systems/ nodes in the system shall be synchronized with the master clock.

In case of failure of Master Clock, the alternate sub-system internal clock (as defined during system configuration) shall automatically assume the charge of Master clock for providing time-synchronization utilizing time reference from GPS clock.

In case of failure of GPS clock, the time synchronization shall continue to be provided by the available Master Clock.

All hardware and/or software required to meet this requirement shall be supplied by the Vendor.

For the requirement of synchronisation of relay HMI and numerical relay clocks, refer elsewhere.

8.3 Redundancies and Backup

The system shall be configured with dual redundant sub systems throughout, including communication sub systems and power supplies, except at I/O interface, engineering console and historical storage, unless specified otherwise. Accordingly all substation and control room equipment, data highway, communications, consoles and computer sub systems (if required) shall have dual redundant configuration. Each RTU of a redundant pair shall have interface with both data highways.
One shall be normally working and other shall be kept as hot standby. In case of failure of the normal working system, the backup system shall be switched on without any loss of information and degradation in control performance.
The health of normal and standby sub systems shall be monitored and the changeover of status shall be notified in the appropriate display in operator console. While this dual redundant scheme is acceptable, the ECS supplier shall have to ensure overall availability of the system as specified.

8.4 Communication with Foreign Devices

a. Foreign devices like numerical relays and communicable meters etc. shall communicate with ECS for intended plant monitoring and control.

8.5 Communication with Existing ECS / SCADA System

a. The proposed ECS system shall exchange data bilaterally with the existing ECS / SCADA of the complex as defined. ECS supplier may seamlessly integrate existing ECS / SCADA into new ECS to achieve the same. If this is not feasible, an OPC link as defined below shall be supplied.

b. 1 no. non redundant point to point connection over Ethernet (TCP/IP) from one of the proposed ECS nodes at control room shall be provided for connectivity between proposed ECS and existing ECS / SCADA. ECS end node shall be an OPC server. The media shall be twisted pair cable of 10baseT specification. The existing ECS / SCADA end node will not function as a router and shall be configured as a slave. The new ECS node is required to operate as master for communication control on this link. The Volume of data exchange between proposed ECS to existing ECS / SCADA shall be on "as required" basis. Any hardware and software required at the existing ECS / SCADA end shall be provided by vendor including termination of the cable at the both ends.

c. The communication scheme should not be a bottleneck for the successful operation of all control systems with defined functionalities during the lifetime operation of the system. If a different protocol for digital transmission of bilateral data is chosen, the ECS supplier shall appropriately select the interface hardware, protocol and suitable networking software for this transmission and coordinate suitably with the existing ECS / SCADA provider for the proper functioning of the data link.

9.0 DATA ACQUISITION FROM SWITCHGEAR / CONTROLGEAR AT VARIOUS SUB STATIONS

Data shall be acquired in the field RTUs located at various substations at convenient locations. The details of data shall be as defined in job specific IO list.

10.0 DATA ACQUISITION AND CONTROL UNITS AT SUB STATIONS

10.1 Units at Sub Stations

a. These units distributed at the various locations in the field shall acquire electrical plant data from sub station switchgear and associated devices. These shall be microprocessor based units with relevant I/O cards and serial port interfaces. These units in conjunction with central units shall ensure full functionality of the ECS system. Processor system shall be configured in dual redundant mode. These units shall send and receive error free data from the central station. Specification of hardware as given earlier shall be applicable for relevant sub systems in these units. Remote I/O, with relevant I/O cards and serial port interfaces can be considered instead of full fledged data acquisition and control units (RTU) subject to proper justification provided by the ECS supplier to prove that this shall not degrade the ECS system performance as outlined in the specifications in any manner whatsoever. All requirements with respect to hardware, redundancy etc. as spelt out earlier shall be applicable for these units also.

b. The panels shall be free standing and suitable for operating in the environment prevailing at site without air conditioning. The power requirement of these units shall be indicated by the ECS supplier. Programming of these units should be possible from central station and also locally with some device which can be connected to one serial port.

10.2 Data Highway

a. Communication between the ECS control centre and the individual units located in different substations shall be by means of a dual redundant data highway. For the purpose, communication link from remote I/O shall also be included in the definition of data highway. The system shall be fully operational even with one highway out of service with

no degradation in performance. The data highway media shall be metal free fibre optic cable.

b. The data highways shall be effectively immune to all types of electrostatic and electromagnetic interference (EMI) that can be expected in power and process plants. The ECS supplier shall state in detail, the precautions which must be observed in installing the highway in order to minimise interference.

c. The protocol employed could be the ECS supplier's standard provided that it meets the following minimum requirements:

   i. Check-before-execute shall be employed for all changes in plant status transmitted over data highway. As a minimum this includes Start, Stop, Close & Open instructions.

   ii. It shall be possible for any station on the highway to fail or be physically removed without interrupting full communication of all other stations.

   iii. Both redundant highways shall operate at all times. There shall be no need to "fail over" and initialise to a standby cable. Diagnostics to check the status of both highways shall run continuously. Failure of a data highway or of one of the stations on the highway shall be alarmed and reported on an appropriate video screen display.

10.3 HDPE Duct for Data Highway

The fibre-optic cable for the ECS data highway shall be laid in HDPE duct by compressed air blowing technology. The HDPE duct, to be supplied for fibre optic cable routing, shall be permanently solid lubricated / with internal spiral groove, UV-protected, fire-retardant (class V2 as per UL-94 and with limited oxygen index of 21 or higher as per ASTM D2863), of 40 mm outer diameter (+5.0/-0.0 mm), minimum thickness 3.7 mm, suitable to withstand load of 6 kg/cm^2. HDPE ducts shall be supplied in drum lengths of 500m. HDPE ducts of two different colours shall be supplied to distinguish between the two redundant data highway cables. For routing information highway cables, if any, HDPE ducts of third (and fourth) different colours shall be supplied.

All HDPE ducts shall be supplied alongwith accessories such as push fit coupler, bend and elbow, end plug, simple plug, sonic head etc. required for blowing cable into HDPE duct by compressed air technology

10.4 Data Transmission Media and Procedure

a. The media for data transmission to outstation units shall be metal free fibre optic cable with a minimum of 4 spare fibres, and having characteristics stated above. The information network, if used, shall also have the same characteristics. Procedure of data transmission, error control and recovery shall be as per acceptable standards.

b. Fibre optic data highway cable shall conform to DoT–TEC specification No. GR/OFC/01/04SEP03/GR/OFC-01/05 JUN07 and its latest update. Cable shall be suitable for water submergence duty and high temperature withstand as per the routing requirements in the plant. All lengths shall be joint free single continuous lengths.

c. Protective Materials/ Coatings – Optical fibres shall be coated with UV cured double acrylate resin. It should not have any reaction with cladding or core material.

d. The coatings shall be in various colours in order to facilitate fibre identification. Fibre colours shall correspond to IEC publication 60793-2 and 60304 and their latest updates. The colours shall correspond reasonably with standard colours and shall be readily identifiable and shall be durable. The colours should have good colour fast properties also in the presence of other materials during the lifetime of cable. The coating and the colour shall not react with the surrounding jelly.

e. The fibre optic cable shall be protected against damages from termite, rodent, chemicals (such as oil & natural gas, LPG and other petroleum products), moisture and water over the life time of the cable.

f. The optical fibre cable construction shall be of loose tube type and there shall be one fibre per tube. The cable shall have central strength member, inner and outer sheaths and moisture barrier layers.

g. The main cable core containing fibres and core wrappings shall be provided with moisture barrier protection by means of flooding compound (jelly) having properties of non hygroscopic dielectric material and / or by water swellable tape. The core wrapping shall not adhere to the secondary fibre coating.

h. The cable shall have sufficient strength to withstand a load of value $T = 9.81 \times W$ newtons, where W = mass of 1 km in kg. The load shall not produce total strain exceeding 0.25% in the fibre. Solid FRP non-metallic strength member / members in the cable core / sheath shall be provided. Aramid yarn can further be used in the periphery over the core of the cable to achieve required tensile strength.

i. The termination enclosures of the optical fibre cable should be dust tight (No dust ingress) and protected against immersion in water (suitable for continuous immersion in water) and should be complete with all accessories including splice cassettes splice protection and all other accessories including accessories for electrical continuity of metallic layers of optical fibre cable and OFC preparation kit alongwith instruction sheet.

j. All fibres (including spare fibres) of a cable shall be terminated in the termination enclosure by pigtails. Subsequent connection shall be by patch chords. Supply and erection of termination enclosure, pigtail, patch chord etc. shall be by vendor.

10.5 Input and Output Panels

10.5.1 General

These panels shall be located in different substations and control rooms. Besides housing I/O cards, the units at sub stations mentioned above shall also be housed in these panels. These shall acquire data and transfer them to the central control station. All commands from the central control station shall be executed through these remote panels.

Transducers and interposing relays shall also be housed in similar panels to be supplied by vendor.

Various input output modules shall be as given below. The number of channels used per input and/or output module shall not exceed 16. I/O cards shall be on-line replaceable type, i.e. these shall be "hot-pluggable".

10.5.2 Discrete input module

a. Ability to sense the change of state of a voltage free dry SPDT contact. Contact bounce shall be suppressed. It shall also have high noise immunity. NO, NC and common terminals shall be made available for wiring.
b. Ability to register a single momentary change of state while suppressing jittering of contacts.
c. At least 1.5 kV rms isolation between input lines and system ground.
d. All inputs should have galvanic isolation, preferably with isolators.

10.5.3 BCD input module

a. Shall be capable of accepting at least 8 digit BCD in dynamic counter.
b. The input data to be buffered.
c. The input should be capable of either accepting TTL signals with common ground or 0 to 10 V/ 24 V signals with common ground.

10.5.4 Hardwired analogue input module

a. The input range to suit CT and PT outputs, RTD output, 4-20 mA or 1-5 V as applicable.
b. Input impedance greater than 1 M ohm.
c. A/D resolution minimum 12 bits without sign bit.
d. Overall accuracy shall be better than 0.2% of full scale ± 0.5 LSB.

e. Common mode rejection shall be better than 80 db, from DC to 100 Hz.
f. All inputs shall have galvanic isolation (opto-isolation can be considered)
g. 24 V DC onboard power supply (if required) for self powered transducers.

10.5.5 **Analogue output module**

a. Output shall be 4-20 mA DC current source to drive a load of minimum of 600 ohm.
b. D/A resolution of 12 bits minimum.
c. Overall accuracy shall be better than 0.2% of full scale.
d. The output resolution shall be better than 0.5% over the range and temperature linearity shall be better than 0.3%.
e. All outputs shall be protected from short-circuits.

10.5.6 **Control On/Off output module**

a. Shall be provided with magnetically latched and sealed plug-in relay outputs.
b. The relay contact resistance less than 300 milliohm at full loading over the rated life.
c. Relay outputs shall be protected from short circuits.
d. Interposing relay coil voltage shall be 24V DC.

10.5.7 **Sequence of event (SOE) cards**

a. The purpose of SOE cards is for monitoring of field status point, recording and time tagging of changes in plant status. Overall system shall work in conjunction with inputs from these cards.
b. Shall have 16 contact inputs
c. Shall be optically isolated for each input
d. Shall be able to withstand a voltage of at least 1.5 kV rms isolation
e. Shall have a resolution of 1 ms or better for event recording
f. Event buffer shall be dual to permit reading from one and entering into the other
g. Shall have on board clock to time tag status changes. Clock shall be 1 minute range, GPS-synchronisable clock with resolution of ±1 ms or better.

10.5.8 **Pulse input card (if required)**

a. Shall have pulse input for speed and energy signals
b. Shall have 2 channels
c. Maximum frequency shall be 1.5 kHz
d. Shall have a capacity of 16 bit counter with 16 bit software overflow extension with interrupt to central station.
e. Interface shall be differential optically isolated.

10.5.9 **Pulse output card (if required)**

To suit the ECS supplier's requirement for software operation, digital output port with pulse generation logic may be used.

10.5.10 **Interposing Relays**

a. Shall be plug-in type
b. Coil voltage shall be 24V DC
c. Configuration shall be less than 1NO + 1 NC
d. Pickup time shall be at most 35ms for make contact (NO) and 15ms for break contact (NC).
e. Dropout time shall be at most 5ms for make contact (NO) and 15ms for break contact (NC).
f. Maximum system voltage within set of contacts shall be 450V dc to 400V ac.
g. Current carrying capacity for already closed contacts shall be at least 55A (200ms), 30A (1s) and 6A (continuous)
h. Making and conducting capacity with L/R> 10ms shall be at least 30A (200ms), 20A (1s) and 30A (1 s with 2 contacts in parallel).
i. Breaking capacity with AC PF> 0.1 and max 250V shall be at least 20A.

10.6 Transducer and Relay Panel Assembly

10.6.1 General

It is intended that only CT and PT inputs shall be given as analogue inputs for each circuit from the electrical plant where hardwired measurements are envisaged. From the current and voltage measurements, the system shall compute active and reactive power, frequency, power factor and energy. The ECS supplier shall keep necessary provision in hardware and software to achieve this. Alternatively separate transducer panel to compute these from current and voltage measurements shall be offered. 19" rack assembly with preferably one card per computation with provision of transmitting each of these signals to the central station every 1 second or in shorter intervals is required.

All the cabinets shall be free standing enclosed type with uniform height and depth. The maximum height shall be limited to 2100mm.

All the RTUs enclosures shall conform to IP-41. The RTU cabinets shall also include a foldable/sliding tray at convenient location for mounting the PDT to facilitate diagnostic and maintenance functions.

All cabinets shall be with lockable front and rear doors and bottom cable entry and with gasket and fittings to keep out moisture, corrosive salts, dust & gases. All doors, drawers, trays and other weight supporting parts shall be fabricated of metal adequately reinforced to limit vibration and ensure plane surfaces and shall be well-housed and tidy in appearance.

The power distribution cabinet will have isolating MCB for each of the incoming feeder and lamps shall be provided for each of the incoming feeder which shall be visible from the outside through glass plate on the front of the Power distribution cabinet. The MCB identification along with the name of the equipment it is meant for, need to be provided. Power distribution cabinet shall have 25% spare MCBs for each rating of the MCBs. Nameplate for indicating lamps and manual reset push buttons shall also be provided.

Static electricity discharging wrist straps shall be provided in all the cabinets.

10.6.2 Cabinets Finish

All frame and steel work of the cabinets shall be degreased, then phosphate treated or coated with primer, followed by at least two undercoats and a final coat of epoxy based paint. The final colour shade shall be 631 of IS:5/ RAL- 7032.

All the cabinets shall have documentation pockets located inside the front door & 'Nameplates' correlating with the type and location of the cabinet. Further all the equipments within cabinets shall be clearly identified with screw-on labels. The cabinets shall be provided with lifting eyes.

The ECS & power distribution cabinets shall be constructed to allow free airflow to dissipate heat generated. Construction shall be such that ventilation grills will not be obstructed when equipment is mounted in its installed position. In order to effectively remove dissipated heat from the cabinets, vent louvers backed by wire fly screen shall be provided. ECS vendor shall calculate the heat dissipation and where the calculations prove the necessity, then air flow ventilation shall be assisted by integral low power silent running air extraction fans and same shall be provided. Inlet ventilation grills shall be fitted with dust filters

All the equipments shall be properly mounted to facilitate ease of maintenance. All individual equipment modules shall be easily accessible and removable. All internal wiring and cabling shall be installed in wiring ducts.

Additional power sockets shall be provided to accommodate test & maintenance equipment.

The low power cabinet lights 2 nos. on front and rear side of the cabinet (activated by available DC voltage level in the RTU cabinets & AC voltage level in the ECS cabinets & Power distribution cabinet) shall be provided, activated by respective front & rear door opening.

10.6.3 **Mounting**

All modules shall be firmly mounted to the chassis with front access screws. The rear back plane assembly shall be mounted from the back of the rack and connect the modules with the field wiring. A current circuit interlock shall have shorting switches that are activated when the module is removed from the rack. This shall protect current transformer from getting open circuited. High current diodes shall be provided for additional protection for shorting switch failure and also for open circuit condition occurring during insertion and removal of modules. A minimum of 20% spare terminals shall be provided in each terminal block.

10.6.4 **Power supply**

Each transducer and relay panel shall be provided with its own power supply unit consisting of at least two redundant hot standby power supply units. These units shall only supply the internal circuits of the transducer and relay units. The status of each power supply unit shall be available for display on the system. Also, low priority alarm shall be generated during switchover to the back up power supply unit.

10.6.5 **Calibration requirement and accuracy**

The transducers shall be sent from factory with calibration done. This shall not normally be affected during transportation. However, vendor shall supply procedures and kits for calibration at site at a later date. Transducers shall be highly accurate (within ± 0.5%) and this accuracy shall have to be demonstrated at factory and at site. Recalibration of all transducers at site is therefore included in the scope of vendor. Vendor shall furnish calibration report and routine / type test certificates for all transducers and interposing relays.

10.6.6 **Wiring and enclosures**

10.6.6.1 Vendor shall use wires of required length preferably with plug-in connection at I/O card end for interpanel wiring connection between dummy, transducer and relay panels to I/O cards of remote units. The wires shall be 650/1100 V grade, copper conductor, 2.5 mm^2 size, PVC-insulated.

10.6.6.2 The panels shall withstand continuous usage in a harsh environment as specified and shall perform without loss of accuracy. The components should have high MTBF and low MTTR.

10.7 System Power Supplies

The ECS supplier shall indicate the power supply requirement of all equipment giving details of voltage, frequency, kVA rating, power dissipation, quality of power supply required in terms of voltage and frequency tolerances, harmonic content, inrush current requirement, etc.

11.0 SUB SYSTEM HARDWARE SPECIFICATION

11.1. The system shall as a minimum meet the following requirement:

a Control including On/Off control
b Data acquisition, monitoring and information generation
c Alarming
d Event and sequence of event recording
e Logging and report generation
f Historical data storage and retrieval
g Trending (historical and real time)
h System health check and switch over to redundant system
i Functionalities of application software
j Communication to other system and foreign devices

11.2. General

a. System hardware shall be highly reliable with a high degree of fault tolerance and with extensive built-in diagnostics. It should be easy to operate, maintain and these should be easily extendible. The entire system should consist of as few types of cards as possible. The system with lesser number of types of cards shall be preferred.

b. All sub system processors shall be based on microprocessors with the following characteristics and features:

i Word length of 32 bits
ii Broad range of memory addressing modes
iii Direct memory addressing
iv General registers
v Input / output control structure that permits priority assignment of interface and peripheral devices connected to the I/O bus
vi Floating point arithmetic

c. Sub systems with reliable and proven class with RISC architecture can also be considered.

d. The sub system involved with processing of real time control tasks and advanced application software with dual redundant configuration shall have following features:

i Power fail / auto start
ii Watch-dog timer
iii Real time clock
iv Memory protection

Notes:

i The processors at every level shall have capability to implement all the intended control functions required, but not all of the advanced application software.
ii The memory capacity shall be sufficient for storage of the program instructions as per segregation of tasks in various processors of the system.
iii RAM memory shall be non-volatile, preferably flash disks. However, in case of volatile memory, battery backup shall be provided with a minimum of 3 months life-time to keep the program storage intact.
iv Watch-dog timer shall be a software device. The healthiness of processors shall be continuously monitored by the watch-dog timer. Any hardware or software problem in the processor system, which shall include CPU, memory, power supply, communication interface, shall cause the watch-dog timer to report a processor failure.
v Changeover from active to standby processor shall be automatic and bumpless in case of failure of the active processor and the system shall be fail proof. Redundancy shall be provided for complete processor system including CPU, memory, power supply and communication sub system.

11.3. Computer

a. All computers shall be of the latest available configuration of HP or equivalent make. The operating system shall be WINDOWS based and graphical user interface shall be X-WINDOWS. The CD-ROM drive shall be of internal type with read / write facility wherever applicable, with data transfer rate of 32X or better.

b. Computers shall be in dual configuration, with a switchover time less than 1 second. CPU occupancy shall be less than 60%. The operating system shall be resident on the hard disk.

c. The system shall have capability for automatic switchover to the standby computer in case of failure of hardware or software of the active computer without causing any degradation in the system performance.

11.4. Bulk Memory

a. Wherever required, ECS supplier shall supply bulk memory in the form of hard disc. It shall be equipped with all necessary read / write amplifiers, addressing equipment and control. An interface for direct memory access channel shall be provided.

b. ECS supplier shall indicate total capacity of the bulk memory that shall be provided at each level wherever required, the memory organisation, data transfer rates and available operational features. Adequate capacity shall be provided to allow execution of all on line functions, and 25% spare capacity shall be provided for expansion of the system.

c. The bulk memory shall provide high reliability with error detection and correction in hardware form. ECS supplier shall advise the Owner on the feasibility of adding spare disc drive capability for additional disc capacity.

11.5. Operator's Console

11.5.1 Operator interface sub system consisting of operator consoles shall provide the centralised information to the plant operator / engineer. These information shall pertain to indication of all analogue and digital variables, closed loops, open loops and all parameters related to manipulation of control loops, alarm display and annunciation, graphic display and status indication, logging, trending including historical trend recording, display of ladder and control loop/blocks under execution, self diagnostic messages, display of control system/sub system status and application software diagrams.

11.5.2 All the displays on all the monitors in the console shall be interchangeable.

11.5.3 Each operator console shall consist of a monitor and keyboard. Each operator console shall be driven by independent redundant drop electronics. Alarm and event printer and hard copy screen copier unit shall be provided as per the indicative configuration drawing.

11.5.4 2 nos. operator consoles shall be located at CPP control room, unless specified otherwise.

11.5.5 **Monitor**

Screen	21" diagonal, flat, TFT, non interlaced, anti glare, black background
Alpha-numeric display	40 lines x 80 columns
Display resolution	1280 x 1024 pixels
Features	Virtual image display function, window display function, overlap display function
Character set	96 character ASCII (7X9 or 8X8 dot matrix format) and 64 user defined symbols
Colour capability	Minimum 256 colours
Cursor	Blinking underline or cross-hair
Data display update rate	< 2 seconds
Screen refresh rate	87 Hz or better

Cursor control shall be possible with keyboard and a track-ball or touch-pad (integral with keyboard and flush mounted in console).

11.5.6 **Keyboard**

The operation keyboard shall be flush with the console desk. It shall be self explanatory, easy to operate and maintain. The keyboard shall preferably be of touch sensitive membrane type. Each press of key shall be registered with an audio beep. The system shall permit the operator to initiate or cancel system services through the keyboard, enter information into the system and request information from the system. Each keyboard shall include a keylock which, when operated, shall unlock selected sub sets of operator functions. In addition, the ECS supplier shall propose functions keys for ease of operation. These function keys shall be integrated with the alpha-numeric keyboard.

11.5.7 **Alarm / event printer**

Type	Dot matrix printer Distinction between alarm and events shall be achieved by BOLD/HIGHLIGHTING/ITALIC etc. to be finalized during details engg. stage.
Speed	Minimum 300 cps
Number of print columns	Minimum 132 characters per line
Character set	96 ASCII character set
Paper type	Continuous fanfold, 381 mm width

Number of copies	Minimum 3
Bi-directional printing feature	Yes
Acoustic cover	Yes
Noise level while printing, at 1 m distance	Less than 65 dba
Mounting	Self-contained integral with stand
Paper feed	Both friction and tractor feed
Test pattern generation	Required
Identification of alarm	Required by dual colour for alarm and events

11.5.8 **Log printer**

Type	Black and white laser printer with duplex printing capability, HP LaserJet 5000 or equivalent
Printer memory	8 MB
Printing speed	16 ppm
Print resolution	1200 dpi
Paper type	Plain paper
Maximum paper size	A3
Paper trays	A3 and A4
Paper tray capacity	850 sheets
Networking capability	Network-ready
Mounting	Self-contained integral with stand

11.5.9 **Hard copy screen copier printer**

Type	Colour inkjet printer, HP DeskJet 2500C or equivalent
Printer memory	12 MB
Printing speed	9 ppm in colour
Print resolution	600 dpi, photo-quality
Paper type	Plain paper
Paper size	A3 and A4
Paper tray capacity	400 sheets
Mounting	Self-contained integral with stand

11.6 Historical Data Storage

The system shall have capability of storage and retrieval of historical data. Historical data shall be stored on the non-volatile memory devices like hard disc in such a way that such historical data can be utilised for archival, storage and subsequent recall. These storage of historical data shall be used for historical trending, alarm history display, various logs (hourly, shift, daily, weekly and monthly). It shall be possible to take a back-up of historical data on to tape or CD-ROM. Unless specified otherwise, the storage capacity shall be adequate for storing 35 days data both acquired and system generated.

11.7 Programmer's Monitor, Keyboard and Printer

For some of the advanced functions, a high level language support could be necessary in the computing node. For this activity, this node shall have a programmer's monitor and keyboard capable of providing access to all programming functions of the system. This monitor shall also be a colour monitor. Screen size shall be minimum 14". The programmer's printer shall be used for hard copy graphics, alpha-numeric information, program listings, system diagnostics and program debug messages. The keyboard shall be of industrial grade of IP-65 enclosure.

11.8 Front End Processors (FEP)

Front End Processors if used shall follow the specifications for computer, programmers monitor, keyboard, printer etc. as specified above, with dual redundancy.

11.9 Engineer's Console

An engineer's console shall be included. This shall have the same capabilities as the operator's console. Only one 21" colour monitor, operator keyboard, track ball / touch pad and one multi-purpose printer shall be provided. In addition, it shall have an industrial grade engineering keyboard (QWERTY) having capabilities for restricted user/engineer access through a key lock. All system configurations and detailed self-diagnostics for maintenance shall be carried out from this console.

The engineer's console, front end processing units, OPC server and computing hardware shall be located in main control room.

11.10 Hand Held Programming Tools (Laptop Computer)

The laptop for programming purposes shall have the latest CPU as commercially available at the time of delivery. It shall be complete with all hardware and software as required.

11.11 Furniture

Furniture for all ECS equipment like operator's console, engineer's console, computing node programmer's monitor, keyboard and printer and FEP system HMI, shall be included in vendor's scope of supply. It shall also include chairs for operator. Operator console desk for ECS shall be identical to that for other console type equipment to obtain aesthetic layout in the control room.

12.0 SOFTWARE SPECIFICATION

12.1 The software supplied with the system shall be segregated appropriately amongst various processors so that the full functionality of the control system is achieved. The descriptions given below against each category are aimed at specifying the requirements of software functions against each category. They are to be resident in various distributed processors in the system, and in integration it shall give full functional requirements. The ECS supplier shall indicate such a functionally segregated software structure in the offer.

12.2 General

The software shall contain the following components for whatsoever processor in the system for which it is applicable.

a. System software
b. Communication software
c. Data-acquisition and control-system software
d. Application software for above specified functions
e. System diagnostic software

12.3 System Software

The system software shall be modular in design and shall provide effective utilisation of resources and facilitate future expansion. It shall have the following features as minimum:

a. Multi programming and multi tasking facility including background and foreground operations in a real time mode
b. Virtual memory system
c. Dynamic memory allocation
d. System security feature
e. Real time programming and processing
f. Line and page editors, library management
g. Automatic switchover to standby computer in case of failure of hardware or software in the active computer
h. Bulk storage management
i. Input and output drivers for all peripherals

j. AutoCAD-compatible graphic support packages
k. On-line and detailed off-line diagnostic package to trouble-shoot CPU, memory and various system and peripheral cards.
l. Compiler for real-time programming
m. Scientific subroutine packages.
n. Some utilities, compilers, scientific subroutine packages are applicable for processors dealing with application software.

12.4 Communication Software

12.4.1 The system shall have appropriate communication protocols and software for inter-processor communication in the system over the data highway and information network / highway with suitable error detection and recovery and a switchover scheme from main to standby highway. It shall also support suitable communication software for networking requirements in the specification. It shall be proven, reliable and shall conform to relevant international standards.

12.4.2 Communication shall be based on open architecture. All databases accessed over communication links shall be ODBC as per IEC.

12.5 Data Acquisition and Control System Software

12.5.1 The system shall have the capability of processing analogue points, low and high resolution inputs. Each point shall be assigned a unique identifying code number by which the point may be referred by the operator or the system. Each point shall be supported by a set of point parameters like description, scan rate, alarm limits, etc.

12.5.2 The system shall have the capability of performing the following:
a. Software filtering of noisy process variables
b. Short circuit detection of current inputs
c. Calibration of all analogue inputs
d. Offset and gain correction of all A/D converter system errors
e. Reasonability checks on all inputs and quality coding of all inputs as good, suspect, bad or substituted
f. All intended control functions and subset of those required to implement all advanced functions.
g. All base-level control block and ladder executions required to generate the overall integrated functions as per this specification

12.5.3 The system shall have the following capabilities for processing of control commands initiated by the operator from the keyboard of the operator's console. The commands issued by the operator shall be processed and transmitted on a "check-before-execute" basis. This means that the selection of the operator command shall be verified before issuing a command execution. If after sending a control to the controlled installation, the relevant signal of completed manoeuvre does not arrive at the central station within a preset time, an alarm shall be given at the central console indicating "command not executed". The initiation and execution of the commands shall be automatically recorded on the alarm/event printer.

12.5.4 **Operator communication**

The software shall be capable of carrying out the most versatile operator communication functions. These functions shall include as minimum the following:

12.5.5 **Monitor displays**

i. The monitor displays shall be capable of presenting all system input values including analogue, digital and logic inputs. A variety of selectable monitor displays shall provide instant system visibility for real time operational monitoring and control. The display packages shall have both the standard displays and the user-defined graphics. The standard displays shall typically include overview, group, loop displays, current and historical trend displays and alarm and event summary displays.

ii. The system shall also display all electrical system key single line diagrams with all associated parameters. Typical formats for the displays shall be developed for the total system. These are sub station wise graphic displays, alarm summary displays (of

acknowledged and un-acknowledged alarms), bar charts, X-Y plots and trends (real time and historical). The graphics shall also include control system status graphics and communication network. The use of colour on the monitor shall serve to draw the operator's attention quickly to important data. The colour of each item shall be configurable by the Owner.

iii. It shall also be possible to assign priorities (High / Low) to each alarm point and segregation of alarm summary pages based on this shall be possible. The display format shall be composed of format title, data and time, page numbers system alarm/message line, operator prompt/response lines, soft key definitions and available display area. The execution of commands shall be available from both the preformatted displays and graphic displays. Details of displays shall be finalised after award of contract. The quantity of displays shall be "as required".

iv. The system shall have both operator and engineer functions and permit the operator to create new monitor displays, modify existing displays, and request displays on-line using monitor with keyboard in a conversational mode with a minimum of keystrokes. Also it shall be possible to generate new graphic symbols and add them to the standard library of symbols to be incorporated into any graphic display page. The engineer function shall be possible to be carried out on-line, and the keyboards shall have both operator and engineer commands with a provision of keylock and/or security password.

v. ECS supplier shall indicate limitations, if any, with regard to the maximum number of display pages that the system can handle.

12.5.6 **Logs and reports**

i The system shall print logs and reports. The printing of these logs shall be initiated automatically at prescribed time intervals (hourly, shift-wise, weekly), and initiated on demand or by the occurrence of predefined events. All logs shall be made from stored data so that once a log is initiated it can be completed without interruption. Multiple logs, when printed from stored data, shall print consecutively without interruption. Programmed log formats shall include, but are not limited to, all required headings, sub-headings, and work descriptions along with time and date. The exact format for each log shall be defined by the Owner after award of contract. In addition, a "note pad" field shall be available in the reports for the operator to enter operational notes and field maintenance information. The quantity of log reports shall be "as required".

ii The operator shall be able to create new logs and reports and modify existing logs and reports. ECS supplier shall indicate limitations, if any, with regard to the complexity and number of logs and reports that can be generated by the system.

12.5.7 **Trend utility**

The trending of current and historical values of any process parameters and computed parameters selected through keyboard averaged over a period of time shall be possible. The sampling rates for trending shall be operator selectable and the ECS supplier shall mention minimum and maximum limits for real and historical trends. Additionally associated with trend shall be tag number, engineering units and range, present value of trended point and alarm status. Recall of up to 25 hours of all parameters shall be possible in case of historical trending, without losing the time resolution.

12.5.8 **Alarm and event processing**

a. Alarm

i. The central station shall facilitate alarm reporting to alert the system operator of abnormal conditions through the operator's console and alarm/event printer. It shall be required to give alarm on the absolute value of measured variable, rate of change of measured variable, deviation high and low, set point high and low, outputs high and low, and change in discrete status. The system shall also be capable of generating desired alarms on the computed variables. All alarm conditions actuate an audio

alarm. The system shall not put off the device and the visual indication as soon as the condition returns to normal, before operator acknowledgement.

ii. It shall be possible to associate the occurrence of alarm to pre-assigned picture for detailed information and acknowledgement in addition to alarm summary display. Separate alarm summary page shall be provided giving information chronologically of tag number, set value, actual value, time/date of occurrence, time/date of return to normal, description, etc. of unacknowledged alarms and alarms acknowledged but still existing in the system. Coloured alarm summary shall be available for display and printing. It shall be possible to mask or disable alarming on certain points. Dedicated time tagged display listing of all such masked points shall be available.

b. Event

i. Occurrence of events which indicate the behaviour of the electrical system and associated equipment shall be displayable on operator request via an event summary display, in addition to getting printed on alarm/event printer.

ii. Typical events to be stored are:
- Commanded device changes
- Uncommanded device changes
- Command failure alarm
- Device time out alarm
- Alarm enable/disable messages
- Every operator action

c. Alarm and event history

Alarm and event history shall be maintained in the system indicating all the alarms and events that happened within the system during the past 25 hours period (preferably).

12.5.9 **Real time variable calculation**

The system software shall have the capability to perform the following calculations with input and software generated points:

a. Conversion to engineering units by using appropriate equations on a group basis. For critical parameters the system shall have the capability for above on a per point basis
b. Difference of two points
c. Maximum or minimum of N points
d. Continuous running, periodic, daily or hourly average or weighted averages
e. Hourly and daily integrations
f. Rate of change
g. Running integration
h. Periodic, daily and hourly minimum and maximum values
i. Comparison to alarm limits which shall be either preset or calculated as functions of other variables

12.5.10 **On-line data base**

a. The system shall have on-line data base which shall have the following provisions on a per point basis for all inputs and computed analogue points:

i. Scan rate
ii. High and low alarm limits
iii. Dead bands to alarm limits
iv. Significant change/repeat increments
v. Description
vi. Alphanumeric point name
vii. Transducer range limits for reasonability checks
viii. Rate of change of alarm limits
ix. Any of 20 engineering unit abbreviations
x. Software filtering constants

xi. Provision to specify individual coded routines which shall be executed when any alarm or return to normal message occurs

b. The system database shall have the following parameters for all inputs and software generated digital points on a per point basis.

i. Scan rate high resolution are milli second low resolution once every second.
ii. Alphanumeric point name
iii. Description
iv. Provision of a pair of state designations (e.g. On/Off, Open/Close)
v. Provision to assign individually coded routines on change of status of a contact
vi. Provision to assign an alarm state to either closed or open status

c. There shall be on-line data base editor which shall permit the operator to examine or modify any of the above parameters on-line. Owner shall define the level of access permitted to the console.

12.6 System Diagnostic Software

The system shall have extensive diagnostic software to identify all software and hardware failures up to card level. This shall include failure of power supplies, I/O cards, ADC, DAC cards, memory card, communication interface cards, peripheral controllers etc. The alarms regarding major sub-systems shall be displayed on the monitor. Further details shall be available on engineer's console.

13.0 I/O QUANTUM AND SYSTEM EXPANSION CAPABILITY

13.1 The I/O quantum required at various locations is indicated elsewhere in the contract document. Requirement of I/O list shall be finalised during engineering.

13.2 Each unit in the sub-stations must be sized considering project requirement and 25% spare in each category of I/O board. The units shall have I/O boards, power supply, termination equipment and cabinets to cater for present requirement and 25% spare. 25% spare transducers are not required.

13.3 Processor at each level must be sized (CPU, memory, disk, etc) considering the present requirement and 25% spare, and shall meet the CPU load and memory / disk utilisation requirement of 60% maximum.

13.4 25% spare serial ports, subject to a minimum of one at each location shall be provided. Additionally 25% carded spares for all I/O's at each location shall be provided.

PART – II

TESTING, INSTALLATION, COMMISSIONING AND ACCEPTANCE OF ELECTRICAL CONTROL SYSTEM

CONTENTS (PART-II)

1.0 SCOPE

1.1 This specification defines the basic guidelines to ECS vendor for factory testing and acceptance, installation, commissioning and field acceptance of the folly integrated system.

1.2 These guidelines shall also be applicable to all sub-systems and hardware bought by ECS vendor.

1.3 On the basis of this specification, vendor shall submit his own testing, installation, commissioning and acceptance procedure (For hardwares, the procedure shall include purpose of test, test definition of input, procedure, results expected and acceptance criteria).

1.4 The testing & acceptance of the system shall be carried out on the mutually agreed procedures and criteria based on this specification and vendor's standard procedures.

2.0 FACTORY TESTING AND ACCEPTANCE

2.1 Test and Inspection at Factory

2.1.1 Owner at his discretion shall post quality control experts in the ECS supplier's works who shall work in conjunction with the ECS supplier's quality control personnel in witnessing tests and control measures. The ECS supplier shall allow such quality control exercise during software configuration.

2.1.2 All factory tests shall be witnessed by Owner/PMC/ Owner's representative. Owner's representative definition shall include "third party inspection agency" appointed by Owner.

2.1.3 Owner/PMC/ Owner's representative shall have free entry and access at any time to all parts of the ECS supplier's facilities associated with manufacturing and testing of system.

2.1.4 ECS supplier shall submit to Owner/PMC test plans prior to actual testing for all factory and field acceptance tests (preliminary plan), which shall be mutually agreed upon.

2.1.5 Under no circumstances shall any action of Owner/PMC/ Owner's representative relieve the ECS supplier of his responsibility of material design, quality or operation of the system.

2.1.6 The ECS supplier shall invite Owner/PMC/ Owner's representative well in advance of the date at which the system is ready for testing.

2.1.7 The equipment shall not be shipped before they have been officially released in the form of release notes by Owner/PMC/ Owner's representative.

2.2 Quality Assurance / Quality Control (QA/QC) Programme Records

ECS supplier shall furnish QA/QC programmes, documentation records covering all hardware and software aspects. All bought out items shall require prior approval of Owner / PMC. For this purpose, QA/QC plan of sub vendors shall be furnished along with sub vendor names. For quality procedure to be followed for the order, refer elsewhere.

2.3 Factory Acceptance Test (FAT)

2.3.1 ECS supplier shall prepare FAT documentation covering all hardware, software and system functional testing and submit it 1 month in advance for Owner / PMC's review and approval. Finalisation and approval of FDS by Owner / PMC is a prerequisite for review and approval of FAT procedure documentation.

2.3.2 ECS supplier is required to conduct pre FAT tests in line with the requirements specified in the contract document and approved FAT documents. These test results shall be submitted for Owner / PMC's review. A complete pre FAT testing and review of the test reports is a prerequisite for conducting FAT.

2.3.3 Integrated FAT on total project hardware and software shall be conducted at ECS application software designer-developer's works. The system offered for FAT shall be complete in all respects in terms of hardware including RTUs complete with panels, all HMI, communication cables, GPS for time synchronisation etc. and in terms of software for all basic and advanced functionalities specified for the system. FAT shall be done based on the stipulations in the approved FAT document in presence of Owner/PMC/ Owner's

representative. The FAT shall also include environmental testing with humidity and temperature cycling of one RTU with panel of each type selected at random by Owner / PMC / Owner's representative. Approval for despatch shall be accorded by Owner/ PMC// Owner's representative only after successful completion of FAT and liquidation of all punch points raised during testing.

2.3.4 The environmental test shall be carried out as per the following procedure:

a. One RTU is to be subjected to thermal and humidity cycling for 72 hours while powered up and in operation. The details of the temperature-humidity cycle is as follows:

b. During a 24 hour cycle, the temperature shall be uniformly increased from the ambient temperature at time t=0 hours till it reaches a temperature of 50 deg C at time t=3 hours, where it will remain constant till time t=19 hours. The temperature will then be uniformly reduced till it reaches the ambient temperature at time t=22 hours, where it will remain constant till time t=24 hours.

c. During the same 24 hour cycle, the relative humidity shall remain constant at the ambient relative humidity level from time t=0 hours to time t=7 hours. It will then be uniformly increased till it reaches a relative humidity of 90% at time t=9 hours, where it will remain constant till time t=13 hours. The relative humidity will then be uniformly reduced till it reaches the ambient relative humidity level at time t=15 hours, where it will remain constant till time t=24 hours.

d. This complete 24 hour cycle shall be repeated 3 times to make up the entire 72 hours test period.

2.3.5 The environmental test shall be carried out simultaneously with other tests as specified in the FAT document. This will ensure that there is no performance degradation in the system.

3.0 INSTALLATION, TESTING AND COMMISSIONING

3.1 Installation at Site and Cabling Works

3.1.1 ECS supplier shall offer the services of an installation team that would supervise installation of the ECS equipment including civil, structural, electrical and necessary facilities.

3.1.2 For other details of requirements for installation at site and cabling works, refer elsewhere in the contract document.

3.2 Test and Commissioning at Site

3.2.1 The list of pre-commissioning tests to be performed shall be mutually agreed and included in the ECS supplier's quality assurance programmes. These tests shall be carried out by the ECS supplier's commissioning engineers. After the pre-commissioning tests are over, the equipment shall be put into operation. The commissioning spares are to be included in the ECS supplier's scope of supply and to be included in the base quote.

3.2.2 All technical personnel assigned to the site by the ECS supplier must be fully conversant with the specific system and its software package. The ECS supplier's field personnel shall have both hardware and software capability to bring the system on-line quickly and efficiently, and with a minimum of interference with other concurrent construction and commissioning activity.

3.2.3 ECS supplier in no case shall bank upon the Owner's personnel/his authorised representative for these activities for his part of work.

3.2.4 Field testing shall be carried out by the ECS supplier for the completely installed system including various sub-systems connected together. Test results shall be submitted to Owner/ site Engineer-in-Charge for review.

4.0 SITE ACCEPTANCE TEST (SAT)

4.1 ECS supplier shall prepare SAT documentation covering all hardware, software and system functional testing and submit it 1 month in advance for Owner/PMC review and approval. SAT shall be done based on the stipulation in the approved SAT document. Once the test is

successfully performed, the temporary acceptance of the system shall be given. Only then the system would be ready for test run.

4.2 ECS supplier shall offer for SAT when he has successfully commissioned all software and carried out pre SAT. The ECS supplier must not bank upon Owner's personnel on the matter.

4.3 Test Run

Test for continuous functional operation of the system. This test aims at keeping the complete system including communication networks in operation for a period of 1 month for all the 24 hours a day. In case of failure, the tests shall be restarted till the system operates without failure for 1 month. Owner/PMC shall have the right to reject the complete system or part there of in the event of the acceptance tests failing in two attempts. The 'Test Run' shall be carried out after the commissioning of complete power plant and electrical and utility system and the complex. Warranty shall start after successful completion of test run.

4.4 Test Reports

The observations and test results obtained during the various tests shall be documented and produced in the form of a report by the ECS supplier.

4.5 Failure of Components

4.5.1 A log of all failed components shall be maintained which shall give date and time of failure, description of the failed component/card along with designation, effect of failure on the system, cause of failure and number of hours of operation of the part before it failed.

4.5.2 For repeated failure of the component/card, the same shall be replaced by better graded components/cards. All the test shall be restarted from the beginning or the previous logical point as the case may be. If after this one replacement the unit or sub-system still fails to meet the specifications, the ECS supplier shall replace the complete unit or sub-system with the one that meets the requirements and restart the test all over again.

4.6 Performance Guarantee and Warranty

The ECS supplier shall undertake to guarantee the following:

a. Overall system availability, including communication network, shall be 99.99%. The system availability shall be calculated as per the following formula on a fortnightly basis:

Net Available Time	=	Total Available Time - Time Lost due to Power Failure and A/C Failure (if applicable).
Y	=	Down Time + Repair Time due to Machine Failure and Schedule Maintenance
Availability	=	(Net available time – Y) / Net available time

The down time shall include the following:

i) System failure
ii) Time lost due to intermittent failure
iii) Unscheduled maintenance

ECS supplier shall submit the calculation for arriving at the overall availability taking into account the availability of individual sub-system.

Automatic switchover of redundant equipments/ sub-systems (with failure annunciation) shall take place in order to maintain normal system operation. Removal of faulty equipments shall in all cases be possible without affecting normal system operation.

b. All the functional requirements of the system with various failure modes, redundancies, network functions, control system software and applicable software features as given in the specification.

c. All guaranteed benefits of all applicable software.

5.0 WARRANTY

5.1 The ECS supplier shall be fully responsible for the manufacture in respect of proper design, quality workmanship and operation of all the equipment, accessories, etc. supplied by the ECS supplier for the warranty period specified in commercial terms and conditions of the requisition.

5.2 It shall be obligatory on the part of the ECS supplier to modify and / or replace any hardware and modify the operating, application and diagnostic software free of cost in case any malfunction is revealed even during on-line operation after taking over within the warranty period.

5.3 The ECS supplier shall provide total maintenance of the system during warranty period. The cost for warranty maintenance, if any, shall be included in the proposal separately.

PART – III

GENERAL REQUIREMENTS

OF

ELECTRICAL CONTROL SYSTEMS

CONTENTS (PART-III)

1.0 SCOPE

1.1 This specification defines the general requirements expected to be fully complied by Electrical Control System vendor including logistic supports, documentation and shipping instructions etc.

1.2 The requirements defined in this specification shall also be applicable to all sub-systems and hardware bought & supplied by vendor from manufacturers other than his own.

2.0 RELIABILITY AND OTHER ATTRIBUTES

2.1 ECS supplier shall justify the selection of the control system processors and furnish percentage CPU load and memory map indicating the utilisation of main memory and disk sub-system. Typically the CPU load and memory / disk utilisation shall not exceed 60%. ECS supplier shall size the system accordingly.

2.2 Owner shall automatically receive free of cost all the necessary elements of any upgraded version of control system software and applicable software delivered originally with the system up to the end of the warrantee period.

2.3 ECS supplier shall supply the fully configured system software, control system software, application software of the project on disks in duplicate, i.e. one of system operation and the other for storage. The disks shall preferably be recordable CD-ROMs.

2.4 ECS supplier shall supply the project-specific source code of application software developed for this project, duly commented along with flow charts, both in paper listing and magnetic media form readable by the system.

2.5 All software offered shall be of the latest version to the extent applicable. The licence of the software shall be for the maximum system capability, even if the project requirement is only a subset.

2.6 All major bought out system equipment such as computers, monitors, printers etc. shall be supplied from such sources that meet the QA-QC requirements of CONTRACTOR and ECS supplier and also have sufficient after sales repair and maintenance facility in India.

3.0 TRAINING

3.1 ECS supplier shall impart training to Owner's personnel on the operation and maintenance of ECS equipment and system at his factory. It shall also include supply of training material on all relevant subjects. All expenditure in connection with travel and stay shall be borne by Owner for their personnel. The period and number of persons shall be as defined in project specifications.

3.2 ECS supplier's installation and commissioning staff shall also train Owner's personnel at site.

4.0 PACKING AND SHIPPING INSTRUCTIONS

4.1 All the material used for packing, wrapping, sealers, moisture resistant barriers and corrosion preventers shall be of recognised brands and shall conform to the best standards in the areas for the articles which are packaged.

4.2 Workmanship shall be in accordance with best commercial practice with the requirement of applicable specifications. There shall be no defects, imperfections or omissions which would tend to impair the protection offered by the package as a whole.

4.3 The package shall be suitable for storing in tropicalised climate and the ambient conditions as specified.

4.4 Shipment shall be thoroughly checked for completeness before final packing and shipment.

TYPICAL ECS I/O LIST FOR FOR DIFFERENT TYPE OF FEEDERS ECS SYSTEM

CAPTIVE POWER PLANT (CPP) PACKAGE TENDER NO. B016-606-02-43-PG-T-7810

PROJECT : VISAKH REFINERY MODERNISATION PROJECT

UNIT : 606

OWNER : HPCL VISAKHAPATNAM

PMC : EIL

JOB NO. : B016

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
A	18.05.2017	ISSUED WITH TENDER	GK	AS	PG

Generator Transformer, SCAP, GTG/STG

Type	Pt type	Signal description	Set condition description	Reset condition description	Remarks
SCAP / ECS Selector Switch					
DI	S	Control from	SCAP	Not_SCAP	Hardwired
DI	S	Control from	ECS	Not_ECS	Hardwired
Generator Synchronisation Selector Switch					
DI	S	Control from	Local (TCP)	Not_Local	Hardwired
DI	S	Control from	Remote (SCAP / ECS)	Not_Remote	Hardwired
Load shed Command Signals from ECS					
DI	S	Load Shed Block-1	Operated	Reset	Hardwired
DI	S	Load Shed Block-2	Operated	Reset	Hardwired
DI	S	Load Shed Block-n	Operated	Reset	Hardwired
Generator Transformers					
DI	S	Trafo OCTC Tap at each tap position			Hardwired signal for each tap position
AI	T	Oil temperature (4-20 mA) (see note 7)			From Trafo, Hardwired
AI	T	Winding temperature (4-20 mA) (see note 7)			From Trafo, Hardwired
Generators (STG/GTG)					
AI	T	Ambient Temperature of ST Skid (4-20 mA signal)			Hardwired
DI	D	STG/GTG/GTG Winding Temp	Alarm	Normal	Hardwired
DI	D	STG/GTG Bearing Temp	Alarm	Normal	Hardwired
DI	S	STG/GTG running mode	Isochronous	Not_Isochronous	Hardwired
DI	S	STG/GTG running mode	Constant MW	Not_Constant MW	Hardwired
DI	S	STG/GTG running mode	Droop	Not_Droop	Hardwired
DI	S	Field CB in service &	Closed	Not closed	Hardwired
DI	S	Field CB in service &	Open	Not open	Hardwired
DI	D	STG/GTG Exciter	Trip	Normal	Hardwired
DI	D	STG/GTG Generator	Trip	Normal	Hardwired
DI	D	STG/GTG Unit	Trip	Normal	Hardwired
DI	D	STG/GTG Rotor Earth Fault	Operated	Normal	Hardwired
DI	D	STG/GTG Relay 80	Operated	Normal	Hardwired
DI	D	STG/GTG Relay 59G	Operated	Normal	Hardwired
DI	D	STG/GTG Relay 27G	Operated	Normal	Hardwired
DI	D	STG/GTG Relay 32 Alarm	Operated	Normal	Hardwired
DI	D	STG/GTG Relay 81 1st setting	Operated	Normal	Hardwired
DI	D	STG/GTG Relay 81 2nd setting	Operated	Normal	Hardwired
DI	D	STG/GTG Excitation Failure Relay	Operated	Normal	Hardwired
DI	D	STG/GTG Overfluxing Relay	Operated	Normal	Hardwired
DI	D	STG/GTG Numerical relay	Unhealthy	Healthy	
DI	S	STG/GTG connected to grid	True	False	Hardwired
DO	C	STG/GTG Voltage RAISE	Activated	Reset	Hardwired, for Synch
DO	C	STG/GTG Voltage LOWER	Activated	Reset	Hardwired, for Synch

Type	Pt type	Signal description	Set condition description	Reset condition description	Remarks
DO	C	STG/GTG Freq RAISE	Activated	Reset	Hardwired, for Synch
DO	C	STG/GTG Freq LOWER	Activated	Reset	Hardwired, for Synch
DO	C	Set STG/GTG Run mode to Droop	Activated	Reset	Hardwired
DO	C	Set STG/GTG Run mode to Isochronous	Activated	Reset	Hardwired
DO	C	Set STG/GTG Run mode to Constant MW	Activated	Reset	Hardwired

Following list is **applicable** for 66 kV, 33kV, 11 kV switchgear and 415 PCC/PMCC/EPMCC in CONTRACTOR's scope.

66kV GIS & 33kV GIS

Incomers I/O signals					
AI	A	R phase current			Hardwired
					Hardwired
AI	A	Y phase current			Hardwired
AI	A	B phase current			Hardwired
AI	W	3-phase real power			Hardwired
AI	R	3-phase reactive power			Hardwired
DI	S	CB in service &	Closed	Not closed	Hardwired
DI	S	CB in service &	Open	Not open	Hardwired
DI	D	Relay 86	Operated	Reset	Hardwired
DI	D	Relay 95	Operated	Reset	Hardwired
DI	D	Feeder Trip on Undervoltage	Operated	Reset	Hardwired
DI	D	Unit Transformer, if any, Alarm	Operated	Reset	Hardwired
DI	D	Numerical relay	Unhealthy	Healthy	
DI	D	Bus 1 Isolator	closed	open	Hardwired
DI	D	Bus 2 Isolator	closed	open	Hardwired
DO	C	Bus 1 isolator closed command	Activated	Reset	Hardwired
DO	C	Bus 1 isolator open command	Activated	Reset	Hardwired
DO	C	Bus 2 isolator closed command	Activated	Reset	Hardwired
DO	C	Bus 2 isolator open command	Activated	Reset	Hardwired
DO	C	Dead Bus Close from ECS	Activated	Reset	Hardwired
DO	C	Synch Close from ECS	Activated	Reset	Hardwired
DO	C	Trip From ECS	Activated	Reset	Hardwired
Line VT					
AI	V	R – Y Line Voltage			Hardwired
AI	V	Y – B Line Voltage			Hardwired
AI	V	B – R Line Voltage			Hardwired
AI	F	Line Frequency			Hardwired
DI	D	Line VT MCB	Tripped	Closed	Hardwired
DI	D	Line	Dead	Not_Dead	Hardwired
Bus VT					
AI	V	R – Y Bus Voltage			Hardwired
AI	V	Y – B Bus Voltage			Hardwired
AI	V	B – R Bus Voltage			Hardwired
AI	F	Bus Frequency			Hardwired
DI	D	Bus VT MCB	Tripped	Closed	Hardwired

DI	D	Bus	Dead	Not_Dead	Hardwired
DI	D	Under Frequency Relay	Operated	Reset	Hardwired
DI	D	df/dt Relay	Operated	Reset	Hardwired
DI	D	Control Supply	Failed	Healthy	Hardwired
Bus Coupler/ bus Sectionaliser					
AI	A	R phase current			Hardwired
AI	A	Y phase current			Hardwired
AI	A	B phase current			Hardwired
AI	W	3-phase real power			Hardwired
AI	R	3-phase reactive power			Hardwired
DI	S	CB in service &	Closed	Not closed	Hardwired for ECS
DI	S	CB in service &	Open	Not open	Hardwired for ECS
DI	D	Relay 86 (Differential)	Operated	Reset	Hardwired for ECS
DI	D	Relay 86	Operated	Reset	Hardwired for ECS
DI	D	Relay 95	Operated	Reset	Hardwired for ECS
DI	D	Numerical relay	Unhealthy	Healthy	
DO	C	Dead Bus Close from ECS	Activated	Reset	Hardwired
DO	C	Synch Close from ECS	Activated	Reset	Hardwired
DO	C	Trip From ECS	Activated	Reset	Hardwired
DI	S	L-E selector switch (see note 2)	Local	Not on local	Hardwired
DI	S	L-E selector switch (see note 2)	ECS	Not on ECS	Hardwired
Outgoing Feeder					
AI	A	R phase current			Hardwired
AI	A	Y phase current			Hardwired
AI	A	B phase current			Hardwired
AI	W	3-phase real power			Hardwired
AI	R	3-phase reactive power			Hardwired
DI	S	CB in service &	Closed	Not closed	Hardwired for ECS
DI	S	CB in service &	Open	Not open	Hardwired for ECS
DI	D	Relay 86	Operated	Reset	Hardwired for ECS
DI	D	Relay 95	Operated	Reset	Hardwired for ECS
DI	D	Numerical relay	Unhealthy	Healthy	
DO	C	Close from ECS	Activated	Reset	Hardwired
DO	C	Trip From ECS	Activated	Reset	Hardwired

HV & MV switchboards

Type	Pt type	Signal description	Set condition description	Reset condition description	Remarks
Isolating breaker I/O signals – If Applicable					
DI	S	CB in service &	Closed	Not closed	Hardwired
DI	S	CB in service &	Open	Not open	Hardwired
DO	C	Trip from ECS	Activated	Reset	Hardwired
HV incomer I/O signals					
AI	A	R phase current			These signals are required over numerical relay and metering LAN
AI	A	Y phase current			
AI	A	B phase current			
AI	W	3-phase real power			
AI	R	3-phase reactive power			
AI	H	Frequency			
AI	T	Oil temp (4-20 mA)			From Trafo, Hardwired
AI	T	Winding temp (4-20 mA)			From Trafo, Hardwired

Type	Pt type	Signal description	Set condition description	Reset condition description	Remarks
DI	S	CB in service &	Closed	Not closed	Hardwired
DI	S	CB in service &	Open	Not open	Hardwired (for SOE)
DI	D	Relay 86	Operated	Reset	These signals are required over numerical relay and metering LAN
DI	D	Relay 95	Operated	Reset	
DI	D	Transformer Trouble	Operated	Reset	
DI	D	Trip on undervoltage	Activated	Reset	
DI	D	Numerical Relay	Unhealthy	Healthy	
DO	C	Trip from ECS	Activated	Reset	Hardwired
DO	C	Breaker inhibited from closing due to load shedding	Operated	Reset	Hardwired
DI	S	OLTC L/R Sel Switch	Local	Not_Local	Hardwired
DI	S	OLTC L/R Sel Switch	Remote	No_Remote	Hardwired
DI	S	OLTC C/R Sel Switch	RTCC	Not_RTCC	Hardwired
DI	S	OLTC C/R Sel Switch	ECS	Not_ECS	Hardwired
DI	S	OLTC I/A Sel Switch	Independent	Not_Independent	Hardwired
DI	S	OLTC I/A Sel Switch	Auto	Not_Auto	Hardwired
DI	S	OLTC Tap on position 17	Set	Reset	Hardwired
DI	S	OLTC Tap on position 16	Set	Reset	Hardwired
DI	S	OLTC Tap on position 15	Set	Reset	Hardwired
DI	S	OLTC Tap on position 14	Set	Reset	Hardwired
DI	S	OLTC Tap on position 13	Set	Reset	Hardwired
DI	S	OLTC Tap on position 12	Set	Reset	Hardwired
DI	S	OLTC Tap on position 11	Set	Reset	Hardwired
DI	S	OLTC Tap on position 10	Set	Reset	Hardwired
DI	S	OLTC Tap on position 9	Set	Reset	Hardwired
DI	S	OLTC Tap on position 8	Set	Reset	Hardwired
DI	S	OLTC Tap on position 7	Set	Reset	Hardwired
DI	S	OLTC Tap on position 6	Set	Reset	Hardwired
DI	S	OLTC Tap on position 5	Set	Reset	Hardwired
DI	S	OLTC Tap on position 4	Set	Reset	Hardwired
DI	S	OLTC Tap on position 3	Set	Reset	Hardwired
DI	S	OLTC Tap on position 2	Set	Reset	Hardwired
DI	S	OLTC Tap on position 1	Set	Reset	Hardwired
DI	D	Tap Change	In Progress	Completed	Hardwired
DI	D	Tap Changer	Stuck	Normal	Hardwired
DO	C	Tap Raise	Activated	Reset	Hardwired
DO	C	Tap Lower	Activated	Reset	Hardwired
HV line PT I/O signals					
AI	V	R-Y line voltage			These signals are required over numerical relay and metering LAN
AI	V	Y-B line voltage			
AI	V	B-R line voltage			
DI	D	Line PT MCB	Open	Closed	
HV bus coupler I/O signals					
AI	A	R phase current			These signals are required over numerical relay and metering LAN
AI	A	Y phase current			
AI	A	B phase current			
AI	W	3-phase Real power			

Type	Pt type	Signal description	Set condition description	Reset condition description	Remarks
AI	R	3-phase Reactive power			
DI	S	CB in service &	Closed	Not closed	Hardwired
DI	S	CB in service &	Open	Not open	Hardwired (for SOE)
DI	D	Relay 86	Operated	Reset	These signals are required over numerical relay and metering LAN
DI	D	Relay 95	Operated	Reset	
DI	D	Auto-changeover	Blocked	Not blocked	
DI	D	Numerical Relay	Unhealthy	Healthy	
DI	S	Switchboard (A-I-M selector switch)	In auto mode	Not in auto mode	Hardwired
DI	S	Switchboard (A-I-M selector switch)	In indep mode	Not in indep mode	Hardwired
DI	S	Switchboard (A-I-M selector switch)	In manual mode	Not in manual mode	Hardwired
DI	D	AC control supply #1	Failed	Healthy	Hardwired
DI	D	AC control supply #2	Failed	Healthy	Hardwired
DI	D	DC control supply #1	Failed	Healthy	Hardwired
DI	D	DC control supply #2	Failed	Healthy	Hardwired
DI	D	AC space heater supply #1	Failed	Healthy	Hardwired
DI	D	AC space heater supply #2	Failed	Healthy	Hardwired
DO	C	Trip from ECS	Activated	Reset	Hardwired
DO	C	Breaker inhibited from closing due to load shedding	Operated	Reset	Hardwired
HV bus PT I/O signals					
AI	V	R-Y bus voltage			These signals are required over numerical relay and metering LAN
AI	V	Y-B bus voltage			
AI	V	B-R bus voltage			
DI	D	Bus PT MCB	Open	Closed	
HV plant feeder I/O signals					
AI	A	R phase current			These signals are required over numerical relay and metering LAN
AI	A	Y phase current			
AI	A	B phase current			
AI	W	Real power			
AI	R	Reactive Power			
DI	S	CB in service &	Closed	Not closed	Hardwired
DI	S	CB in service &	Open	Not open	Hardwired (for SOE)
DI	D	Relay 86	Operated	Reset	These signals are required over numerical relay and metering LAN
DI	D	Relay 95	Operated	Reset	
DI	D	Numerical Relay	Unhealthy	Healthy	
DO	C	Trip from ECS	Activated	Reset	Hardwired
DO	C	Breaker inhibited from closing due to load shedding	Operated	Reset	Hardwired
Outgoing transformer feeder I/O signals					
AI	A	R phase current			These signals are required over numerical relay and metering LAN
AI	A	Y phase current			
AI	A	B phase current			
AI	W	Real power			
AI	R	Reactive power			
DI	S	CB in service &	Closed	Not closed	Hardwired
DI	S	CB in service &	Open	Not open	Hardwired (for SOE)
DI	D	Relay 86	Operated	Reset	These signals are required over numerical relay and metering LAN
DI	D	Relay 95	Operated	Reset	
DI	D	Transformer trouble	Operated	Reset	
DI	D	Numerical Relay	Unhealthy	Healthy	

Type	Pt type	Signal description	Set condition description	Reset condition description	Remarks
DO	C	Trip from ECS	Activated	Reset	Hardwired
DO	C	Breaker inhibited from closing due to load shedding	Operated	Reset	Hardwired
HV motor feeder I/O signals					
AI	A	R phase current			These signals are required over numerical relay and metering LAN
AI	A	Y phase current			
AI	A	B phase current			
AI	W	Real power			
AI	R	Reactive power			
DI	S	CB in service &	Closed	Not closed	Hardwired
DI	S	CB in service &	Open	Not open	Hardwired (for SOE)
DI	D	Relay 86	Operated	Reset	These signals are required over numerical relay and metering LAN
DI	D	Relay 86 (Process trip)	Operated	Reset	
DI	D	Relay 95	Operated	Reset	
DI	D	Trip on undervoltage	Activated	Reset	
DI	D	Motor Trip from Process	Activated	Reset	
DI	D	Numerical Relay	Unhealthy	Healthy	
DO	C	Trip from ECS	Activated	Reset	Hardwired
DO	C	Breaker inhibited from closing due to load shedding	Operated	Reset	Hardwired
HV synchronous motor feeder I/O signals					
AI	A	R phase current			These signals are required over numerical relay and metering LAN
AI	A	Y phase current			
AI	A	B phase current			
AI	W	Real power			
AI	R	Reactive power			
DI	S	CB in service &	Closed	Not closed	Hardwired
DI	S	CB in service &	Open	Not open	Hardwired (for SOE)
DI	D	Relay 86	Operated	Reset	These signals are required over numerical relay and metering LAN
DI	D	Relay 86 (Process trip)	Operated	Reset	
DI	D	Relay 95	Operated	Reset	
DI	D	Trip on undervoltage	Activated	Reset	
DI	D	Motor Trip from Process	Activated	Reset	
DI	D	Numerical Relay	Unhealthy	Healthy	
DO	C	Trip from ECS	Activated	Reset	Hardwired
DO	C	Breaker inhibited from closing due to load shedding	Operated	Reset	Hardwired
DI	S	Excitation control in constant PF mode	Set	Reset	Hardwired
DI	S	Excitation control in constant VAR mode	Set	Reset	Hardwired
DI	S	Excitation control in VAR control mode	Set	Reset	Hardwired
DI	S	L-E selector switch (see note 3)	Local	Not on local	Hardwired
DI	S	L-E selector switch (see note 3)	ECS	Not on ECS	Hardwired
DO	C	Set Excitation in Constant PF mode	Activated	Not_Activated	Hardwired
DO	C	Set Excitation in Constant VAR mode	Activated	Not_Activated	Hardwired
DO	C	Set Excitation in VAR control mode	Activated	Not_Activated	Hardwired
DO	C	Excitation raise	Activated	Not_Activated	Hardwired
DO	C	Excitation lower	Activated	Not_Activated	Hardwired

Type	Pt type	Signal description	Set condition description	Reset condition description	Remarks
AO	C	Excitation set point			4-20mA signal from ECS, Hardwired
HV capacitor feeder I/O signals					
AI	A	R phase current			These signals are required over numerical relay and metering LAN
AI	A	Y phase current			
AI	A	B phase current			
AI	R	Reactive power			
DI	S	CB in service &	Closed	Not closed	Hardwired
DI	S	CB in service &	Open	Not open	Hardwired (for SOE)
DI	D	Relay 86	Operated	Reset	These signals are required over numerical relay and metering LAN
DI	D	Relay 95	Operated	Reset	
DI	D	Numerical relay	Unhealthy	Healthy	
DI	S	L-E selector switch (see note 2)	Local	Not on local	Hardwired
DI	S	L-E selector switch (see note 2)	ECS	Not on ECS	Hardwired
DO	C	Close from ECS	Activated	Reset	Hardwired
DO	C	Trip from ECS	Activated	Reset	Hardwired
MV PMCC incomer I/O signals					
AI	A	R phase current			These signals are required over numerical relay and metering LAN
AI	A	Y phase current			
AI	A	B phase current			
DI	W	Real power			
DI	R	Reactive power			
DI	S	CB in service &	Closed	Not closed	Hardwired
DI	S	CB in service &	Open	Not open	Hardwired (for SOE)
DI	D	Relay 86	Operated	Reset	These signals are required over numerical relay and metering LAN
DI	D	Relay 95	Operated	Reset	
DI	D	Trip on U/V	Activated	Reset	
DI	D	Numerical Relay	Unhealthy	Healthy	
DO	C	Trip from ECS	Activated	Reset	Hardwired
DO	C	Breaker inhibited from closing due to load shedding	Operated	Reset	Hardwired
MV PMCC line PT I/O signals					
AI	V	R-Y line voltage			These signals are required over numerical relay and metering LAN
AI	V	Y-B line voltage			
AI	V	B-R line voltage			
DI	D	Line PT MCB	Open	Closed	
MV PMCC bus PT I/O signals					
AI	V	R-Y bus voltage			These signals are required over numerical relay and metering LAN
AI	V	Y-B bus voltage			
AI	V	B-R bus voltage			
DI	D	Bus PT MCB	Closed	Open	
MV PMCC bus coupler I/O signals					
DI	S	CB in service &	Closed	Not closed	Hardwired
DI	S	CB in service &	Open	Not open	Hardwired (for SOE)
DI	D	Relay 86	Operated	Reset	These signals are required over numerical relay and metering LAN
DI	D	Relay 95	Operated	Reset	
DI	D	Auto-changeover	Blocked	Not blocked	
DI	D	Numerical Relay	Unhealthy	Healthy	
DI	S	Switchboard (A-I-M selector switch)	In auto mode	Not in auto mode	Hardwired
DI	S	Switchboard (A-I-M selector switch)	In indep mode	Not in indep mode	Hardwired
DI	S	Switchboard (A-I-M selector switch)	In manual mode	Not in manual mode	Hardwired

Type	Pt type	Signal description	Set condition description	Reset condition description	Remarks
DI	D	AC control supply #1	Failed	Healthy	Hardwired
DI	D	AC control supply #2	Failed	Healthy	Hardwired
DI	D	DC control supply #1	Failed	Healthy	Hardwired
DI	D	DC control supply #2	Failed	Healthy	Hardwired
DI	D	AC space heater supply #1	Failed	Healthy	Hardwired
DI	D	AC space heater supply #2	Failed	Healthy	Hardwired
DO	C	Trip from ECS	Activated	Reset	Hardwired
DO	C	Breaker inhibited from closing due to load shedding	Operated	Reset	Hardwired
MV PMCC outgoing feeder I/O signals					
AI	A	R phase current			These signals are required over numerical relay and metering LAN
AI	A	Y phase current			
AI	A	B phase current			
AI	W	Real power			
AI	R	Reactive Power			
DI	S	CB in service &	Closed	Not closed	Hardwired
DI	S	CB in service &	Open	Not open	Hardwired (for SOE)
DI	D	Relay 86	Operated	Reset	These signals are required over numerical relay and metering LAN
DI	D	Relay 95	Operated	Reset	
DI	D	Numerical Relay	Unhealthy	Healthy	
DO	C	Trip from ECS	Activated	Reset	Hardwired
DO	C	Breaker inhibited from closing due to load shedding	Operated	Reset	Hardwired
Miscellaneous I/O signals					
DO	C	Lighting feeder ' ON'	Activated	Reset	Hardwired
DO	C	Lighting feeder ' OFF'	Activated	Reset	Hardwired
DI	D	UPS Charger	Failure	Normal	Hardwired
DI	D	UPS Inverter	Failure	Normal	Hardwired
DI	D	UPS Battery	Discharged	Normal	Hardwired
DI	D	UPS Battery	Isolated	Normal	Hardwired
DI	S	UPS load on	Inverter	Bypass Trafo	Hardwired
DI	D	DC supply Charger - I	Failure	Normal	Hardwired
DI	D	DC supply Charger - II	Failure	Normal	Hardwired
DO	C	Load Shedding	Operated	Reset	Hardwired

Notes:

1. It is assumed that HV boards and MV PCCs & MCCs have numerical relays. All signals of I/O list that are to be acquired on the relay LAN have been indicated as such. All other I/Os shall be acquired hardwired. In case any of these data can not be acquired over the relay LAN, these signals have to be provided as hardwired.

2. There shall be one Local-ECS selector switch in each HV capacitor feeder in HV switchboard. When this switch is in Local mode, CB closing from local shall be permitted and CB closing from ECS shall be blocked. When the switch is in ECS mode, CB closing shall be permitted from ECS but blocked from local. Simultaneous monitoring and CB tripping are permitted both from ECS and local. Motor feeders are not to be closed from ECS.

3. There shall be one Local-ECS selector switch in each HV synchronous motor feeder in HV switchboard. When this switch is in Local mode, the excitation control of the motor shall be from local. When the switch is in ECS mode, the excitation control of the motor shall be from ECS but blocked from local. The excitation control from ECS may be hardwired raise/lower contacts, or in the form of 4-20 mA signal. Provision has to be kept in ECS for both. Simultaneous monitoring and CB tripping are permitted both from ECS and local.

4. There shall be one lighting feeder ON/OFF DO pair (non-latched) per sub-station. These contacts are to be multiplied on 110 V DC control supply voltage, by CPP CONTRACTOR and used for centralised lighting control in his area.

5. ECS shall also be used for load-shedding purposes and will trip some of the breakers to which ECS monitoring is extended, on load shedding. The reset command for breakers tripped on load shedding shall also be generated from the ECS so that a load tripped on load shedding is not allowed to be restored until the exigency leading to load shed has been attended to. Hence a latched changeover type contact DO shall be provided for each breaker feeder, which shall inhibit closing of the circuit breaker tripped on load shedding. CPP CONTRACTOR shall keep suitable provisions in the switchboard control schemes to implement the same.

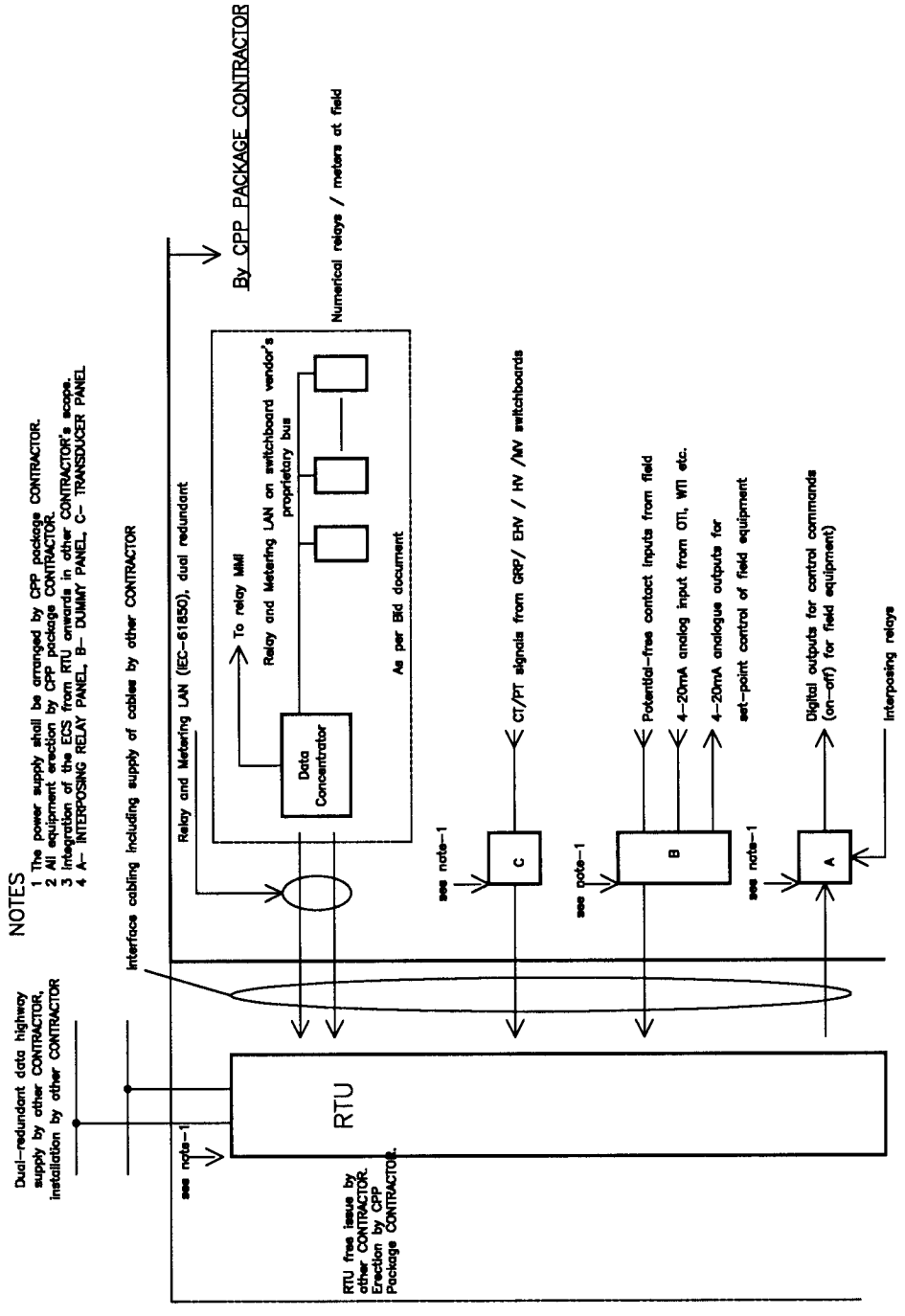
6. This I/O list is indicative only. Any other I/O required to meet the contract requirements shall be identified and provided by CPP CONTRACTOR.

7. For the purpose of ECS, "MV", "LV" or "LT" stands for voltage rating ≤ 415 V. "HV" or "HT" stands for voltage rating ≥ 3.3 kV.

Guidelines for ECS I/O Interface Design:

Analogue Input Signals	All measurements for I, V, MW, MVAR, Hz, obtained through signal transducers shall have an accuracy limit of ±0.2% within the nominal range of measurement i.e. 0-120%. For all measurements for I, V, MW, MVAR, Hz, obtained on the relay and metering LAN, maximum possible accuracy shall be ensured.
Digital Input Signals	
Alarm (D)	Alarm is a signal which requires operator to be alerted such as VT circuit MCB (closed, open), relays 86 & 95 (operated, reset), auto-changeover (blocked, not blocked), DC control supply (healthy, failed), line voltage (unhealthy, healthy), bus voltage (unhealthy, healthy), motor trip from process, under-voltage trip. This shall be hardwired / on relay LAN as specified. For hardwired signal, potential free contacts of rating 2 A, 110 V DC or 240 V AC, make to alarm (NO) preferred. CONTRACTOR shall specifically indicate if NC contact is being provided in place of NO contact. Generally a hardwired alarm point is put under "sequence of event" monitoring.
Status (S)	For hardwired signal, potential free contacts of rating 2 A, 110 V DC or 240 V AC, make to alarm (NO) required.
Digital Output Signals	
Command (C)	Hardwired through potential free changeover type contact of interposing relay, contact rating 5 A, 240 V AC and/or 6 A, 110 V DC.

REV.	DATE	REVISION	BY	CHECKED	APPD.	APPD.
A	18.05.17	ISSUED WITH TENDER	GK	AS	PG	



ENGINEERS INDIA LIMITED NEW DELHI	Scope Division for ECS Interface at RTUs in Contractor Area HPCL, VRMP	DRAWING NO. B016-606-16-50-SK-4001 REV. A SHEET 1 OF 1

1-1641-0504 REV.0 A4-210x297

A4-210X297

ENGINEERS INDIA LIMITED
NEW DELHI

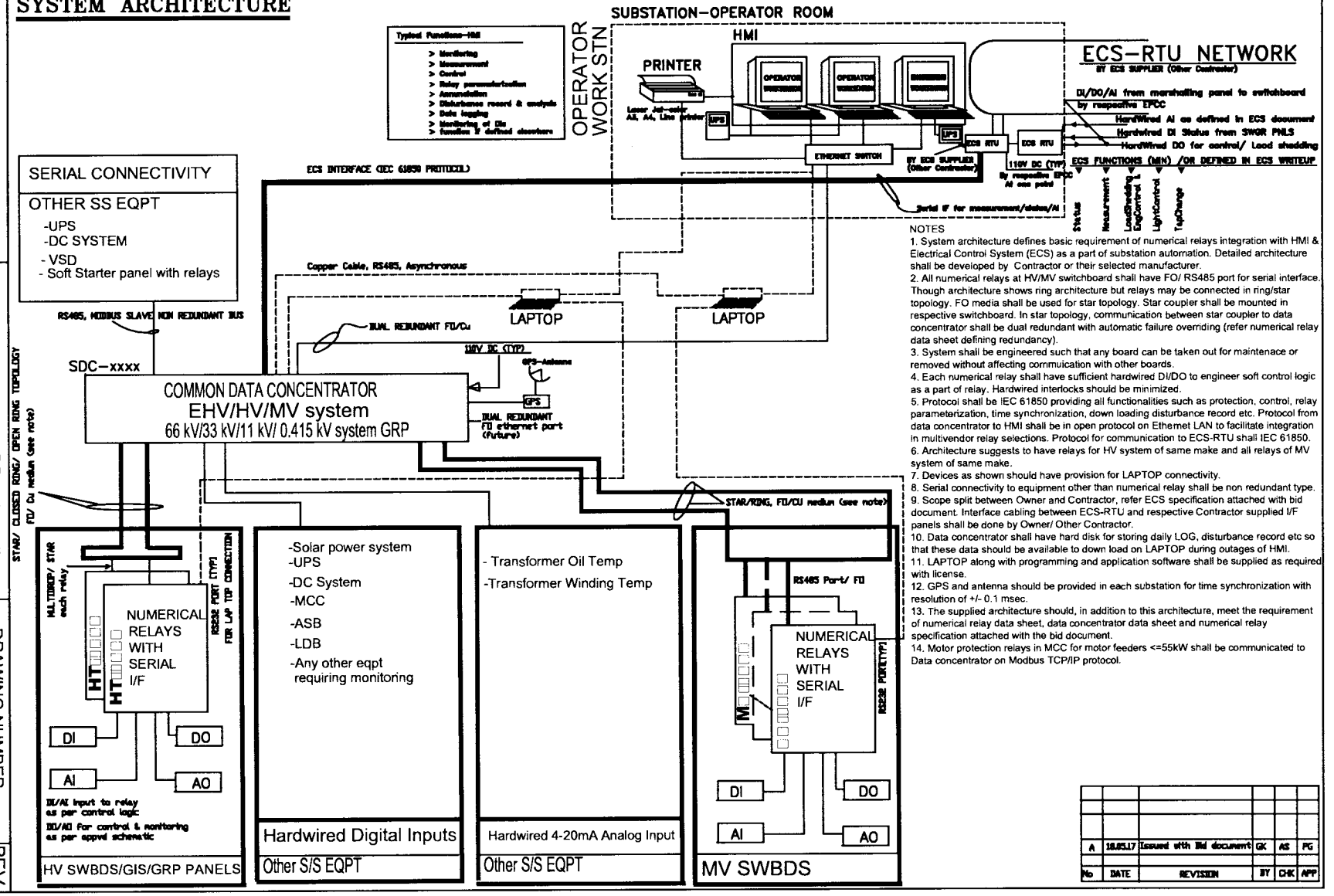
PROJECT: Visakh Refinery Modernisation Project

System Architecture-SS automation

DRAWING NUMBER: B016-606-16-50-SK-4504

REV.: A

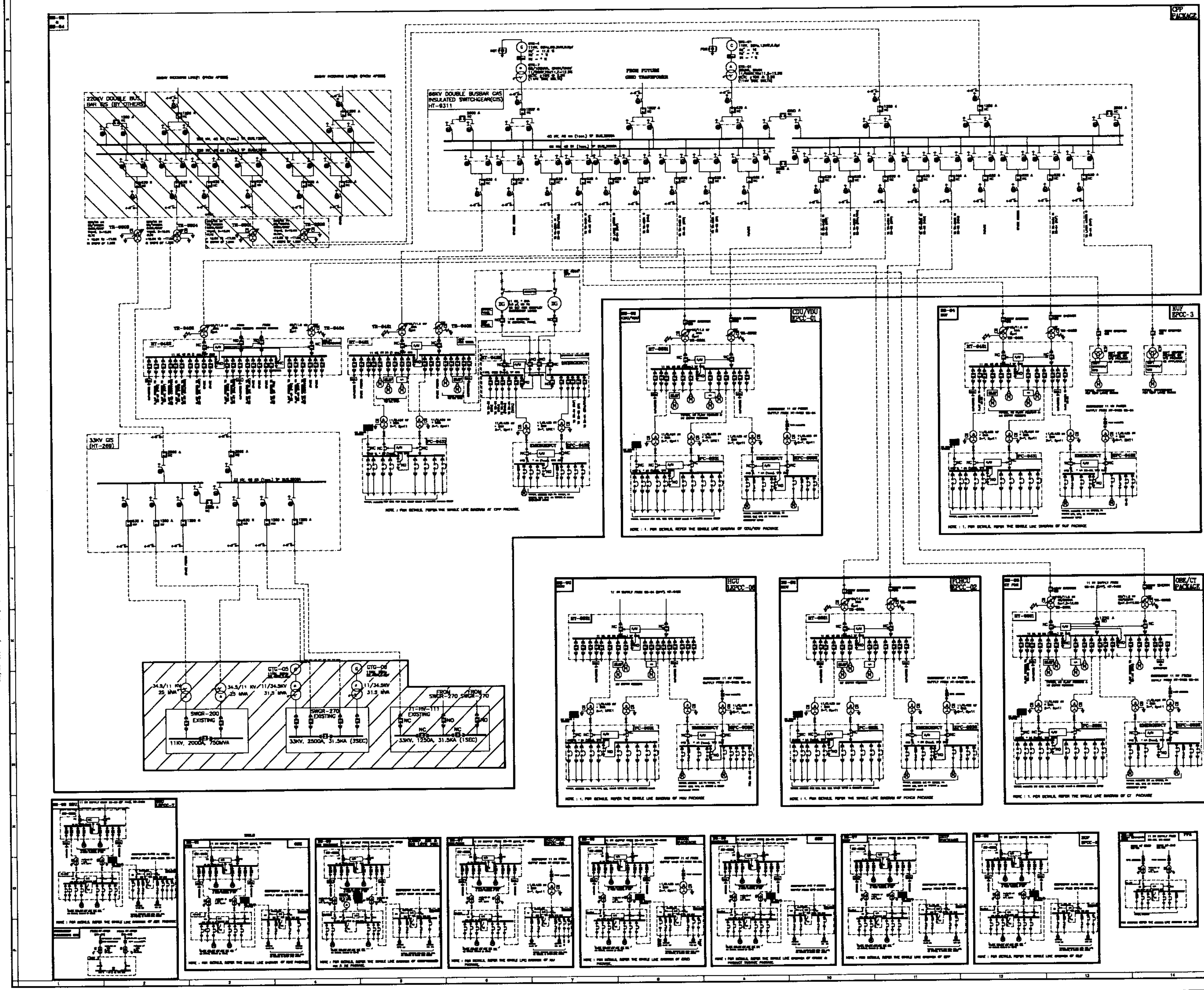
SYSTEM ARCHITECTURE



NOTES

1. System architecture defines basic requirement of numerical relays integration with HMI & Electrical Control System (ECS) as a part of substation automation. Detailed architecture shall be developed by Contractor or their selected manufacturer.
2. All numerical relays at HV/MV switchboard shall have FO/ RS485 port for serial interface. Though architecture shows ring architecture but relays may be connected in ring/star topology. FO media shall be used for star topology. Star coupler shall be mounted in respective switchboard. In star topology, communication between star coupler to data concentrator shall be dual redundant with automatic failure overriding (refer numerical relay data sheet defining redundancy).
3. System shall be engineered such that any board can be taken out for maintenace or removed without affecting commuication with other boards.
4. Each numerical relay shall have sufficient hardwired DI/DO to engineer soft control logic as a part of relay. Hardwired interlocks should be minimized.
5. Protocol shall be IEC 61850 providing all functionalities such as protection, control, relay parameterization, time synchronization, down loading disturbance record etc. Protocol from data concentrator to HMI shall be in open protocol on Ethernet LAN to facilitate integration in multivendor relay selections. Protocol for communication to ECS-RTU shall IEC 61850.
6. Architecture suggests to have relays for HV system of same make and all relays of MV system of same make.
7. Devices as shown should have provision for LAPTOP connectivity.
8. Serial connectivity to equipment other than numerical relay shall be non redundant type.
9. Scope split between Owner and Contractor, refer ECS specification attached with bid document. Interface cabling between ECS-RTU and respective Contractor supplied I/F panels shall be done by Owner/ Other Contractor.
10. Data concentrator shall have hard disk for storing daily LOG, disturbance record etc so that these data should be available to down load on LAPTOP during outages of HMI.
11. LAPTOP along with programming and application software shall be supplied as required with license.
12. GPS and antenna should be provided in each substation for time synchronization with resolution of +/- 0.1 msec.
13. The supplied architecture should, in addition to this architecture, meet the requirement of numerical relay data sheet, data concentrator data sheet and numerical relay specification attached with the bid document.
14. Motor protection relays in MCC for motor feeders <=55kW shall be communicated to Data concentrator on Modbus TCP/IP protocol.

No	DATE	REVISION	BY	CHK	APP
A	18.05.17	Issued with Bid document	GK	AS	PG



REF. DWG. NO.	REFERENCE DRAWING TITLE

NOTES :-

LEGEND

G	STEAM/GAS TURBINE GENERATOR
	NGT FOR GENERATOR
	EHV/HV CIRCUIT BREAKER
	POWER TRANSFORMER WITH OLTC
	POWER/DISTRIBUTION TRANSFORMER
	DRAWOUT FEATURE
	AIR CIRCUIT BREAKER
	SWITCH
	FUSE
	CONTACTOR
	MOTOR
	CABLE GLAND
NO	NORMALLY OPEN
NC	NORMALLY CLOSED
DG	DIESEL GENERATOR
	EMERGENCY STOP PB FOR TRAFO.
	NEUTRAL GROUNDING RESISTOR
A/M	AUTO MANUAL CHANGEOVER
	ISOLATOR MOTOR OPERATED
	LIGHTNING ARRESTOR
	ISOLATOR WITH EARTH SWITCH
	BUS DUCT
	PHOTOVOLTAIC SOLAR POWER SYSTEM
	EXISTING
	BY OTHERS

No.	DATE	REVISIONS	BY	CHKD	APPD
C					
B					
A					

ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

HINDUSTAN PETROLEUM CORP. LTD.
VISAKH REFINERY MODERNISATION PROJECT

OVERALL SINGLE LINE DIAGRAM

SCALE	JOB NO.	UNIT	DEPT	SECT.	DWG. NO.	REV.
N.T.S.	B016	000	16	50	00010	C

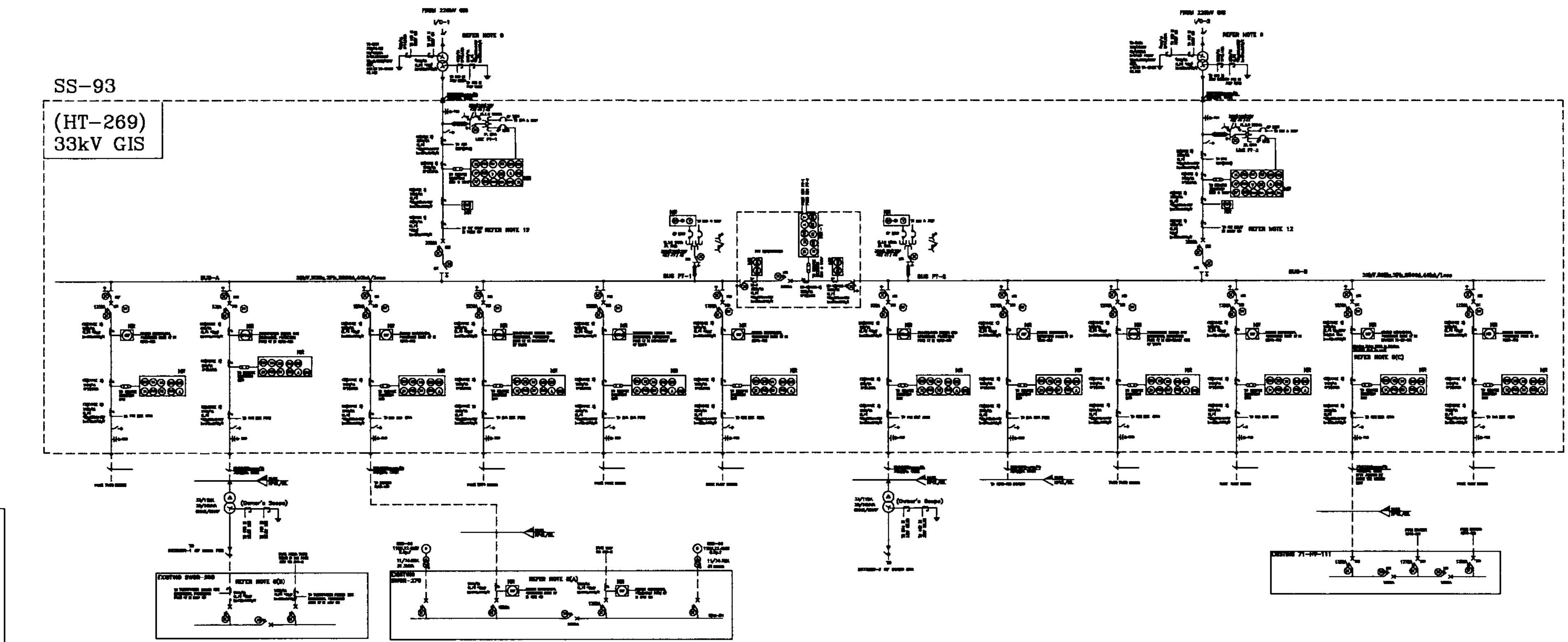
3-1641-0500 REV.2 A0-1189 x 841

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

ESP-001-11A

DRG. NO. PY-DL-1-M104-8801-01 SH. 01 OF 01



GENERAL DIMENSIONAL LIMITS,FITS & TOLERANCES AS PER HY0230261

PROJECT: CAPTIVE POWER PLANT (CPP) PACKAGE
VISAKH REFINERY MODERNIZATION PROJECT (VRMP)
JOB NO. B016

OWNER: HINDUSTAN PETROLEUM CORPORATION LIMITED

PMC: ENGINEERS INDIA LIMITED (EIL), NEW DELHI

BHARAT HEAVY ELECTRICALS LTD. HYDERABAD

	NAME	SIGN.	DATE
DRN.	GRM/AVS	-SD-	30.03.18
CHD.	P.SURESH	-SD-	30.03.18
APPD.	J.K.PATTANAIK	-SD-	30.03.18

REV.	DATE	ALTERED	CHD/APPD
01	09.05.18	REVISED IN LINE WITH CONSULTANT COMMENTS ON ROO.	C.MONICA / J.K.PATTANAIK

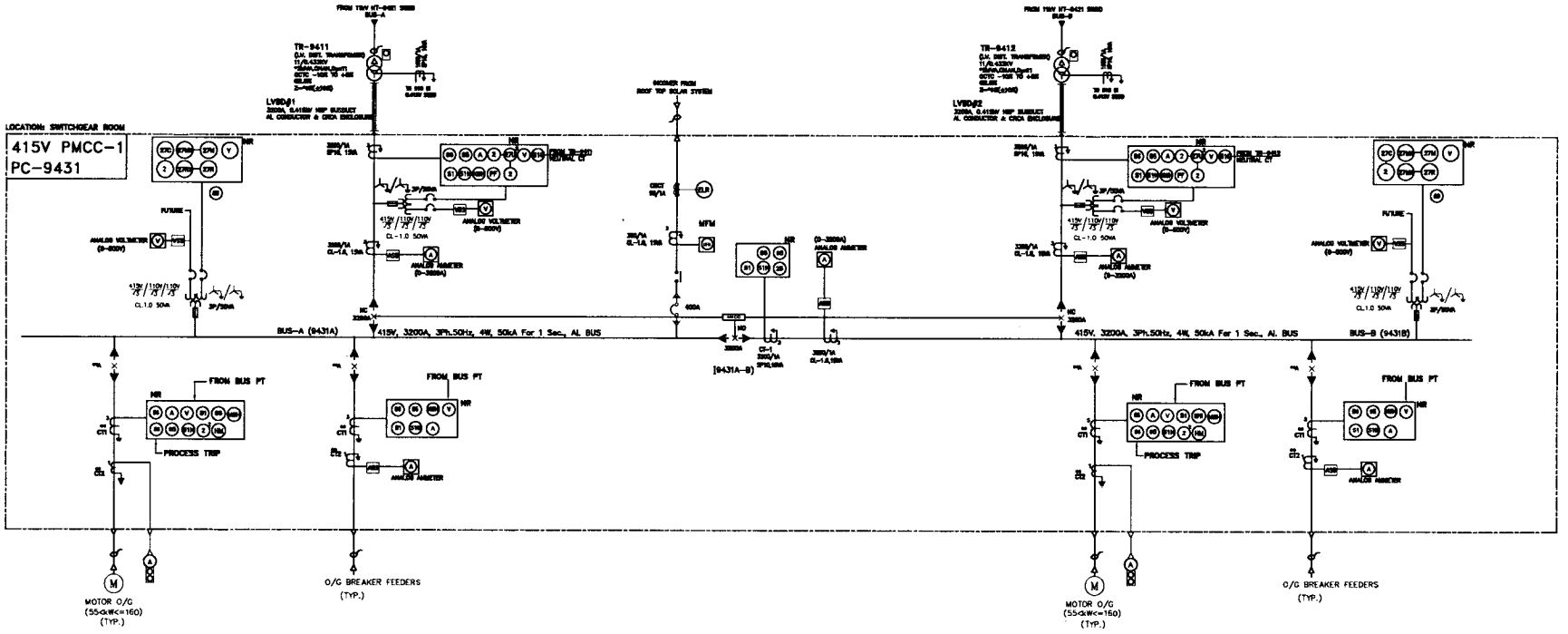
DEPT. PEASD CODE 450

UNTOL. DIMS. OR -SAL/E- | SCALE | WEIGHT (KG) | REF. TO ASSY. DRG. -N.A.-

TITLE
SINGLE LINE DIAGRAM OF
33kV GIS SWITCHGEAR

BHEL DRG NO. PY-DL-1-M104-8801-01
CUST DRG NO.
SHT. No 01 NO. OF

GENERAL DIMENSIONAL LIMITS,FITS & TOLERANCES AS PER HY02230261



LEGEND :-

- DRAWOUT TYPE ACB
- DRAWOUT TYPE SFU
- DRAWOUT MODULE
- CONTACTOR
- MCCB(WITH OC+SC+EF RELEASES)
- POTENTIAL TRANSFORMER
- CURRENT TRANSFORMER
- AMMETER SELECTOR SWITCH
- VOLTMETER SELECTOR SWITCH
- AMMETER
- VOLTMETER (90 DEGREE CAUT SCALE)
- KILO WATT HOUR METER
- ACB AIR CIRCUIT BREAKER
- SFD SWITCHFUSE CONTACTOR
- A/M C/O AUTO/MANUAL CHANGEOVER
- PF POWER FACTOR METER
- T TIMER
- SE CHECK SYNCH. RELAY
- VHC VOLTAGE HEALTH CHECK RELAY
- 27U U/V RELAY (SETTING RANGE 40-80%)
- 27R RESIDUAL U/V RELAY (SETTING 40%)
- 27M U/V RELAY FOR TRIPPING MOTORS (SETTING RANGE 40-80%)
- 50 INSTANTANEOUS O/C RELAY
- 50N INSTANTANEOUS E/F RELAY
- 51 IDMT O/C RELAY
- 51N IDMT E/F RELAY
- 86 BC SUPPLY SUPERVISION RELAY
- 86 MASTER TRIP RELAY
- 95 TRIP CIRCUIT SUPERVISION RELAY
- 96N STANDBY E/F RELAY
- 64R RESTRICTED E/F RELAY
- ELR EARTH LEAKAGE RELAY (SETTING RANGE 1-10A) WITH BUILTIN TIMER
- MPR MOTOR PROTECTION RELAY (49,46,50,50N,27,66,F)
- AT (CURRENT TRANSDUCER (4-20mA, DUAL OUTPUT))
- NR NUMERICAL RELAY
- F FREQUENCY METER
- SFU SWITCHFUSE UNIT
- ECS ELECTRICAL CONTROL SYSTEM
- CORE BALANCE CURRENT TRANSFORMER
- TB TEST TERMINAL BLOCK
- I/F TRANSFORMER
- NON SEGREGATED PHASE BUSDUCT (NSPBD)

TABLE-1: 415V PMCC-1 OUTGOING FEEDER DETAILS.

SL NO.	FEEDER DESCRIPTION	FEEDER RATING	FEEDER TYPE	BREAKER RATING	FEEDERS QUANTITY			CT DETAILS			TERMINATION
					TOTAL	BUS-A	BUS-B	CT-1	CT-2	CBCT	
1	415V BOP MCC	450kVA	ACB FEEDER	800A	2	1	1	700/1A, 5P10, 10VA	700/1A, CL-1.0, 10VA	NA	
2	415V ASB	142kVA	ACB FEEDER	800A	2	1	1	700/1A, 5P10, 10VA	700/1A, CL-1.0, 10VA	NA	
3	CONDENSATE TRANSFER PUMPS	75kW	MOTOR FEEDER	630A	2	1	1	200/1A, 5P10, 10VA	200/1A, CL-1.0, 10VA	NA	
4	DM GT ACC PUMP	90kW	MOTOR FEEDER	630A	2	1	1	200/1A, 5P10, 10VA	200/1A, CL-1.0, 10VA	NA	
5	ELECTRIC HEATER	400kW	ACB FEEDER	800A	2	1	1	700/1A, 5P10, 10VA	700/1A, CL-1.0, 10VA	NA	
7	SPARE BREAKER O/G FEEDER	-	ACB FEEDER	1000A	1	1	-	700/1A, 5P10, 10VA	700/1A, CL-1.0, 10VA	NA	
8	SPARE MOTOR O/G FEEDER (55-160kW)	-	MOTOR FEEDER	630A	1	-	1	200/1A, 5P10, 10VA	200/1A, CL-1.0, 10VA	NA	

NOTES:

1. ALL BREAKER AND MCCB FEEDERS IN 415V PMCC ARE SINGLE FRONT AND DRAW OUT TYPE. CABLE ENTRY FROM BOTTOM.
2. PAINT SHADE SHALL BE RAL 7032.
3. CONTROL SUPPLY FOR BREAKERS, SPRING CHARGING MOTORS, NUMERICAL RELAYS,ELR,SHUNT TRIP, INDICATIONS SHALL BE 110V DC (REDUNDANT WITH AUTO CHANGEOVER FACILITY).
4. MPR SHALL HAVE COMMUNICATION FACILITY.
5. INCOMERS & BUS-COUPLER ARE PROVIDED WITH AUTO CHANGEOVER AND MOMENTARY PARALLING FACILITY.
6. CABLE SIZES SHALL BE AS PER LT POWER CABLE SIZING CALCULATION WHICH SHALL BE SUBMITTED SEPARATELY.
7. EQUIPMENT RATING/PARAMETERS/QUANTITY ARE SUBJECT TO APPROVAL OF RESPECTIVE EQUIPMENT SIZING CALCULATIONS.
8. FOR PROCESS TRIPS ADDITIONAL SELF RESET TYPE LOCKOUT RELAY AND ITS INDICATION SHALL BE PROVIDED IN NR FOR MOTOR FEEDERS.
9. ALL RELAYS EXCLUDING AUXILIARY RELAYS SHALL BE NUMERICAL MICROPROCESSOR BASED WITH IEC-61850 COMMUNICATIONS PROTOCOL.
10. MCCB SHALL BE PROVIDED WITH SHUNT TRIP COIL.
11. EARTH LEAKAGE RELAY SHALL HAVE BUILTIN TIMER.
12. # - 2 ACB FEEDERS OF 800A FOR OWNER'S USE (TOTAL 300kVA) IS CONSIDERED AS PER CONTRACT. INDIVIDUAL FEEDER RATING IS ASSUMED AS 150kVA.
13. EQUIPMENT RATING/PARAMETER/QUANTITY MARKED WITH (*) ARE TENTATIVE.

PROJECT: CAPTIVE POWER PLANT (CPP) PACKAGE
VISAKH REFINERY MODERNIZATION PROJECT (VRMP)
JOB NO. B016

OWNER: HINDUSTAN PETROLEUM CORPORATION LIMITED

PMC: ENGINEERS INDIA LIMITED (EIL), NEW DELHI

BHARAT HEAVY ELECTRICALS LTD. HYDERABAD

	NAME	SIGN.	DATE
DRN.	GRM/AVS	-SD-	12.04.18
CHD.	P.SURESH	-SD-	12.04.18
APPD.	J.K.PATTANAIK	-SD-	12.04.18

DEPT. P&SD CODE 450 | UNTOL. DIMS. GR. C | SCALE | WEIGHT (KG) | REF. TO ASSY. DRG. -N.A.- | ITEM NO. -N.A.- | NO.OF ITEMS -N.A.-

TITLE: SINGLE LINE DIAGRAM OF PMCC

CARD CODE N.A. | BHEL DRG NO. PY-DL-1-M104-8809-01 | CUST DRG NO. | SH1. No 01 | NO. OF SHT. 02 | REV. 00

DOCUMENT REVIEW DETAILS

REV.	DATE	ALTERED	CHD/APPD	ZONE
1				
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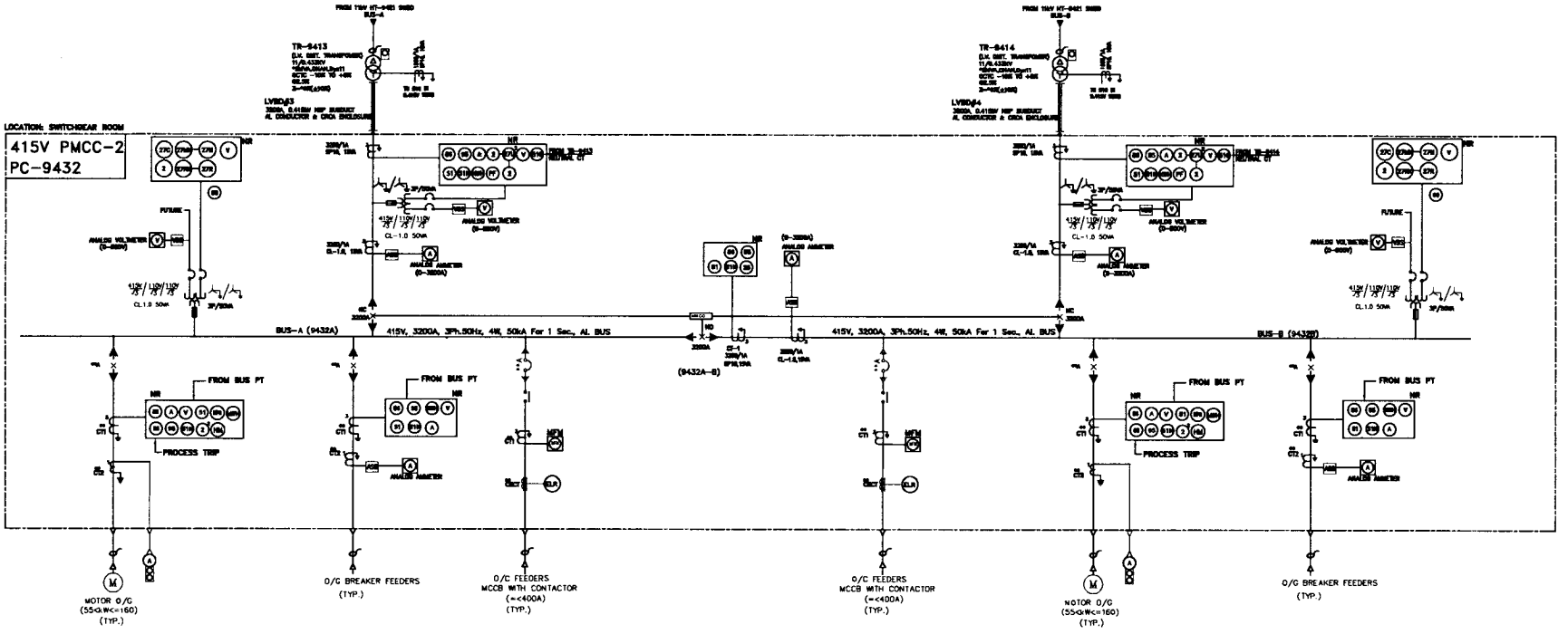

LEGEND :-

- BRANCH TYPE ACB
- BRANCH TYPE SFU
- BRANCH MODULE
- CONTACTOR
- MCB(WITH IOI+IOI+IOF RELEASES)
- POTENTIAL TRANSFORMER
- CURRENT TRANSFORMER
- AMMETER SELECTOR SWITCH
- VOLTMETER SELECTOR SWITCH
- AMMETER
- VOLTMETER (90 DEGREE TAUT BAND)
- MLD WATT HOUR METER
- ACB AIR CIRCUIT BREAKER
- SPC SWITCHFUSE CONTACTOR
- A/M C/O AUTO/MANUAL CHANGEOVER
- PF POWER FACTOR METER
- T TIMER
- CS CHECK SYNCH. RELAY
- VHC VOLTAGE HEALTH CHECK RELAY
- UVR U/V RELAY (SETTING RANGE 40-80%)
- RUVR RESIDUAL U/V RELAY (SETTING 40%)
- UVM U/V RELAY FOR TRIPPING MOTORS (SETTING RANGE 40-80%)
- IOR INSTANTANEOUS O/C RELAY
- IOGR INSTANTANEOUS E/F RELAY
- TR EMT O/C RELAY
- EFR EMT E/F RELAY
- SV DC SUPPLY SUPERVISION RELAY
- MR MASTER TRIP RELAY
- TCS TRIP CIRCUIT SUPERVISION RELAY
- SBR STANDBY E/F RELAY
- REF RESTRICTED E/F RELAY
- ELR EARTH LEAKAGE RELAY (SETTING RANGE 1-10S) WITH BUILT-IN TIMER
- CT CURRENT TRANSDUCER (4-20mA, 2WIRE, OUTPUT)
- NR NUMERICAL RELAY
- F FREQUENCY METER
- SFU SWITCHFUSE UNIT
- ECS ELECTRICAL CONTROL SYSTEM
- CBCT CORE BALANCE CURRENT TRANSFORMER
- TB TEST TERMINAL BLOCK
- T/F TRANSFORMER
- NON SEGREGATED PHASE BUSDUCT (NSPB)

GENERAL DIMENSIONAL LIMITS,FITS & TOLERANCES AS PER HY0230261

COMPUTER FILE NAME

REF. DRG. NO.

DESIGN AND DATE

TABLE-2: 415V PMCC-2 OUTGOING FEEDER DETAILS.

SL. NO.	FEEDER DESCRIPTION	FEEDER RATING	FEEDER TYPE	BREAKER RATING	FEEDERS QUANTITY			CT DETAILS			TERMINATION
					TOTAL	BUS-A	BUS-B	CT-1	CT-2	CBCT	
1	415V HRSG MCC	130kVA	ACB FEEDER	800A	2	1	1	200/1A, 5P10, 10VA	200/1A, CL-1.0, 10VA	NA	
2	415V AC&VENT MCC	655kVA	ACB FEEDER	1250A	2	1	1	1000/1A, 5P10, 10VA	1000/1A, CL-1.0, 10VA	NA	
3	415V MLDB	200kVA	MCCB WITH CONTACTOR	400A	2	1	1	400/1A, 5P10, 10VA	NA	*50/1A	
4	AUGMENT AIR FAN(HRSG LOAD)	160kW	MOTOR FEEDER	630A	2	1	1	400/1A, 5P10, 10VA	400/1A, CL-1.0, 10VA	NA	
5	ELECTRIC HEATER	400kW	ACB FEEDER	800A	1	1	0	700/1A, 5P10, 10VA	700/1A, CL-1.0, 10VA	NA	
6	FEEDER FOR OWNER'S USE	150kVA#	ACB FEEDER	800A	2	1	1	250/1A, 5P10, 10VA	250/1A, CL-1.0, 10VA	NA	
7	FEEDER FOR OWNER'S USE	75kVA#	MCCB WITH CONTACTOR	250A	2	1	1	160/1A, 5P10, 10VA	NA	*50/1A	
8	SPARE BREAKER O/G FEEDER	-	ACB FEEDER	1250A	1	1	-	1000/1A, 5P10, 10VA	1000/1A, CL-1.0, 10VA	NA	
9	SPARE MOTOR O/G FEEDER (55-160kW)	-	MOTOR FEEDER	630A	1	-	1	400/1A, 5P10, 10VA	400/1A, CL-1.0, 10VA	NA	
10	SPARE MCCB WITH CONTACTOR FEEDER	-	MCCB WITH CONTACTOR	400A	1	1	-	400/1A, 5P10, 10VA	NA	*50/1A	

PROJECT: CAPTIVE POWER PLANT (CPP) PACKAGE
VISAKH REFINERY MODERNIZATION PROJECT (VRMP)
JOB NO. B016

OWNER: HINDUSTAN PETROLEUM CORPORATION LIMITED

PMC: ENGINEERS INDIA LIMITED (EIL), NEW DELHI

BHARAT HEAVY ELECTRICALS LTD. HYDERABAD

	NAME	SIGN.	DATE	NO OF VAR.
DRN.	GRM/AVS	-SD-	12.04.18	
CHD.	P.SURESH	-SD-	12.04.18	
APPD.	J.K.PATTANAIK	-SD-	12.04.18	

DEPT. PE&SD CODE 450 | UNTOL DIMS. OR. | SCALE | WEIGHT (KG) | REF. TO ASSY. DRG. -N.A.- | ITEM NO. -N.A.- | NO.OF ITEMS -N.A.-

TITLE: SINGLE LINE DIAGRAM OF PMCC

CAPD CODE N.A.

BHEL DRG NO. PY-DL-1-M104-8809-01 | REV. 00

CUST. DRG NO.

SHT. No 02 | NO. OF SHT. 02

REV.	DATE	ALTERED	CHD/APPD	ZONE

ESP-001-11A

Section 3:
Project Details and General technical requirements for all equipment under the Project

The Break-up for section is as follows,

1. Project Details and Documental Requirements
2. Engineering Design Basis-Electrical
3. Specification for Documentation Requirements from Contractors
4. Methodology of Drawing & Document Review Procedure

Section 3:
Project Details and General technical requirements for all equipment under the Project

1.1 PROJECT DETAILS

Sl. No.	Description	Specific Details
1.	**Project Information**	
i.	Customer	Hindustan Petroleum Corporation Limited (HPCL)
ii.	Project Management Consultant (PMC)	Engineers India Limited (EIL)
iii.	Projects	Captive Power Plant (CPP) package of M/S Hindustan Petroleum Corporation Limited, Visakh Refinery, Vishakhapatnam (Andhra Pradesh), India
iv.	Project locations	Visakh Airport: 12 Kms Visakh Sea port: 10 Kms BHEL HPVP: 8 Kms Hyderabad: 630 Kms Chennai: 800 Kms
v.	Transport facilities	Visakh Airport: 12 Kms Visakh Sea port: 10 Kms
2.	**Site Conditions**	Equipment to be supplied against this specification shall be suitable for satisfactory continuous operation under the following tropical conditions,
i.	Maximum Ambient air temp. (max.)	45°C
ii.	Minimum Ambient air temp. (max.) °C	12.5°C
iii.	Design ambient temperature	45°C
iv.	Relative Humidity	95 %
v.	Environment	Humid & highly corrosive
vi.	Altitude above MSL	<5.56M
vii.		
3.	**Auxiliary Supply**	Details are as follows,

Normal Voltage	Voltage Variation	Frequency (Hz) Variation	Phase/Wire	Neutral Connection
415 Volts	±10%	50+3% to -5%	¾ wire	Solidly earthed
230 Volts	±10%	50+3% to -5%	½	Solidly earthed
110 Volts DC	±10%	DC	2 wire	Isolated 2 wire system

Note:
Combined variation of voltage and frequency shall be limited to ±10%.

1.2 INSPECTION, TESTING AND INSPECTION CERTIFICATE

Inspection testing shall be done as per customer specification and inspection plan mentioned elsewhere in the specification.

1.3 DOCUMENTATION

1.3.1 DRAWINGS AND INSTRUCTION MANUALS

A. Drawings to be furnished by the bidder after Award of Contract

The Bidder shall submit a 'drawing list' within 15 days from the effective date of Contract. Drawings/ documents for 'approval' shall be submitted in (7) copies and shall be commented or approved within four (4) weeks after submitting. In case the approval or comment of drawings/documents by the BHEL/OWNER/PMC is delayed beyond a period of four (4) weeks after submitting, drawings/ documents shall be deemed as approved.

In case acceptance, one set of drawings/ documents shall be returned marked 'approved'.

In case of comments the following procedure shall apply
In case the drawings/document are accepted in principle, but minor modifications are required, the drawings/ documents should be marked 'approved with comments' and the required modifications shall be spelt out detailed in the covering letter and / or clearly marked in the drawings. Fabrication / construction shall proceed, considering the comments. The corrected drawings/ documents shall be submitted after incorporating comments.
In case of disagreement with the drawings/ documents, these shall be marked 'returned for correction' and the reasons should be spelt out detailed in the covering letter. The drawings / documents shall be corrected and resubmitted for approval by return.

The drawings shall show sufficient overall dimensions, clearances etc. required for assembling and dismantling, and space requirement of all apparatus to enable the BHEL/OWNER/PMC to determine the design and layout at the installation.

After the completion of the erection work, the Bidder shall furnish fifteen (15) sets of the completion drawings and Ten (10) CD with Auto Cad 2011 or later version drawings in 2D and 3D marked 'as built' shall be submitted.

B. Operation and Maintenance Instruction Manuals

The Bidder shall furnish subsequent to completion of despatch twelve (12) sets of approved O&M instruction manuals. These manuals shall be properly bound in book form and contain all information, description of equipment, diagrams etc. necessary to enable the BHEL/OWNER/PMC to operate and maintain the complete equipment. Drawings with 'as built' status shall be added after commissioning. Reduced scale drawings/diagrams must be fully legible.

The title block of drawings shall contain the following information incorporated in all contract drawings

1.3.2 TITLE BLOCK

Title block for project shall be as follows,

Customer	Hindustan Petroleum Corporation Limited (HPCL)
Consultant:	Engineers India Limited (EIL)
Main Contractor	Bharat Heavy Electricals Limited (BHEL)
Project	Captive Power Plant (CPP) package of M/S Hindustan Petroleum Corporation Limited, Visakh Refinery, Vishakhapatnam (Andhra Pradesh), India

1.3.3 DOCUMENTS TO BE SUBMITTED ALONGWITH OFFER

1) Drawings in 2D and 3D format.
2) Guaranteed Technical Particulars
3) Type Test Reports
4) Manufacturing Quality Plan
5) Any other drawings/ documents as per Master Drawing List

1.3.4 DOCUMENTATION SCHEDULE AT CONTRACT STAGE

No. of Copies	A: For Approval
5	Copies of GA drawings (2d and 3D) with projects details, dimension, equipment weight, fixing details, tolerances and terminal details etc.
5	Copies of type test reports
5	Copies of shipping list detailing the description & quantities of all items being dispatched separately, with shipping weights, number of cases and dimensions.
5	Copies of manufacturing and field quality plan.
5	Copies of installation, operation & Maintenance manual.
	B : After Approval and For Information/Distribution.
6	Copies of All drawings
6	Bound sets containing all drawings/manuals, type and routine test reports etc. along with sub-vendor's test reports for all bought out assemblies/components/parts including Internal wiring diagrams and exploded diagrams of assemblies/ parts, shall be furnished.
10	Copies of Installation, Operation & Maintenance manual.
	C: On Completion of Entire works
12	Bound sets of Installation, Operation & Maintenance manual and all as built drawings
10	Set of Computer CD-ROMs (with unbreakable CD Covers) containing all as-built drawings in Auto-Cad version 2008 or later with 2D and 3D drawings, Instruction Manual and GTP.

1.4 STANDARDS AND CODES OF PRACTICE

All equipment, systems and works covered under these specifications shall be in

accordance with all the applicable statutes, regulations, codes and standard specified as well as all such standards, statutes, regulations and safety codes applicable in the locality where the equipment will be installed. Bidder may familiarize themselves with all such requirements.
Complete design including pressure parts, piping, valves and fittings shall meet or exceed all the latest requirements of the Indian Boiler Regulations (IBR), latest Indian Standards /ASME codes, latest codes and standards as applicable. Any Indian/International standards shall be followed for any imported equipment. For plant layout aspects and area classification requirements OISD standards shall be followed.

The design, construction and testing of all equipment, facilities, components and systems shall be in accordance with relevant standards and codes issued by Bureau of Indian Standards (BIS) and/or reputed international standards and codes as on the date of Award of Contract. A non-exhaustive list of reputed international standards follows for reference,

a) American National Standards Institute (ANSI)
b) American Petroleum Institute (API)
c) American Society of Mechanical Engineers (ASME)
d) American Society of Testing and Materials (ASTM)
e) American Water Works Association (AWWA)
f) American Welding Society (AWS)
g) British Standards (BS)
h) Cooling Technology Institute (CTI)
i) Deutsches Institut fur Normung (DIN), Germany
j) Gosstandart of Russia (GOST) standards
k) Heat Exchange Institute (HEI), USA
l) Hydraulic Institute Standards (HIS), USA
m) International Electro-technical Commission (IEC)
n) Institute of Electrical and Electronics Engineers (IEEE)
o) International Organisation for Standardisation (ISO)
p) Japanese Industrial Standards (JIS)
q) National Electric Code (NEC), USA
r) National Electrical Manufacturers Association (NEMA), USA
s) Central Electricity Authority (Construction of Electrical Plants and Electric Lines) Regulations, Notification, 20th August 2010 and to those referred therein
t) National Fire Protection Association (NFPA), USA
u) Occupational Safety and Health Administration (OSHA)
v) Tubular Exchanger Manufacturers Association (TEMA), USA
w) VDE association for Electrical, Electronic and Information Technologies (VDE), Germany
x) OISD

Other international Standards, equivalent or superior to the above Standards can also be adopted. However, In the event of any conflict between the requirements of the international standards or codes and the requirements of the BIS standards or codes, the latter shall govern unless specified elsewhere in the specifications. Any Indian/International standards shall be followed for imported equipment.

The Plants and Electric Lines (within the plant) shall also be designed to comply with the

requirements stipulated in.

a) Central Electricity Authority (Installation and Operation of Meters) Regulations, 2006.
b) Central Electricity Authority (Technical Standards for Connectivity to the Grid) Regulations, 2007.
c) Central Electricity Authority (Measures relating to Safety and Electricity Supply), Regulations as and when these are notified by the Authority.
d) Central Electricity Authority (Safety Requirements for Construction, Operation and Maintenance of Electrical Plants and Electric Lines) Regulations as and when these are notified by the Authority.
e) Central Electricity Authority (Grid Standards) Regulations as and when these are notified by the Authority.
f) Central Electricity Authority (Construction of Electrical Plants and Electric Lines) Regulations, Notification, 20th August 2010 and to those referred therein
g) Indian Electricity Grid Code issued by Central Electricity Regulatory Commission (CERC) and
h) Applicable State Grid Code issued by appropriate Regulatory Commission.

All material and equipment supplied and all work carried out as well as calculation sheets, drawings, quality and class of equipment, methods of inspection, constructional peculiarities of equipment and parts and acceptances of partial plants, as far as these are beyond the special requirements of the specifications, shall comply in every respect with the technical codes of the above listed codes and Standards.

It shall be the responsibility of the bidder to take all approvals required and get the HRSG registered under the IBR. In all other cases where IBR does not govern, IS/ASME, Japanese, American, British, German or other international standards established to be equivalent or superior to IS/ASME shall be acceptable with the approval of the Owner/Owner's representative at the time of detailed engineering.

Where there are no standards or regulations, or the standard is not sufficient to meet the need of design and supply, for such items relating to the power plant, the bidder shall carry out the design, manufacture, supply and installation on the basis of good engineering practice.

During the period of Contract execution, if any standards change, the bidder shall be responsible to notify the Owner/Owner's representative and provide the basis for the prospect that it would not cause the lowering of quality, performance and service life of the power plant due to alteration of the standard and the latest standards shall be followed by the bidder.

Further requirements about applicable standards and codes are specified in the detailed technical specifications.

1.5 SPECIAL TOOLS, TACKLES AND EQUIPMENT

One set of special tools and tackles required unit for the operation, maintenance, inspection and repair of the individual main equipment and auxiliary equipment shall be supplied by the bidder in sufficient quantity to equip the shift personnel, maintenance personnel and

workshop craftsman for commissioning, testing, calibration, modification and maintenance of the unit, List of such special tools, tackles and equipment shall be submitted in the EPC bid. Special tools and tackles excludes conventional ones and those locally available normally (not those requiring a drawing and considered as those made to order).

The special tools and equipment for maintenance and repair shall be delivered by the bidder in lockable steel boxes and they shall be marked in an approved manner for identification purposes and a corresponding tool chart shall be supplied with the steel boxes.

The following tools and appliances shall be supplied under this Contract for use by the Owner/Owner's representative:
• two sets of special tools and gauges required for the maintenance of the Plant
• one set of special lifting and handling tackles / appliances required for the maintenance of the Plant.

The tools, tackles and appliances supplied in general, shall not be used for erection purposes by the bidder and shall be handed over in brand new condition. Damaged tools, tackles, and appliances shall be replaced before handing over. The exception to this is the special lifting gear which may be used provided that when it is handed over to the Owner/Owner's representative it has not been subjected to more than normal wear and is still fully suitable for its intended use. Each set of tools, gauges and appliances under category (a) above shall be suitably arranged in fitted boxes of mild steel construction, the number of boxes being determined in relation to the layout of the plant and equipment in question. If the weight of any box and its contents should be such that it cannot conveniently be carried, it shall be supported on steerable rubber-tyred wheels. Each cabinet and box shall be painted, fitted with a lock and clearly marked in white letters with the name of the item of equipment for which the tools and appliances contained are intended.

Suitable storage racks shall be provided for all portable lifting tackle supplied under this contract. Suitable lifting lugs, ears or ring bolts, or tapped holes for lifting rings shall be provided on all equipment items where the weight exceeds 15 kg.

All lifting tackle shall be stamped with a unique identification number and safe working load. A test certificate from an approved Authority shall be supplied for each item of lifting tackle. The bidder shall provide a schedule of all lifting tackle and tools and appliances being supplied, for the approval of the Owner/Owner's representative.

The bidder shall provide all runway beams, trolleys, lifting blocks, special slings necessary for the safe and efficient handling and maintenance of the works. Particular attention shall be paid to handling of equipment located at higher elevations safety valves

The tools and appliances with the appropriate storage racks, cabinets and boxes shall be handed over to the Owner/Owner's representative at the time of Taking Over of the complete Plant. Since the Contract includes supervision of site erection, any special tools or appliances required solely for erection shall be provided by the bidder for his own use and shall remain the property of the bidder.

Control and Instrumentation: Software with associated hardware required to access

instruments or control systems to be provided.

1.6 PAINTING, INSULATION AND ANTI DEWING

Anti-corrosive coatings and painting shall be carried out as a pre-treatment to all equipment and parts. The paint system used should coordinate with the painted objects and surrounding conditions of project.

In multi-layer painting system, different painting layers should be selected to make the painting coordinate. If multi-layer painting system is used, various painting layers should have distinct colours so that the later layer can be distinguished from the former one.

After the equipment or apparatus finished preliminary or full painting, it can be supplied to field. After the installation is finished, ground coat must be painted. Entire painting procedure should be supplied in order to repair the injures of painting coat after the equipment is delivered to field.

Colour strip indication system should be used for pipes. These strips should be painted on the joint of pipes, entrance, valves of pipe. This pipe without outside protection layer should be marked by some colour in whole length.

The principal colour of field equipment should be determined by Owner/Owner's representative and bidder during execution stage. For Electrical equipment, paint shade shall be as mentioned in the equipment Specification.

Further requirements with regard to painting, insulation, and anti-dewing are specified in the relevant sections in the detailed technical specifications. The specified requirements shall be applied to the whole equipment and facilities of the Contract. Insulation specification for MPP supplied equipment shall be as mentioned in detailed technical specification.

1.7 CONSUMABLES

1.7.1 Lubricants and greases

All lubricants proposed for the Plant operation shall be suitable for all operating and environmental conditions that will be met on site. All oils and greases shall where possible be readily available in India. The number of oils and greases shall be kept to a minimum to the extent feasible. For each type and grade of lubricant recommended the bidder shall list at least three equivalent lubricants manufactured by alternative companies. This will be in line with that suggested by OEM and outcome will be informed to the Owner/Owner's representative.

In case of imported oils, lubricants and other consumables, the bidder shall indicate the indigenous equivalents to enable the Owner/Owner's representative to arrange subsequent fills. Preference should be given to indigenous oils and lubricants during first filling itself. Short shelf life items if any may be supplied in a phased manner keeping in view of their actual use.

The bidder shall supply the first fill lubricants and greases, and also shall provide at the Completion Certificate sufficient lubricants and greases necessary for the efficient operation and maintenance of the Plant at full load 24 hours per day for a period as mentioned in the

relevant portion of Commercial Specification.

1.7.2 Chemicals and other consumables

Contract includes the supply (by the bidder) of all chemicals, reagents, resins, and other consumables required for testing, commissioning and setting to work of each section of the Works.

The bidder shall provide all chemicals and other consumables required for the efficient operation and maintenance of the plant at full load 24 hours per day for a period as mentioned in the relevant portion of Commercial Specification.

The bidder shall prepare a list of these consumables giving quantities necessary for each section of the works and the recommended suppliers.

The bidder shall deliver to site sufficient quantities of consumables in his supply to allow for 6 months running of the Works prior to the issue of the Completion Certificate. The delivery of the remainder of the consumables shall be programmed to suit the operational requirements and space availability within the various stores.

ENGINEERING DESIGN BASIS
ELECTRICAL

JOB NO : **A758**

PROJECT : **Visakh Refinery Modernization Project**

CLIENT : **HPCL**

EIL SIGNATURE :

CLIENT SIGNATURE:

H.P.C.L

(NIKKI AGARWAL) (G.HARIPRASAD) (P.K.Chattopadhyay)

Rev. No.	Date	Purpose	Prepared by	Reviewed by	Approved by
0	07/Oct/2016	Issued For Implementation	RAVI SARUPRIA	VIJAY KUMAR	BHOGAL B R
A	15/Jul/2016	Issued For Client Comments	BANSAL VARUN	SINGH ARVIND N P	BHOGAL B R

Legend: ***Bold italic*** text denotes change with respect to previous revision.

Table of Contents

1.0 SCOPE

This electrical design basis defines the design requirements agreed by owner/clients in addition to "EIL standard design philosophy for electrical facilities no. 6-51-0099 Rev. No. 6" In case of any conflict between statutory requirements, this design basis and standard design philosophy, the most stringent requirement shall govern.
This electrical design basis is applicable for New process units (CDU/VDU, RUF, Isomerisation Unit, full conversion HCU), Auxiliary units (Hydrogen generation, Sulfur block, SWS-I, SWS-II, ARU, SR LPG Treater, FG ATU & Fuel gas PSA and existing revamp units (NHT, CCR, DHDT, PRIME-G, & PRU), CPP, Offsites & Utilities, etc.

2.0 ABBREVIATIONS, CODES & STANDARDS / PUBLICATIONS

2.1 ABBREVIATIONS

Code	Description
@	To be decided during detail engineering
NA	Not Applicable
#	To be decided/data to be provided by Client
AC	Alternating Current
ACB	Air Circuit Breaker
ASB	Auxiliary Service Board
CBCT	Core Balance Current Transformer
CEA	Central Electricity Authority
CT	Current Transformer
DC	Direct Current
DCP	Data Concentrator Panel
DG	Diesel Generator
DGMS	Director General Mines Safety
DOL	Direct On Line
EHV	Extra High Voltage
ELCB	Earth Leakage Circuit Breaker
EPC	Emergency Power Control Center
EPMCC	Emergency Power cum Motor Control Center
FRLS	Flame Retardent Low Smoke
GI	Galvanised Iron
GTG	Gas Turbine Generator
HMI	Human Machine Interface
HSR	High Availability Seamless Redundancy
HV	High Voltage
IEC	International Electro-Technical Commission
LDB	Lighting Distribution Board
LV	Low Voltage
MCC	Motor Control Centre
MCCB	Moulded Case Circuit Breaker
MOV	Motor Operated Valve
MV	Medium Voltage
NGR	Neutral Grounding Resistor
OLTC	On Load Tap Changer
PCC	Power Control Centre
PESO	Petroleum & Explosive Safety Organisation
PLC	Programmable Logic Control
PMCC	Power Cum Motor Control Centre

Code	Description
PRP	Parallel Redundancy Protocol
PT	Potential Transformer
PTB	Physikalisch-Technische Bundesanstalt
PVC	Polyvinyl Chloride
RCC	Reinforce Cement Concrete
RSTP	Rapid Spanning Tree Protocol
SFU	Switch Fuse Unit
SPN	Single Phase & Neutral
STG	Steam Turbine Generator
TP	Three Phase
TPN	Three Phase & Neutral
UPS	Uninterrupted Power Supply
VFD	Variable Frequency Drive
XLPE	Cross Link Poly Ethylene

2.2 CODES & STANDARDS / PUBLICATIONS

The main codes and standards, considered as minimum requirements, as applicable, are as follows -

S.No.	Description	Standards / Codes	Edition
1	Code of practice for the fire safety of buildings - Electrical Installations.	IS-1646	Latest
2	Code of practice for selection: installation and maintenance of automatic fire detection and alarm system.	IS-2189	Latest
3	Code of practice for the protection against lightning.	IS/IEC-62305	Latest
4	Code of practice for fire safety of industrial buildings - Electrical generating and distributing stations.	IS-3034	Latest
5	Code of practice for Earthing.	IS-3043	Latest
6	Code of practice for Interior Illumination.	IS-3646	Latest
7	Application guide for Insulation Coordination.	IS-3716	Latest
9	Guide for safety procedures and practices in electrical work	IS-5216	Latest
10	Guide for selection of electrical equipment for hazardous areas.	IS-5571	Latest
11	Classification of hazardous areas(other than mines) having flammable gases and vapours for electrical installations.	IS-5572	Latest
12	Code of practice for Industrial Lighting.	IS-6665	Latest
13	Guide for Control of undesirable static electricity.	IS-7689	Latest
14	Guide for improvement of power factor - consumer's installations.	IS-7752	Latest

S.No.	Description	Standards / Codes	Edition
15	Application guide for on load tap changers.	IS-8478	Latest
16	Reference ambient temperature for electrical equipment	IS-9676	Latest
17	Code of practice for selection, installation and maintenance of transformer.	IS-10028	Latest
18	Code of practice for selection, installation and maintenance for switchgear and control gear.	IS-10118	Latest
19	Application guide for Power Transformer.	IS-10561	Latest
20	Voltage bands for electrical installations including preferred voltages and frequencies.	IS-12360	Latest
21	Guide for short circuit calculations in three phase AC systems.	IS-13234	Latest
22	Code of practice for the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres.	IS-13408(Part-1)	Latest
23	Guide to the use of electrical apparatus for potentially explosive atmospheres in the presence of combustible dusts	IS- 15142	Latest
24	National Electrical Code (NEC) - BIS Publication.	SP-30	Latest
25	Recommended practices on static electricity	OISD-STD-110	Latest
26	Classification of Area for electrical installation at Hydrocarbon Processing and handling facilities	OISD STD-113	Latest
27	Inspection and safe practices during electrical installation	OISD-STD-147	Latest
28	Design aspects for safety in electrical systems	OISD STD-149	Latest
29	Fire Protection System for Electrical Installations	OISD STD 173	Latest
30	Lightning Protection	OISD STD-180	Latest
31	Electrical apparatus for explosive gas atmospheres - General requirements.	IS/IEC 60079-0	Latest
32	Equipment protection flameproof enclosures "d"	IS/IEC 60079-1	Latest
33	Electrical apparatus for explosive gas atmospheres - Intrinsic safety 'I'	IS 5780/IEC 60079-11	Latest
34	Electrical apparatus for explosive gas atmospheres Increased safety type "e"	IS-6381/IEC 60079-7	Latest

S.No.	Description	Standards / Codes	Edition
35	Classification of flammable gases or vapours with air with air according to their maximum experimental safe gaps and minimum igniting currents	IS 9570/IEC 60079-12	Latest
36	Electrical apparatus for explosive gas atmosphere -Part-15 Construction, test and marking of type of protection "n" electrical apparatus	IS/IEC 60079-15	Latest
37	Material characterstics for gas and vapour classification- Test methods and data	IS/IEC 60079-20-1	Latest
38	Energy efficient induction motors- Three phase squirrel cage	IS-12615	Latest
39	Outdoor distribution transformers of ratings upto and including 100 KVA, for use on systems with nominal voltages upto and including 11 KV.	IS-1180	Latest

3.0 GENERAL / DESIGN CONSIDERATIONS

S.No.	Project Philosophy
1	LV - Low Voltage. The voltage which does not normally exceeds 250 V.
2	MV - Medium Voltage. The voltage which normally exceeds 250 V and does not exceeds 650 V.
3	HV - High Voltage. The voltage which normally exceeds 650 V but does not exceed 33 kV.
4	EHV - Extra High Voltage. The voltage which exceeds 33 kV under normal condition.
5	Canopy shall be provided for all outdoor equipments except transformers, Capacitor Banks & control gear boxes of non-integral lighting fixtures. However, Roof slab for all transformers, Capacitor banks and removable type shed for Generator transformers & Tie transformers shall be provided.

4.0 SPECIFIC DESIGN REQUIREMENTS

S.No.	Project Philosophy
1	MCC incomer shall be electrically operated air circuit breaker in place of load break switch.
2	Minimum 4 nos., 400A 415V, TPN load break switch shall be provided in each process units for Annual shut down and maintenance. Each load break switch shall consists of 1 no. 400A heavy duty switch and outgoing switch fuse feeders as per the following: (a) 2 Nos. 100A, TPN (b) 2 Nos. 63A, TPN (c) 2 Nos. 32A, TPN (d) 2 nos. 32A, SPN
3	For spare philosophy of outgoing feeders in EHV/HV/MV switchboards, AC distribution board (UPS system) & DC distribution board (DC system), etc., refer relevant clauses of "EIL standard design philosophy for electrical facilities no. 6-51-0099 Rev.No. 6"

5.0 OWNER / CLIENT SPECIFIC REQUIREMENTS

5.1 SITE CONDITIONS

S.No.	Description	Selected Option	Available Options
1	Equipment design temperature (IS-9676)	45 DEG C	a)40 DEG C b)45 DEG C c)50 DEG C d)Any other
2	Relative humidity	Refer Gen. Civil Design basis	
3	Soil Resistivity	As per soil investigation report. Min. value shall be considered as 20 ohm-m	
4	Minimum temperature. for battery sizing	10 DEG C	a)10 DEG C b)20 DEG C c)Any other
5	Altitude above mean sea level	5.56 m	a)Less than 1000m above MSL b)Any Other
6	Maximum temp	45 DEG C	a)40 DEG C b)45 DEG C c)50 DEG C d)Any other
7	Minimum temp	12.5 DEG C	
8	Siesmic Zone	As per IS-1893 (Also Refer Structural Design Basis)	

5.2 POWER SOURCE DETAILS

S.No.	Description	Selected Option	Available Options
1	Power System	Mixture of Independent and existing system	a)Independent system b)Existing system
2	Grid Supply	Grid and CPP in Parallel	a)Yes b)No (Below Clause is not applicable)
2.1	Name of sub station	@	
2.2	Number of feeders	@	
2.3	Length of feeder	@	
2.4	Type /size of conductor/ cable size	@ __ sqmm	
2.5	Voltage	@ kV ± %	
2.6	Frequency	@ Hz ± %	
2.7	Maximum fault level		
2.7.1	3 Phase fault	@ kA, sec.	
2.7.2	1 Phase fault	@ kA, sec.	
2.7.3	X/R Ratio	@	
2.8	Minimum fault level	@ kA, sec.	
2.9	Design fault level	@ kA	
2.10	Basic Insulation Level	@ kV	
2.11	System neutral Earthing	@	

S.No.	Description	Selected Option	Available Options
2.12	Minimum power factor	0.9	a)0.9 b)0.95 c)Any other
2.13	Parallel operation of incomers	Momentary Parallel	a)YES b)NO
2.14	PLCC requirement	NA	a)YES b)NO
3	CPP and its configuration		#
3.1	Type of Generator	STG & GTG	a)STG b)GTG
3.1.1	Number of Generator	1 no. STG, 1 no. GTG	
3.1.2	Rating of Generator/Voltage/P.f	@ MW/ 11KV/ 0.8	
3.1.3	Requirement of Generator Circuit Breaker	NO	a)YES b)NO
3.2	Parallel operation with grid	YES	a)YES b)NO
3.3	Type of Neutral Earthing for Generators	Neutral Grounding Transformer	
3.4	Black Start DG Envisaged	NO	a)YES b)NO
4	Emergency generator	Centralised(REFER NOTE-1)	a)Centralised b)Distributed
4.1	Generator Voltage	6.6KV	a)6.6KV b)415V c)Any Other
4.2	Parallel operation with other sources	Momentary Paralleling	a)Momentary Paralleling b)Continuously Paralleling
4.3	Auto Starting	Yes	a)YES b)NO
4.4	Type of Emergency Generator	Diesel	a)Diesel b)Gas
5	Solar Power System	REQUIRED	
5.1	Solar PV System	Provided	a)Provided b)Not provided
5.2	Buildings on which solar power system to be mounted	Substation, Administration building(if any), Car parking	
5.3	Technology	SPV -Crystalline	
5.4	Battery	NO	
5.5	Connectivity	Local Switchboard	
5.6	Monitoring System	Provided	a)Provided b)Not provided
5.7	Location of Inverter	Indoor	a)Outdoor b)Indoor

Note:
1. The rating of emergency DG set shall be finalized during detailed engineering. The emergency DG set for the plant shall cater to emergency loads of various units, utility and offsite areas. 2 nos. Emergency DG set shall be considered each rated for 50% of full load capacity.

5.3 POWER SUPPLY DISTRIBUTION SYSTEM

5.3.1 VOLTAGE AND FREQUENCY VARIATION

S.No.	Description	Selected Option	Available Options
1	AC System		
1.1	Voltage	± 10%	
1.2	Frequency	± 3%	
2	DC System		
2.1	Electrical protection and Control system	± 10%	
2.2	DC critical Lighting system	± 10%	
2.3	Instrumentation Power Supplies	Refer Instrumentation Design Basis	

Note:
1. Refer section 5.6.10 of this document for design voltage/frequency variation for motors.

5.3.2 UTILISATION VOLTAGE

S.No.	Description	Selected Option	Available Options
1	Primary EHV/HV distribution voltage	220kV/66kV/33kV	a)33kV b)66kV c)Any other
2	Secondary HV distribution voltage	11kV/6.6kV (for new units/areas); 6.6kV (for revamp units)	a)11kV b)6.6kV c)3.3kV d)Any Other
3	Primary EHV/HV distribution system neutral Earthing	Solidly Earthed (for 220kV, 66kV, 33kV)	a)Solidly Earthed b)NGR c)Unearthed
4	Secondary HV distribution system Neutral Earthing	NGR	
5	HV motor voltage for DOL	6.6kV (For motors rating > 160kW)	
6	MV motor voltage	415 V AC (except VFD motor) (For motors rating 0.18<=kW<=160)	
7	AC Motors	240V AC (except MOVs) (For motors rating < 0.18kW)	
8	DC Motor	As per equipment supplier std.	
9	Motor operated valves	415V AC, TP	
10	Battery chargers incoming power supply	415V AC,TPN	
11	UPS System incoming power supply	415V AC,TPN	
12	AC Lighting/Power Panels	415V AC,TPN	
13	Auxiliary Boards incoming power supply	415V AC,TPN	
14	Welding Receptacles	415V AC,TPN	

S.No.	Description	Selected Option	Available Options
15	Bulk loads like Process Heaters etc	415V AC,TPN	
16	Normal Lighting/Emergency Lighting	240V AC,SPN	
17	LAN UPS	240V AC,SPN	

NOTES:
1) Electrical heaters shall be designed with 415V elements connected in delta.

5.3.3 UTILISATION VOLTAGE FOR CRITICAL SUPPLIES

S.No.	Description	Selected Option	Available Options
1	Switchgear protection control power supply	110 V DC	a)220V DC b)110V DC
2	Critical lighting power supply	220 V DC	a)220V DC b)110V DC
3	Input power supply for Plant communication system	110V AC UPS	a)240V AC SPN (With Dedicated battery back up) b)110V AC UPS
4	Input power supply Fire alarm system power supply	240V AC SPN (With Dedicated battery backup)	
5	Power supply for electrical annunciation panel	Not Applicable	a)220V DC b)110V DC
6	Normal Instrumentation power supply	Refer Instrumentation design basis	
7	Critical instrumentation power supply	Refer Instrumentation design basis	
8	Instrumentation Shut-down system power supply	Refer Instrumentation design basis	

NOTES:
1) Auxiliary supply of all critical systems such as VFD control supply and DAVR control supply shall be provided from Battery chargers/DC system.

5.3.4 OPERATING PHILOSOPHY

S.No.	Description	Selected Option	Available Options
1	Auto/Manual transfer at primary distribution voltage bus with momentary paralleling	YES	a)YES b)NO
2	Auto/Manual transfer at secondary distribution voltage bus with momentary paralleling	Yes	a)YES b)NO
3	Auto /Manual transfer at MV with momentary paralleling		
3.1	At PCC/EPC/EPMCC Level	Yes	manual momentary paralleling of incomer of MCC shall be provided through 25 relay

S.No.	Description	Selected Option	Available Options
3.2	At MCC/ASB/LDB Level	YES (for MCC of process area only)	a)YES b)NO
4	Continuous Parallel operation of Incomers		
4.1	Primary EHV/HV voltage	YES @	a)YES b)NO
4.2	Secondary HV voltage	NO	a)YES b)NO
4.3	PCC/PMCC	NO	a)YES b)NO
5	Power Factor Correction	Required	
5.1	Power factor improvement capacitors- location	11kV bus (for new units/areas)	a)6.6kV bus b)415V c)Both 6.6kV & 415V d)Any other
5.2	Minimum P.F. to be maintained at Transformer Primary	0.95	
5.3	Monitoring at Transformer Primary	Yes	a)YES b)NO
6	Load shedding	Yes	a)YES b)NO
6.1	Voltage level for Load Shedding	Up to PCC/PMCC Incomers & Bus-coupler only (Part of ECS System)	a)33kV b)11kv c)6.6kV d)0.415kV e)Any Other

5.4 CONTROL-PROTECTION - METERING

5.4.1 CONTROL PHILOSOPHY

S.No.	Description	Selected Option	Available Options
1	Location of Relays for Generator	Separate relay & control panel	
2	Location of Relays for Outdoor Switchyard	Separate relay & control panel	
3	Location of Protection relays for EHV/HV switchgear		
3.1	Primary voltage EHV/HV switch gear	On Switchgear for 33kV; Separate relay & Control panel for 66kV, 220kV	a)On switchgear b)Separate relay and control panel
3.2	Secondary Voltage HV switchgear	On switchgear	a)On switchgear b)Separate relay and control panel
4	EHV/HV Switchgear control		
4.1	Generator	Separate relay and control panel , SCAP	
4.2	Outdoor Switchyard	Separate relay and control panel	
4.3	Primary voltage EHV/HV switch gear	Separate relay & control panel	a)On switchgear b)Separate relay and control panel

S.No.	Description	Selected Option	Available Options
4.4	Secondary Voltage HV switchgear	On switchgear. ECS for selected switchgears	a)On switchgear b)Separate relay and control panel c)ECS
5	Numerical Protection/Monitoring system for		
5.1	EHV system	YES	a)YES b)NO
5.2	HV Switchboard	YES	a)YES b)NO
5.3	PMCC/PCC	YES	a)YES b)NO
5.4	MCC	YES (Incomer & Bus-coupler with non-communicable relays)	a)YES b)NO
6	Control and logic through numerical relays	YES	a)YES b)NO
7	Hardwired synchronization control panel-SCAP	YES	a)YES b)NO
7.1	Synchronizing trolley required	YES	a)YES b)NO
7.2	Type of Panel	Mosaic	a)Mosaic b)Simplex
7.3	Extent of Coverage on SCAP	New GTG, new STG, new CPP auxiliary transformers, HV switchboard, MV switchboard, existing GTG-03 to 06, existing 11kV & 33kV CPP bus, existing 132kV Switchgear, new CPP substations & all new Substations of VRMP.	
8	Type of annunciation panel	Part of SCAP	a)HMI b)Part of SCAP
9	Load shedding panel	Part of ECS	a)Part of ECS b)Separate PLC c)Hardwired
10	Method of motor starting		
10.1	HV Motors	DOL/ Soft Starter upto 2 MW (Note-2)	
10.2	HV Motors	Note-2 (Above 2 MW)	a)Auto transformer b)Soft starter c)VFD d)Dedicated transformer 2 MW and above
10.3	MV Motors	DOL up to motor 160 kW rating	
11	Starting MVA limitation conditions for Motors		
11.1	HV Motors	Up to 1 MW : 550% inclusive of + tolerance rating >1MW - to be decided during detailed engineering (Note-3)	
11.2	MV Motors	600%	

Notes:
1. Provision of laptop connectivity to the data concentrator shall be provided for unmanned sub-station.
2. V/F controlled soft starter shall be considered for starting large HV motors if essential/unavoidable as per system design requirement/equipment design limitation.
3. Starting current for motors shall be further reduced from 500% as per motor start up study.

5.4.2 POWER ISOLATION FOR TRANSFORMERS LOCATED REMOTELY AWAY FROM HV SUBSTATION

S.No.	Description	Selected Option	Available Options
1	Push button in transformer bay for tripping remote breaker	NO,Push button (Break glass type with hammer) shall trip the local isolator breaker.	a)YES b)NO
2	Local power isolating device	Yes	a)YES b)NO
3	Type	Breaker in panel	
4	Protection relay required	Yes	

5.4.3 RELAY PROTECTION SYSTEM

5.4.3.1 PROTECTION DEVICES FOR POWER DISTRIBUTION SYSTEM

Protection devices for power distribution system shall be as indicated below -
(Figure inside bracket refers to note below)
(YES - Applicable)

S.No.	Relay Description	Relay No.	HV Transformer Feeder - Sec. Winding Volt=>3.3kv	HV Transformer Feeder - Sec. Winding Volt<=0.433kv	HV Motor Feeder	Outgoing Breaker Feeder - HV Plant Feeder	Outgoing Breaker Feeder - MV PCC/PMCC	Incomer - EHV/HV	Incomer - MV PCC/PMCC
1	IDMTL over-current relay	51	YES	YES	-	YES	YES	YES (1)	YES
2	IDMTL earth-fault relay	51N	YES(4)	NO	-	YES	YES	YES (1)	YES
3	51G backup earth-fault relay (Earthed neutral)	51G(11)	YES(23)	YES(23)	-	-	-	-	-
4	Motor protection relay with (50, 50N,46, 49, 50L/R,86,95)	99	-	-	YES(3)	-	YES(3)	-	-
5	Instantaneous restricted earth-fault relay (Earthed side)	64R(11)	YES	YES, for rated 2.5MVA & more	-	-	-	-	-
6	Instantaneous over-current relay	50	YES	YES	-	-	-	-	-
7	Instantaneous earth-fault relay	50N	YES(2)	YES	-	-	-	-	-
8	Differential protection relay	87	YES(5)	-	YES(6)	YES(7)	-	-	-

S.No.	Relay Description	Relay No.	HV Transformer Feeder - Sec. Winding Volt=>3.3kv	HV Transformer Feeder - Sec. Winding Volt<=0.433kv	HV Motor Feeder	Outgoing Breaker Feeder - HV Plant Feeder	Outgoing Breaker Feeder - MV PCC/PMCC	Incomer - EHV/HV	Incomer - MV PCC/PMCC
9	High speed tripping relay	86(20)	YES	YES	YES	YES	YES	YES	YES
10	Trip circuit supervision relay	95(20)	YES	YES	YES	YES	YES	YES	YES
11	Transformer auxiliary relay	63	YES	YES	-	-	-	-	-
12	Under-voltage relay with timer	27/2	-	-	Note(14)	-	-	YES(9)	YES(9)
13	Check synchronisation relay	25	-	-	-	-	-	YES(10)	YES(10)

5.4.3.2 POWER GENERATION AND EXTERNAL POWER SUPPLY

Minimum protection relays for Synchronous generator (GTG/STG), generator transformer Grid power supply incomer and Synchronous motors shall be as follows:
(YES - Applicable)

S.No.	Relay Description	NEMA Code	Generator	Generator Transformer	EHV Incomer	EHV Transformer	Syn. Motor
1	Distance protection						
2	Synchronous check	25					
3	Under voltage with timer	27					
4	Reverse power	32					
5	Low power flow	37					
6	Loss of excitation	40					
7	Negative sequence	46					
8	Over current	50					
9	Earth fault relay	50N					

S.No.	Relay Description	NEMA Code	Generator	Generator Transformer	EHV Incomer	EHV Transformer	Syn. Motor
10	Over current	51					
11	Voltage restrained	51V					
12	Earth Fault back up	51G					
13	Over current E/F	51N					
14	Over voltage with timer	59					
15	VT failure	60					
16	Auxiliary relay for transformer	63TX					
17	Transformer Restricted Earth Fault	64R					
18	Stator back up earth fault	64G					
19	Generator Rotor Earth fault	64R					
20	Directional O/C	67					
21	Directional E/F	67N					
22	Under frequency/df/dt	81					
23	Tripping relay	86					
24	Gen differential	87G					
25	Gen and Transformer differential	87GT					
26	Transformer differential	87T					
27	Feeder differential	87F					
28	Bus bar differential and check	87B/ 87CH					
29	Trip circuit supervision	95					

S.No.	Relay Description	NEMA Code	Generator	Generator Transformer	EHV Incomer	EHV Transformer	Syn. Motor
30	Dead bus charging relay	98					
31	Over fluxing	99					
32	Out of step	78					

5.4.3.3 RELAY PROTECTION PHILOSOPHY

S.No.	Project Philosophy
1	For air insulated HV switchboards, One set of 87B (Bus differential) relay and 95 B (Bus wire supervision) relays shall be provided for each bus section. The Bus wire supervision relay (95B) shall be provided for alarm and shall not lead to trip. Further, in case of HV switchboards with continuous parallel operation of incomers, One set of 67 and 67N (Directional IDMTL over current and earth fault) relays shall be provided for the incomers.
2	Instantaneous earth fault (50N) shall be provided only for transformer with delta primary.
3	MPR shall be provided for breaker fed motor feeders. However, for Contactor controlled motor feeders, the relay 50 shall not be provided in MPR.
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, excluding 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 synchronising relay shall be provided.
11	51G and 64R relays for input transformer of VFD system shall be decided by VFD Manufacturer. CT′ s for REF 64R) and SEF (51G) shall be located at either side of the neutral tap point of transformers to prevent spurious tripping of transformers on 51G due to unbalanced current.
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.

S.No.	Project Philosophy
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 a. HV and MV capacitor feeders b. HV and MV breaker controlled motor feeders c. Contactor controlled motor feeders with DC control supply. Numerical relays where ever provided for motor and capacitor feeders shall use in built under voltage relay and timer for delayed tripping on bus under voltage.
15	One no. DC supply supervision relay (80) shall be provided for each incoming DC supply to the switchboard.
16	One set of bus differential relays (87B) and bus wire supervision relay (95 B) for each bus section shall be provided for HV switchboards connected directly to generation buses.
17	In case of numerical relays, all relays shall be comprehensive units including all protection, metering and control.
18	Under voltage and over voltage function along with associated timer shall be part of the numerical relays.
19	Auto changeover logic between Incomers and bus coupler shall be built in the numerical relay.
20	Tripping relays (86) & Trip Circuit supervision relay (95) shall be part of numerical relay.
21	2 Nos. of 86 relays shall be considered for HV and MV breaker fed motors for ease of differentiation between process & electric trip in the numerical relay. Built-in logic to be provided in relay for process/electrical trip with LED latched condition. Process trip in the numerical relay should be auto reset but LED should be latched.
22	Breaker control switch shall be hardwired type.
23	Stand by earth fault relay 51G shall be provided for all transformers.
24	Restricted earth fault relay 64R shall be provided in the incomer of switchboard fed from transformer of rating >= 2.5 MVA and secondary winding is star connected.
25	Relay 51V voltage controlled over current relay shall be provided on specific requirement considering the rating of the outgoing feeders with respect to the Incomer rating. Generally this relay shall be provided wherever CT primary current of outgoing feeders is exceeding 40% of the CT primary current of the Incomer.
26	415V DG set shall be provided with protection but not limited to 51V,51G,40,46,86,95,80,64R etc for generator rated above 500KVA and Generator rated less than 500KVA shall have 51V,51G,40,46,86,95,80 unless otherwise agreed with the owner.
27	All master trip relay (86) shall be part of numerical relay. No electromechanical type relay shall be provided.
29	Relay 87 and 64R shall be seperate 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.
30	Stabilizing resistors shall be provided in residual earth fault connections for all motors & transformers even in case of Numerical relays to prevent any spurious tripping during starting.

5.4.4 METERING

5.4.4.1 METERING DEVICES IN EHV, HV AND MV SWITCHBOARDS

The metering devices in EHV, HV and MV switchboards shall be as below:
Type of metering : Multifunction digital meter / As part of the Numerical relay

(Figure inside bracket refers to note below) (YES - Applicable)

S.No.	Feeder Type	A	V	Hz	PF	MW	MWH	HM	MVAR	MVAH	MVA
1	Grid Incomers										
2	Grid Bus Tie										
3	Grid Transformer	YES				YES	YES				
4	Grid Bus P.T.										
5	EHV/HV Incomer	YES	YES	YES	YES	YES	YES	-	YES	YES	YES
6	EHV/HV Bus Tie	YES	-	-	-	-	-	-	-	-	-
7	EHV/HV Transformer	YES	-	-	-	-	YES	-	-	-	-
8	EHV/HV Bus P.T.	-	YES	-	-	-	-	-	-	-	-
9	EHV/HV Plant Feeder	YES	-	-	-	-	YES	-	-	-	-
10	EHV/HV Motor	YES	-	-	-	-	YES(kWh)	YES	-	-	-
11	EHV/HV Capacitor	YES	YES	-	-	-	-	-	-	-	-
12	PCC/PMCC Incomer	YES	YES	-	YES	-	YES(kWH)	-	-	-	-
13	PCC/PMCC Bus Tie	YES	-	-	-	-	-	-	-	-	-
14	PCC Bus P.T.	-	YES	-	-	-	-	-	-	-	-
15	ACB Outgoing (Non motor)	YES	-	-	-	-	YES(kWh)	-	-	-	-
16	MV Motor (>55kW)	YES	-	-	-	-	-	-	-	-	-

S.No.	Feeder Type	A	V	Hz	PF	MW	MWH	HM	MVAR	MVAH	MVA
17	MCC/ASB Incomer	YES	YES	-	-	-	-	-	-	-	-
18	MCCB/SFU O/G(250A)	YES	-	-	-	-	YES(kWh)	-	-	-	-
19	LDB Incomer	YES	YES	-	-	-	YES(kWh)	-	-	-	-
20	DG Set-MV	YES	YES	YES	YES	YES(kW)	YES(kWh)	YES	-	-	-

Notes:
1. MVA meter in EHV external power supply Incomers shall include maximum demand indication also.
2. Separate MW, MVAR, MVA and MVAH meters shall be provided for EHV external power supply Incomers only.
3. Seperate 3 nos. voltmeter and 3 nos. ammeter shall be provided for EHV external power supply incomers.
4. All metering shall be provided through numerical relay in case switchboard are having numerical relay
5. One no CT with 1 secondary core shall be provided in Y phase of motor feeder in switchgear for remote metering on local control station.
6. Field Ammeters are to be provided for motors >=3.7 KW.
7. In LT panels, wherever metering is not available as part of Numerical relays, separate digital multifunction meter (MFM) shall be provided.

5.4.4.2 METERING FOR GENERATOR AND GENERATOR TRANSFORMER

S.No.	Meter	HV Generator	Generator transformer
1	Ammeter (3 nos.)	YES	YES
2	Voltmeter (3 nos.)	YES	YES
3	MW meter	YES	YES
4	MVAR meter	YES	
5	MVA meter	YES	
6	MWH meter	YES	YES
7	MVARH meter	YES	
8	Power factor	YES	YES
9	Frequency meter	YES	

5.5 SUBSTATION DESIGN

5.5.1 SUBSTATION AUTOMATION SYSTEM

S.No.	Description	Selected Option	Available Options
1	Substation Automation System (SAS)	Required	
2	Communication protocol for relay network	IEC 61850 (Note-1)	a)IEC 61850 b)open protocol
3	System architecture	IEC 61850 HSR (Note-1)	a)IEC 61850 RSTP b)IEC 61850 PRP c)IEC 61850 HSR d)Redundant architecture for other open protocols
4	Data concentrator for SAS	common for HV & MV	a)not required b)common for HV & MV c)seperate for HV & MV
5	Communication with other devices		
5.1	Communication with ECS	YES (with load shedding cum logic control panel)	
5.1.1	Protocol for communication with ECS	IEC 61850	a)IEC 61850 b)Modbus
5.2	Communication with DCS	Part of data concentrator	a)part of data concentrator b)part of ECS RTU
5.2.1	Protocol for communication with DCS	MODBUS TCP/ IP protocol	
5.3	Communication with VFD & UPS	Part of data concentrator	a)part of data concentrator b)part of ECS RTU
5.3.1	Protocol for communication with VFD & UPS	MODBUS TCP/ IP protocol	
6	HMI for SAS	2 operator & 1 engineering workstation with redundant servers as applicable	a)not required b)operator cum engineering workstation c)1 operator & 1 engineering workstation

S.No.	Description	Selected Option	Available Options
7	Laptop	Separate for HV & MV for each substation	a)not required b)common for HV & MV for each substation c)seperate for HV & MV for each substation
8	Local storage of data	part of HMI	a)not required (part of ECS) b)part of HMI c)part of data concentrator
9	Relay parameterization	SAS HMI	a)SAS HMI b)ECS HMI

Note:
1) Communication protocol & system architecture mentioned above is applicable for new system/units/areas only. For revamp units/areas, the communication protocol of existing system shall be followed.

5.5.2 EHV SWITCHYARD

S.No.	Description	Selected Option	Available Options
1	Type	NOTE-1	
2	Type of bus	NOTE-1	a)String bus b)Tubular bus
3	Structure for outdoor	NOTE-1	a)Galvanised b)Painted c)Not applicable
4	Bus material	NOTE-1	a)Aluminium b)Copper

NOTES:
1) EHV SWITCHYARD is not applicable. In case it is found essential at later date, the same shall be further discussed and suitable options shall be decided during detail engineering.

5.5.3 SUBSTATION FEATURES

S.No.	Description	EHV	HV	MV	MCC/Elec. Room
1	Elevated with trays in cable cellar	YES	YES	YES	NO
2	Raised with internal trenches	NO	NO	NO	YES
3	All top cable entry with trays below ceiling	NO	NO	NO	NO
4	Pressurisation against ingress of dust	NO	YES (NOTE-2)	YES NOTE-2)	NO
5	Air-conditioned room for operator	YES	YES	YES	YES
6	Roof slab for				
6.1	Power transformer	NO (NOTE-3)	YES (NOTE-3)	YES (NOTE-3)	NO

S.No.	Description	EHV	HV	MV	MCC/Elec. Room
6.2	Distribution transformer	NA	YES (NOTE-3)	YES (NOTE-3)	NA
7	Air conditioning of switchgear hall	YES	YES (NOTE-2)	YES (NOTE-2)	NA
8	EOT crane in sub-station	NO (NOTE-5)	NO (NOTE-5)	NO (NOTE-5)	NA

Column HV is defined below :-
1. Substation having full fledged HV Switchboard having incomer, bus coupler & outgoing feeder.
2. All new Unit Substations and Interconnecting Substations under VRMP shall be provided with HVAC system with chemical filters. However, other new Substations shall be provided with pressurization system against ingress of dust.
3. Roof slab for all transformers shall be provided except for Generator transformers & Tie transformers. However, removable type shed shall be provided for Generator transformers & Tie transformers.
4. Each substation shall be provided with a toilet, maintenance/store room for workmen to keep their tools and operator room (based on space availability), etc.
5. Lift to be provided with adequate capacity for substations having higher than 2 floors.
6. The clear height of bottom most cable tray running across the width of the substation cellar shall be at 1.8m from FFL to enable smooth movement of personnel inside the cellar room.
7. Substations shall have provision of access control & CCTV (Refer instrumentation design basis for technical design data & specifications of access control & CCTV system).

5.5.4 SPECIFIC EQUIPMENT LOCATIONS

S.No.	Description	Selected Option	Available Options
1	Batteries in substation and control Rooms	Separate room	
2	Battery charger in substation	Air conditioned room	a)Air conditioned room b)Non air conditioned room
3	Battery charger in control room	Air conditioned room	a)Air conditioned room b)Non air conditioned room
4	Variable speed drive panels	Air-conditioned room in substation	a)Air-conditioned room in substation b)SRR
5	Thyristor controlled panels	Air-conditioned room in substation	a)Air-conditioned room in substation b)SRR
6	UPS System	Air conditioned room in control room	
7	Lead-Acid and Nickel-Cadmium	Separate room	a)Separate room b)Common room
8	Location of VRLA battery	Air conditioned room	
9	Annunciation panel	Part of HMI	
10	Energy saver panel with Lighting transformers	NA	
11	GIS Hall	Air conditioned	a)Air Conditioned b)Pressurised

1. Battery room shall be preferably located in corner side at cable cellar level/switchgear floor level of the substation building.

2. Battery charger for Instrumentation if applicable, shall be placed in air-conditioned UPS room in control room.
3. Electrical equipment installed in battery room such as exhaust fan, lighting fixtures, receptacles shall be of flameproof and certified for gas group II-C classified locations. Heat detectors installed in battery room shall be of intrinsically safe type.

5.6 EQUIPMENT DESIGN

5.6.1 EHV DESIGN

5.6.1.1 EHV OUTDOOR SWITCHYARD

S.No.	Description	Selected Option	Available Options
1	Bus bar system	Double	a)Single b)Double
2	Circuit breaker type	SF6	
3	Isolator type	During detail engineering	a)Pantograph b)Semi Pantograph c)Centre rotating d)Centre break

5.6.1.2 EHV SWITCHBOARD

S.No.	Description	Selected Option	Available Options
1	Execution	Fixed Type	
2	Type of Switchgear	Gas Insulated	
3	Busbar	Double	a)Double b)Single
4	Circuit Breaker Type	SF6	

5.6.2 HV SWITCHBOARD

S.No.	Description	Selected Option	Available Options
1	Execution	Drawout for AIS, Fixed for GIS	a)Drawout b)Fixed
2	Type of switchgear	Air Insulated for 11kV, 6.6kV & 3.3kV; Gas insulated for 33kV	a)Air insulated b)Gas insulated
3	Bus bar	Single bus for AIS & GIS	a)Single bus b)Double bus
4	Circuit breaker type	VCB/SF6	a)SF6 b)VCB
5	Motor Control	Breaker	a)Breaker b)Vacuum contactor

NOTES:
1) All HV Switchboard shall be LOTO compliant.
2) In HT Switchboards, the thermo-graphic window shall be provided to check cable termination.
3. HV switchboards (6.6kV & 11kV) shall be provided with earthing trucks for cable side and/or busbar side earthing.

5.6.3 CURRENT TRANSFORMER (CT)/POTENTIAL TRANSFORMER (PT)

S.No.	Description	Selected Option	Available Options
1	CT Secondary		
1.1	General Protection	1A	
1.2	Special protection(87,64R ,51G etc)	1A	
1.3	Metering	1A for conventional and remote metering	
2	PT Secondary	110V AC	

Note :-
1.) CT for metering shall be separate from the protection CT and no interposing CT shall be provided in the protection CT secondary circuit for metering purpose.

5.6.4 TRANSFORMERS (POWER/DISTRIBUTION)

S.No.	Transformer	Voltage Ratio	Vector Group	Tap Changer	Cooling
1	Power transformer	# During Detail engineering	Dyn1	OLTC	ONAN/ONAF
2	Dedicated (e.g. for VFD)		As Reqd.	Off-circuit	AN
3	Distribution transformer (<= 2500 KVA)		Dyn 11	Off-circuit	ONAN

Note:
1) Provision of Oil Soak Pit & Oil Collection Pit for transformers shall be as follows:
a) Oil quantity <= 2000L: Not Required
b) 2000L < Oil Quantity <= 9000L: Soak Pit
c) Oil Quantity > 9000L: Soak Pit + Collection Pit
2) Fire fighting system (Nitrogen injection fire protection system) shall be provided for transformers having oil greater than 2000 Liters.

5.6.5 MV SWITCHBOARD

S.No.	Description	Selected Option	Available Options
1	PCC / PMCC		
1.1	Breaker panels	Drawout Single front	
1.2	Contactor feeders	Drawout Single front	a)Drawout Single Front b)Drawout Double front c)Fixed Single front
2	MCC	Drawout Single front	a)Drawout Single Front b)Drawout Double front c)Fixed Single front
3	ASB	Drawout Single front	a)Drawout Single Front b)Drawout Double front c)Fixed Single front
4	LDB	Drawout Single front	a)Drawout Single Front b)Drawout Double front c)Fixed Single front

S.No.	Description	Selected Option	Available Options
5	Motors		Single front for critical applicationa and utilities.
5.1	PMCC	Above 55 kW Up to 160 kW	
5.2	MCC	Up to 55 kW	
6	Type of switchboard for small package (AC system, Pressurisation system ,Bagging plant etc)	Compartmentalised Fixed type; Draw-out type for HVAC System	a)Compartmentalised Fixed type b)Non Compartmentalised Fixed type

Notes:
1) 4-pole ACBs for PCC/PMCC incomer & bus coupler having direct/ immediate connection with distribution transformer shall be provided.
2) All MV Switchboard shall be LOTO compliant.
3) All super critical application motors shall be provided with double contactors in DOL feeder. HPCL shall identify and furnish the list of motors for super critical applications during detail engineering.

5.6.6 MEDIUM VOLTAGE MOTOR STARTER TYPE

S.No.	Description	Selected Option	Available Options
1	Contactor and switch fuse with overload relay	NA	
2	Contactor, switch fuse and overload relay with CBCT for earth fault protection	NA	
3	Contactor and switch fuse with motor protection relay	NA	
4	Air circuit breaker with motor protection relay	Above 55kW up to 160KW (Note-1)	
5	Contactor and MCCB with overload relay	Upto 55kW (Note-1 & 2)	
6	Contactor, MCCB and overload relay with CBCT for earth fault protection	Not Applicable	

NOTES:
1) Motor protection relay (numerical type) shall be provided with communication facility.
2) All LT motor upto 55kW shall be provided with motor protection relay (numerical type) with earth fault protection.

5.6.7 MEDIUM VOLTAGE OUTGOING FEEDER TYPE

S.No.	Description	Selected Option	Available Options
1	Switch fuse	NA	
2	Switch fuse with Contactor and CBCT for earth fault protection	NA	
3	MCCB with Contactor and CBCT for earth fault protection	above 100A and up to 400A (with O/C & S/C protection)(Note-1)	a)___A and up to ___A b)Not Applicable

S.No.	Description	Selected Option	Available Options
4	MCCB	Upto 100A (with O/C,S/C & E/F protection) (Note-1)	a)___A and up to ___A b)Not Applicable

NOTES:
1) MCCB shall be provided with shunt trip coil.
2) R-C Circuit across power contactor and low-burden auxiliary contactor for receiving start/ stop command from field shall be provided in all DOL starter feeders.
3) MCCB feeders feeding to VFD shall be provided with under voltage protection.
4) ELCB with 30mA rating shall be provided for all power points, receptacles, plant lighting system, heat tracing system etc. for human safety.

5.6.8 MOTOR CONTROLS (AS PER PROCESS PACKAGE & OPERATING PHILOSOPHY)

S.No.	Description	Selected Option	Available Options
1	Auto/OFF/Manual switch	Control room	a)Near motor b)Switchgear c)Control room
2	Local/OFF/Remote switch	Near Motor	a)Near motor b)Switchgear c)Control room
3	Process interlock	PLC/DCS/Switchgear (Note-1)	a)PLC b)Switchgear
4	Reacceleration equipment	Switchgear	a)PLC b)Switchgear

Note :-
1) To be made available at Switchgear as per instrumentation philosophy.

5.6.9 CONTROL SUPPLY VOLTAGE

S.No.	Description	Selected Option	Available Options
1	Breaker control	110V DC	a)220V DC b)110V DC
2	Breaker spring charging	110V DC	a)240V AC b)220V DC c)110V DC
3	Contactor feeder	110V DC / 240V AC (for remotely located MCCs)	
4	Control supply for earth fault relay in contactor feeder(Note 1)	110V DC	a)24V DC b)220V DC c)110V DC d)240V AC
5	Control supply for contactor motor starter	Control Transformer (one for each bus section) for remotely located MCCs)	a)Control Transformer b)Tapping P-N of Respective Feeder c)Control Transformer in individual DOL Starter
6	Control transformer for each feeder	NO	a)YES b)NO c)Not Applicable

Notes:
1) DC control supply to MCC is applicable for main sub-station where DC power supply is available.

5.6.10 MOTORS

S.No.	Motors	High voltage	415 volts
1	Enclosure		
1.1	Indoor	IP55	IP55
1.2	Outdoor	IP55	IP55
2	Insulation class	F (Temp. Rise limited to B)	F (Temp. Rise limited to B)
3	Anti-condensation heater	Yes	30 kW and Above
4	Additional canopy (outdoor motors)	Yes (FRP type)	Yes (FRP type)
5	Design voltage variation	±10%	±10%
6	Design frequency variation	±3%	±3%
7	Combined voltage / frequency variation (Design)	±10 % Any combination of above	±10 % Any combination of above

1. Motors for MOV actuator shall have F class of insulation with temperature rise limited to class-B.

5.6.11 UPS SYSTEM

S.No.	Description	Selected Option	Available Options
1	Redundancy	100%	a)50% b)100%
2	Type of redundancy	Parallel redundant	a)Parallel redundant b)Hot standby
3	Back-up time	30 minutes	a)30 minutes b)60 minutes c)120 minutes
4	Bypass transfer control	Auto	a)Auto b)Manual
5	Separate fault diagnostic unit (Note 1)	YES	a)YES b)NO
6	Battery type	Ni-Cd (2x50%)	a)Lead acid b)Ni-Cd c)VRLA(in 2x50% configuration)
7	Type of UPS	IGBT	a)IGBT b)Transistorised
8	UPS Output Supply	Single Phase	a)Single Phase b)Triple Phase
9	UPS Output Voltage	110V AC (Final voltage shall be as per Instrumentation Design Basis)	

NOTES:
1. IP based in built Fault Diagnostic Unit (FDU) is required.

2. UPS for data communication system, CFAP of FA system and sub-station HMI and small package units shall be non redundant with bypass type with VRLA battery.

5.6.12 COMMUNICATION SYSTEM

S.No.	Description	Selected Option	Available Options
1	Plant Communication System	Yes (Note-1 & 2)	a)YES b)NO
2	Telephone System	Yes (Note-1, 3 & 4)	a)YES b)NO c)Separate
3	Telephone system and plant Communication system	Separate	a)Separate b)Integrated
4	Interface of Communication system		
4.1	With fire alarm system	Yes	a)YES b)NO
4.2	With telephone system	Yes	a)YES b)NO

Notes:-
1) New system for new units and Expansion of existing system for NHT/CCR/DHDT/ PRIME-G/PRU unit
2) Dedicated battery is not envisaged for plant communication system. 110 V AC UPS supply shall be given to Plant communication exchange.
3) Flameproof telephones are to be provided in all classified areas.
4) No. of intercom and external P&T lines to be furnished by client.

5.6.13 FIRE DETECTION AND ALARM SYSTEM

S.No.	Description	Selected Option	Available Options
1	Type	Analogue addressable (Note-1)	a)Conventional b)Analogue addressable
2	Name of buildings to be provided with Detectors	Control room, sub-station, SRR, other buildings as required.	
3	Detection System	Break Glass, Multi sensor detectors (for heat & smoke detection), linear beam detectors	
4	Type of manual call point	Without call back facility	a)With call back facility b)Without call back facility
5	Qty of Siren and location	@ To be decided during detail engineering.	
6	Power supply for Siren	415V AC	a)415V AC b)110V AC UPS c)48V DC
7	Siren range	5 Km(Diametrically)	
8	Response indicator for rooms and concealed area for Addressable Fire alarm system	YES	a)YES b)NO c)Not Applicable

NOTES:
1) New system for new units and Expansion of existing system for NHT/CCR/DHDT/ PRIME-

G/PRU unit to be considered.
2) Fire siren hooter & flashlight to be provided inside control room and major buildings.

5.6.14 DC SYSTEM

S.No.	Description	Selected Option	Available Options
1	Battery type		
1.1	Switchgear Protection Control and critical lighting	Ni-Cd	a)Lead acid b)Ni-Cd c)VRLA
1.2	Instrumentation System	As per Instrumentation Design Basis	a)Lead acid b)Ni-Cd c)VRLA
1.3	Diesel Engine Starting	Lead Acid	
1.4	DC Motors	As per equipment supplier recommendations	a)Lead acid b)Ni-Cd c)VRLA
1.5	Fire alarm system	VRLA	
1.6	Telephone system	VRLA	
1.7	End Cell Voltage		
1.7.1	Lead Acid Battery	1.85 VOLT	
1.7.2	VRLA Battery	1.75 VOLT	
1.7.3	Ni-Cd Battery	1.0 VOLT	
2	Battery backup time		
2.1	Switchgear Protection and Control	120 minutes	a)30 minutes b)60 minutes c)120 minutes
2.2	DC Critical lighting	120 minutes	a)30 minutes b)60 minutes c)120 minutes
2.3	Instrumentation	As per Inst. Design basis	a)30 minutes b)60 minutes c)120 minutes
2.4	Diesel Engine Starting	10 starts (FW pumps) & 6 starts (others)	
2.5	DC Motors	As per equipment manufacturer's recommendation	
3	Battery Configuration	2X50%	a)2X50% b)1X100%

5.6.15 VARIABLE FREQUENCY DRIVE

S.No.	Description	Selected Option	Available Options
1	By pass feature required	Yes(Note-1)	a)YES b)NO
2	VFD rated output voltage		
2.1	MV Inverter	i) Motor kW rating less than 315kW at 415V , ii) More than 315kW & up to 700kW at voltage upto 690V	

S.No.	Description	Selected Option	Available Options
2.2	HV Inverter	Motor rating more than 700kW	

Notes:
1. Bypass for VFD shall be provided as a standard practice unless not recommended from Process or driven equipment operation point of view.

5.6.16 CABLE SIZES

The power and control cables shall have the following minimum cross sectional areas:

S.No.	Description	Selected Option	Available Options
1	Medium voltage power cable	Upto 10 Sq.mm.-Copper. Greater than and equal to 25 Sq.mm.- Aluminium	a)Above 16 sqmm (Aluminium) b)2.5 sqmm to 16 sqmm (Copper)
2	Control cables	2.5 sqmm (Copper) Overall shielded (Note-5)	
3	Lighting	2.5 Sq.mm.(Copper)/ 4 Sq.mm. (Copper)for street lighting	
4	Communication system	6P*0.9 mm dia. (Copper) Note-7)	
5	Telephone System	0.63 mm dia.(Copper)	
6	Fire alarm system	1.5 sqmm (Copper)- twisted pair (Note-7)	

Notes:
1. For lighting inside the building, minimum 1.5 sqmm copper conductor, PVC Insulated FRLS wires shall be used in conduit system (for circuit and point wiring), with proper colour coding.
2. Cable sizes are indicative only and these shall be finalised as per the recommendations of the equipment manufacturer.
3. Special cable type and size shall be decided on specific requirement.
4. The outgoing cables of UPS & DC system shall be 3-core copper cables.
5. Control cable& FA cables shall be twisted pair overall shielded type.
6. Outer PVC sheath of all cables shall be flame retardent type. Cables shall have low smoke properties i.e. FRLS type with 60% (Max) smoke density.
7. Cable sizes are indicative only and these shall be finalised as per the recommendations of the equipment manufacturer.

5.7 CABLING SYSTEM

5.7.1 CABLE DETAILS

S.No.	Design Criteria	EHV	HV	415 volts
1	Loads located beyond 1 km	1C cable	1C / 3C cable	1C / 3.5C cable
2	Loads located 200-1000 m	1C cable	1C / 3C cable	1C / 3.5C cable

S.No.	Design Criteria	EHV	HV	415 volts
3	Loads located upto 200 m	1C cable	1C / 3C Cable	1C / 3.5C Cable
4	Loads beyond 1000A rating & located near the transformer	NA	Busduct	Busduct / 1C cable
5	Recommended limiting size of multi-core cable (sqmm)	630 (1C Cable)	300 (3C Cable) & 630 (1C Cable)	300 (3C Cable) & 630 (1C Cable)
6	Short circuit withstand time (sec)	1.Incomer from transformer:1.0 2.Plant feeder:0.6 3.Transformer feeder:0.2	1.Incomer from transformer:1.0 2.Plant feeder:0.6 3.Transformer feeder:0.2	NA
7	Insulation voltage grade	220kV(Earthed), 66kV (Earthed)	33kV (Earthed), 11kV (Unearthed), 6.6kV(Unearthed), 3.3kV(Unearthed)	Earthed
8	Type of cable insulation	XLPE	XLPE	XLPE
9	Fire survival (Resistant) cable for Fire proof MOV	NA	NA	Yes
10	Power Cable for Motors/MOV	NA	3 core	3 core
11	Cable Conductor	Copper	Copper / Aluminium	Refer Sr no. 1 of Cl. 5.6.16
12	Power & Earthing cable	Armoured	Armoured	Armoured

NOTES:
1) Copper cables shall be used for termination to all Electrical heaters.
2) All power cables for Electrical heat tracing and lighting loads shall be 4-Core of suitable size.

5.7.2 CABLE LAYING PHILOSOPHY

S.No.	Description	Selected Option	Available Options
1	Process area	RCC trench with sand filling	a)Overhead cable tray b)RCC trench
2	Offsite paved area	Above Ground cable tray on sleeper /Overhead rack /RCC trench as per site requirement	a)Above Ground cable tray on sleeper b)Overhead rack c)RCC trench
3	Offsite unpaved area	Above Ground cable tray (on sleeper/ Overhead rack) /directly buried as per site requirement	a)Above Ground cable tray b)Directly buried

S.No.	Description	Selected Option	Available Options
4	Type of cable trays	Galvanized prefabricated	a)Galvanized prefabricated. b)Site fabricated and painted c)FRP type
5	Road Crossings for underground cables	PVC Pipes embedded in concrete(ERC)/ Cable culvert/ RCC Hume pipes	a)PVC Pipes b)Cable culvert
6	Road Crossings for Above ground cables	Overhead cable bridge / pipe rack	a)Overhead cable bridge b)Culvert

1.) Plant communication, fire alarm and telephone cables shall be laid in instrumentation overhead cable duct / instrumentation trenches as far possible. In case these are not available. Cable shall be laid in buried cable trenches along berm of the roads.
2.) Walkways shall be provided on either side of cable tray (with ladders at regular intervals) to facilitate movement of people while pulling cable.
3.) No cable Trays/ racks will be provided in RCC lined trenches.
4.) RCC cable trenches shall be filled with river sand/manufactured sand.
5.) Street lighting cables shall not be laid along with fire alarm, communication and telephone cables. These cables shall be laid in separate buried cable trench in road berm.
6.) The single core cables shall be laid in trefoil formation except for short run of cables within substations. Single core cables pertaining to 3-phase circuits shall be laid together & separated from multi-core cables as per requirements specified in IS-1255.
7.) Underground Road crossings shall be provided using Cable culverts where ever large number of cables cross the roads. At road crossings where few cables cross the roads, Electrical road crossings(ERC) using 150mm PVC/RCC pipes may be provided. The ERC shall have minimum 40% spare pipes. The pipes shall be embedded in concrete. Minimum 2 nos. 150mm pipes shall be provided at any road crossing.
8) In case of vehicular traffic over the RCC cable trench, the same shall be of heavy duty construction suitable for vehicular movement.

5.8 EARTHING SYSTEM

S.No.	Description	Selected Option	Available Options
1	Earth electrode	GI pipe (Note-1)	
2	Main earth loop material	GI strip	
3	Substation earth loop	GI strip	
4	EHV switchyard earth grid	Not Applicable	

Note:
1. For Instrumentation earth, copper electrode to be provided.

5.9 LIGHTING SYSTEM

5.9.1 SUPPLY SYSTEM

S.No.	Description	Selected Option	Available Options
1	Centralised with Lighting distribution board-LDB	Yes	a)YES b)NO
2	LDB at each substation	Yes	a)YES b)NO
3	Lighting transformer required	Yes	a)YES b)NO

S.No.	Description	Selected Option	Available Options
4	100% Standby transformer for normal lighting system	Yes	a)YES b)NO
5	100% Standby transformer for emergency lighting system	YES	a)YES b)NO
6	Lighting transformer voltage ratio	415V/415V	a)415V/415V

5.9.2 CONTROL PHILOSOPHY

S.No.	Description	Selected Option	Available Options
1	Outdoor yard	Auto through timer	a)Auto b)Manual c)Centralised d)Local
2	Street lighting	Auto through timer	a)Auto b)Manual c)Centralised d)Local
3	Outdoor process area	Auto through timer	a)Auto b)Manual c)Centralised d)Local
4	Process building	Manual	a)Auto b)Manual c)Centralised d)Local
5	Auto control	Synchronous timer	a)Synchronous timer b)Photocell c)ECS
6	Lamp type for outdoor general lighting	(1). Process Area:LED (2). Offsite Hazardous Area: LED (3). Offsite Safe Area: LED (4). Street Lighting: LED (5). High Mast: HPSV/SON-T	
7	Lamp wattage for outdoor lighting (Normal)	@	
8	Lamp type for emergency AC lighting	LED (for building Lighting)	a)CFL b)LED
9	ELCB at Incomer of Lighting / Power Panels	NO (ELCB shall be provided in Outgoing of LDB/ASB)	a)YES b)NO
10	Switch ON/OFF push button at substation entry	Yes	a)YES b)NO

Note:
1. LED Lighting fixtures shall be provided for all building normal & emergency lighting.
@ To be decided during detail engineering

5.9.3 AC EMERGENCY LIGHTING

S.No.	Description	Selected Option	Available Options
1	Name of process plants	ALL new & revamp units under VRMP scope	
2	Name of buildings	Substation, Control room, Fire Water Pump House, Admin Building, Lab., Workshop, DG Shed, Canteen, Warehouse (Office Area and other locations as per OISD	
3	Power supply source	Diesel generator	

5.9.4 DC CRITICAL LIGHTING FOR ESCAPE

S.No.	Description	Selected Option	Available Options
1	Name of process units	ALL new & revamp units under VRMP scope	
2	Name of building	Substation, control room, SRR, Administration building/office, FWPH, Fire Station, DG Shed, Compressor House and other locations as per OISD	
3	Power supply	220V DC	a)220V DC b)110V DC
4	DC lighting for remote buildings	Lighting fixture with built in battery	

5.9.5 WIRING TYPE

S.No.	Description	Selected Option	Available Options
1	Process plant / Building / Shed	Armoured cable	
2	Large service building	Armoured cable	
3	Buildings with false ceiling	Black enamelled Surface conduit above false ceiling/ PVC concealed conduit below false ceiling	a)Surface conduit above false ceiling b)Cables
4	Substation (Switchgear Room)	METSEC channel/Black enamelled Surface conduit above false ceiling/ PVC concealed conduit below false ceiling	a)METSEC channel b)Concealed conduit
5	Substation (Cable Cellar)	Armoured cable	a)Surface Conduit b)Armoured cable
6	Other buildings in safe area	Black enamelled Surface conduit above false ceiling/ PVC concealed conduit below false ceiling	

5.9.6 SPECIFIC LIGHTING REQUIREMENTS

S.No.	Description	Selected Option	Available Options
1	Aviation lighting	Yes (Clustered LED lamps) (Note-1)	a)YES b)NO

S.No.	Description	Selected Option	Available Options
2	Security lighting for peripheral road boundary wall	Yes	
3	Type of control gear for HPMV/HPSV lamps	Separate	a)Separate b)Integral
4	Control gear box location	Accessible level	
5	Type of high mast flood light	30 meters Telescopic tubular	a)30 meters Telescopic tubular b)Lattice structural mast

NOTES:
1) Xenon flash light for aviation lighting to be provided for Chimneys and heater stacks at the top most level instead of Clustered LED light.
2) Illumination level in Control room buildings shall be minimum. 400 Lux.

5.10 ELECTRIC HEAT TRACING SYSTEM

S.No.	Description	Selected Option	Available Options
1	System Design Basis approach	Product classification/ as per process recommendation	a)Product Classification b)System approach

5.11 ELECTRICAL EQUIPMENT FOR HAZARDOUS AREAS

The electrical equipment for hazardous areas shall be selected as per IS-5571 and petroleum rules & Gas group shall be selected based on the hazardous area classification. The minimum requirement is summarised below:

S.No.	Equipment	Zone-1	Zone-2
1	MV Motors	Ex-de	Ex-e/Ex-de (Note-2.9, 2.10 & 2.11)
2	HV Motors	Ex-de / Ex-p (Refer note-2.8)	Ex-e/Ex-de/Ex-p (Note-2.9, 2.10 & 2.11)
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 fitting	Ex-de	Ex-nR
8	Control Gear Box	Ex-de	Ex-de
9	Junction Boxes	Ex-de	Ex-de/Ex-n
10	Transformer Unit	Ex-de	Ex-de
11	Plug & Socket	Ex-de	Ex-de
12	Break Glass Unit (Fire Alarm System)	Ex-de	Ex-de
13	Lighting Panel/Power Panel	Ex-de	Ex-de
14	Transformers	Hermetically sealed with surface temperature not exceeding 200 DEG C	Hermetically sealed with surface temperature not exceeding 200 DEG C

For additional Hazardous Area requirements, refer notes below -

5.11.1 NOTES

S.No.	Notes
1	The electrical equipment for hazardous areas shall generally be suitable for gas group IIB and temp classification T3 as applicable to the selected type of explosion protection. In case of hydrogen or hydrocarbon mixtures having more than 30% hydrogen, the gas group to be considered shall be IIC.
2	As additional safety features, the following requirements for electrical equipment shall be followed.
2.1	All electric motors for agitators/mixers and metering pumps handling flammable material shall be flameproof type irrespective of the area being classified as zone 2 or zone 1.
2.2	All electric motors for vertical sump pumps handling flammable material shall be flameproof type. (Ex-de)
2.3	Irrespective of the area classification (whether zone 1 or zone 2), all lighting fixtures within the storage areas shall be flameproof type. (Ex-de)
2.4	Irrespective of the area classification (whether zone 1 or zone 2), all motors and lighting fittings within the pump house/pump station/compressed house associated with offsite tank farm and within the loading/unloading gantries shall be of flameproof type. (Ex-de)
2.5	All emergency/critical lighting fixtures and associated junction boxes in hazardous areas (whether zone-1 and zone-2) shall be flameproof type. (Ex-de)
2.6	Even though fired heaters in process units are not considered for area classification, all electrical equipments associated with fired heaters in process units shall as a minimum be suitable for installation in Zone-2 area.
2.7	Building such as Compressor sheds inside the process area shall be designed to allow adequate ventilation to allow area classification as Zone-2. Lighting equipment, EOT crane etc. in the shed shall be flameproof type. All other electrical equipment shall be suitable for Zone-1 or Zone-2 area depending on extent of hazard.
2.8	All motors for hazardous area Zone-1 shall preferably be Ex-de type. Pressurised motors may be provided in exceptional cases, when Ex-de motors are not available. Pressurised motors shall be provided with facility to trip motor in case of failure of pressurisation.
2.9	Ex-e motors shall be used unless any other type is specified by process licensor, except for following cases: (i) HV motors in Zone-2 area for centrifugal compressors shall be Ex-de type. (ii)Ex-de motors shall be used in zone-2 areas having frequent start-stop requirements such as EOT cranes, elevators, MOV actuators, etc.
2.10	For zone-2 areas, motors with rating above 100kW having average starting frequency of more than 1 per week, Ex-de or Ex-p motors shall be used.
2.11	Ex-p motors shall be used for higher rated motors where Ex-de / Ex-e motors are not available.
3	Statutory Approval 1. Statutory Authority for Electrical Installation: State Electrical Inspectorate/CEA 2. Statutory authority for hazardous area: DGMS:For mining area PESO:For area other than mines

5.12 ELECTRICAL CONTROL SYSTEM-ECS

S.No.	Description	Selected Option	Available Options
1	Extent of coverage	Upto PCC/PMCC level	
1.1	No of substations	@	
1.2	Monitoring		
1.2.1	EHV/HV switchboard	YES	a)YES b)NO

S.No.	Description	Selected Option	Available Options
1.2.2	415V switchboard (I/C, B/C & outgoing breaker feeders)	YES	a)YES b)NO
1.2.3	Emergency DG set	YES	a)YES b)NO
1.3	Control		
1.3.1	EHV/HV switchboard	YES	a)YES b)NO
1.3.2	415V switchboard (I/C, B/C & outgoing breaker feeders)	YES	a)YES b)NO
1.3.3	Emergency DG set	NO	a)YES b)NO
2	Base ECS functionalities		
2.1	Breaker control in CPP & Switchyard	YES	
2.2	Breaker control in other substations	YES	
2.3	Area lighting	YES	
2.4	Electrical plant data acquisition and display	YES	a)YES b)NO
2.5	Routine log report generation and energy balance report	YES	a)YES b)NO
2.6	Detection and reporting of alarms	YES	a)YES b)NO
2.7	Sequence of event recording	YES	a)YES b)NO
3	Advanced ECS functionalities		
3.1	Load shedding including maximum demand limit control	YES	a)YES b)NO
3.2	Synchronization	YES	a)YES b)NO
3.3	Capacitor feeder control for power factor improvement	YES	a)YES b)NO
3.4	Active & Reactive power control	YES	a)YES b)NO
3.5	Frequency & load control of all generators except DG	YES	a)YES b)NO
3.6	Excitation control of synchronous motors	YES	a)YES b)NO
3.7	Grid transformer OLTC control	@	a)YES b)NO
4	Communication with other systems	Communication with DCS system for exchange of data, Interface with data concentrator	

6.0 SPARE PARTS

6.1 MANDATORY SPARES

Mandatory spares shall be procured along with the main equipment. Such spares for each equipment shall be as per the below table. These spares include only those spares, which

are critical for equipment.

S.No.	Part Description	Description
1	Generator (one set of spare for each Generator)	
1.1	Generator relay	one set (each type & make)
1.2	DVR -all control card	One each type
2	Power Transformer (one set of spare for each power transformer)	Quantity is per transformer
2.1	Gasket	one set
2.2	Gauge glass	2 Nos of each rating & type.
3	Gas Insulated Switchgear	
3.1	Portable gas filling equipment/SF6 gas cart	6 Nos.
3.2	Handle for disconnector switch drive	6 Nos.
3.3	Handle for earthing switch drive	6 Nos.
3.4	Pre selection key for three position switch	6 Nos.
3.5	Power cable termination kit	12 Nos.
3.6	Tripping coil (Per Switchgear)	1 Nos.
3.7	Closing coil (Per Switchgear)	1 Nos.
3.8	Capacitive type voltage detectors	6 Nos.
3.9	Control fuses (Per switchboard)	10 Nos. each rating and type
3.10	Network switches	1 Nos. of each type
4	33 kV Switchgear (one set of spare for each switchgear)	Quantity is per switchboard
4.1	Closing coil	1 No. of each Rating/Type
4.2	Shunt trip coil	1 No. of each Rating/Type
4.3	control fuses(all type & rating)	10 Nos. each rating & type
5	11 kV & 6.6 Switchgear (one set of spare for each switchgear)	Quantity is per switchboard
5.1	Closing coil	1 No. of each Rating/Type
5.2	Shunt trip coil	1 No. of each Rating/Type
5.3	control fuses(all type & rating)	10 Nos. each rating & type
6	415 V PCC/PMCC/EPCC or MV Switchboard (one set of spare for each Switchboard)	Quantity is per switchboard
6.1	Closing coil	1 No. of each Rating/Type
6.2	Shunt trip coil	1 No. of each Rating/Type
6.3	control fuses(all type & rating)	10 Nos. each rating & type
7	Variable Frequency Drive (one set of spare for each VFD)	Quantity is per VFD
7.1	Transistors/IGBT	One No of each rating & type
7.2	Control cards	One No of each type
7.3	Power supply cards	One No of each rating & type
7.4	Power & control fuses	20 % or one no (min) of each rating & type, whichever is more
8	Data concentrator panel/HMI (one set of spare for each)	
8.1	All cards such as input & output cards, power supply cards, processor cards etc.	One No of each type
8.2	All control fuse	10 Nos of each rating & type
9	UPS (one set of spare for each UPS system)	
9.1	Power transistors/IGBT	One No of each rating & type
9.2	Power supply cards	One No of each type
9.3	operating console card	One No of each type

S.No.	Part Description	Description
9.4	All fuses	10 nos. of each rating & type
10	DC System(one set of spare for each DC System)	
10.1	All fuse	10 nos. of each rating & type
10.2	All cards such as input & output cards, power supply cards, processor cards etc.	1 no. of each rating & type
10.3	Thyristors	1 no. of each rating & type
10.4	fuse link	10 nos. of each rating & type
10.5	Blocker Diode	Two nos.
11	Synchronous motors (one set of spare for each rating & type)	
11.1	Fuses	10 nos of each rating & type
11.2	Bearing (DE & NDE) (as applicable)	one each
12	HV induction motors (one set of spare for each rating & type)	
12.1	Bearing (DE & NDE)	one each
12.2	Terminal studs/bushing assembly	one no.
13	MV induction motors 37 kW & above (one set of spare for each rating & type)	
13.1	Bearing set (DE & NDE)	one no of each type
13.2	Terminal/ bushing	one set each
14	Telephone exchange	
14.1	All line cards, Processing cards, power supply cards	1 no of each type
15	Fire alarm system	
15.1	All cards	one no. of each type
15.2	Fuses	10 nos. of each rating & type
15.3	Terminal blocks	20 nos
15.4	Fire detectors	5 % of total installed capacity of each type
15.5	Glass for Break Glass Boxes/ Manual call point	10 %
16	Paging system / Plant Communication System	
16.1	All cards	one no of each type
16.2	All fuses	10 nos. of each rating & type
16.3	Field call stations	10% of each type
17	Thyristor control panel for heaters	
17.1	Rectifier control module(Control card fully assembled)	one no. of each type
17.2	Power supply card	one no. of each type
18	ECS	
18.1	Interposing relays (As applicable)	5 Nos. of each type
18.2	Power supply & control cards	1 nos. of each type
19	Numerical relays	1 no. of each type

1. The word "TYPE" means the Make, Model no., Type, Range, Size/ Length, Rating, Material as applicable.
2. Wherever % age is identified, Contractor shall supply next rounded figure.
3. The terminology used under "Part Description" is the commonly used name of the part and may vary from manufacturer to manufacturer.
4. Mandatory spares as indicated above do not cover commissioning spares.
5. Mandatory spares as indicated above do not cover two year O&M spares.
6. Mandatory spares shall be applicable for electrical items of motors / sub-packages as per

mandatory spares philosophy specified elsewhere in the bid document.

6.2 COMMISSIONING SPARES

Commissioning Spare Parts shall be procured along with the main equipment as per equipment manufacturer's recommendations. The list of such recommended spares shall be obtained along with the offer.

6.3 RECOMMENDED SPARE FOR NORMAL OPERATION & MAINTAINENCE

Quotation for two-years spares for normal operation and maintenance (over and above mandatory spares) along with unit price shall be obtained with the proposal for Client to order the same separately.

6.4 SPECIAL TOOLS AND TACKLES

Required Special Tools and Tackles shall be procured along with the main equipment as per equipment manufacturer's recommendations. The list of such recommended special tools/tackles shall be obtained along with the offer.

7.0 VENDOR DATA REQUIREMENT

Vendor Data Requirement as indicated in the respective equipment Material Requisitions shall be followed.

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SPECIFICATION FOR DOCUMENTATION REQUIREMENTS FROM CONTRACTORS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convener	Standards Bureau Chairman
					Approved by	
1	12.03.15	General Revision	QMS Standards Committee	QMS Standards Committee	MPJ	SC
0	04.06.09	Issued as Standard Specification	QMS Standards Committee	QMS Standards Committee	SCT	ND

Abbreviations:

DCI	-	Document Control Index
eDMS	-	Electronic Document Management System
FOA	-	Fax of Acceptance
HOD	-	Head of Division / Department
IC	-	Inspection Certificate
IRN	-	Inspection Release Note
ITP	-	Inspection and Test Plan
LOA	-	Letter of Acceptance
MOU	-	Memorandum of Understanding
QMS	-	Quality Management System
URL	-	Universal Resource Locator

QMS Standards Committee

Convener: Mr. M.P. Jain

Members: Mr. A.K. Chaudhary (Insp.)
Mr. S.K. Kaul (C&P)
Mr. R.K. Trivedi (Engg.)
Mr. Ravindra Kumar (Const.)
Mr. Tilak Raj (Projects)
Mr. Vinod Kumar (CQA)

CONTENTS

1.0 SCOPE

This specification establishes the Documentation Requirements from Contractors

All documents/data against the Tender / Contract shall be developed and submitted to EIL/Owner by the contractor for review / records, in line with this specification.

2.0 DEFINITIONS

2.1 Contractor

For the purpose of this specification, the word "CONTRACTOR" means the person(s), firm, company or organization who is under the process of being contracted by EIL / Owner for delivery of some products and services. The word is considered synonymous to bidder, supplier or vendor.

2.2 Owner

Owner means the owner of the project for which services / products are being purchased and includes their representatives, successors and assignees.

3.0 REFERENCE DOCUMENTS

6-78-0001	Specification for Quality Management System Requirements from Bidders

4.0 DOCUMENTATION REQUIREMENTS

4.1 Documents/Data to be submitted by the Contractor

4.1.1 The contractor shall submit the documents and data against the Tender/Contract as per the list specified in respective Tender/Contract.

4.1.2 Review of the contractor drawings by EIL would be only to review the compatibility with basic designs and concepts and in no way absolve the contractor of his responsibility/contractual obligation to comply with Tender/Contract requirements, applicable codes, specifications and statutory rules/regulations. Any error/deficiency noticed during any stage of manufacturing/execution/installation shall be promptly corrected by the contractor without any extra cost or time, whether or not comments on the same were received from EIL during the drawing review stage.

4.1.3 Unless otherwise specified, submission of documents for Review/Records shall commence as follows from the date of Fax of Intent / Letter of Intent/ Fax of Acceptance (FOA)/ Letter of Acceptance (LOA):

QMS	- 1week
Drawing/Document Control Index	- 2weeks
Other Documents/Drawings	- As per approved Drawing/Document Control Index/Schedule

4.1.4 Documents as specified in Tender/Contract are minimum requirements. Contractor shall submit any other document/data required for completion of the job as per EIL/Owner instructions.

4.2 Style and Formatting

4.2.1 All Documents shall be in ENGLISH language and in M.K.S System of units.

4.2.2 Before submitting the drawings and documents, contractor shall ensure that the following information are properly entered in each drawing:

Tender Number
Name of Equipment / Package
Equipment / Package Tag No.
Name of Project
Owner
Main Contractor (if work is sub-contracted)
Drawing / Document Title
Drawing / Document No.
Drawing / Document Revision No. and Date

4.3 Review and Approval of Documents by Contractor

4.3.1 The Drawing/Documents shall be reviewed, checked, approved and duly signed/stamped by contractor before submission. Revision number shall be changed during submission of the revised contractor documents and all revisions shall be highlighted by clouds. Whenever the contractor require any sub- contractor drawings to be reviewed by EIL, the same shall be submitted by the contractor after duly reviewed, approved and stamped by the contractor. Direct submission of sub-contractor's drawings without contractor's approval shall not be entertained.

4.4 Document Category

4.4.1 Review Category

Following review codes shall be used for review of contractor Drawings/Documents:

Review Code 1	-	No comments. Proceed with manufacture/ fabrication/ Construction as per the document.
Review Code 2	-	Proceed with manufacture/ fabrication/ Construction as per commented document. Revised document required
Review Code 3	-	Document does not conform to basic requirements as marked. Resubmit for review
R	-	Document is retained for Records. Proceed with manufacture/ fabrication
V	-	Void

4.5 Methodology for Submission of Documents to EIL/Owner

4.5.1 Document Control Index (DCI)

Contractor shall create and submit Document Control Index (DCI) for review based on PO/PR/MR along with schedule date of submission of each drawing/document on EIL eDMS. The DCI shall be specific with regard to drawing/document no. and the exact title. Proper sequencing of the drawings/documents should be ensured in schedule date of submission.

4.5.2 **Submission of Drawings/Documents**

Drawings/documents and data shall be uploaded on the EIL eDMS Portal. The detail guidelines for uploading documents on EIL eDMS Portal are available on following URL

http://edocx.eil.co.in/vportal

4.5.3 **Statutory Approvals**

Wherever approval by any statutory body is required to be taken by Contractor, the Contractor shall submit copy of approval by the authority to EIL.

4.5.4 **Details of Contact Persons of Contractor**

After placement of order contractor shall assign a Project Manager for that order. The details are to be filled online through the portal. The details include e-mail address, mailing address, telephone nos., fax nos. and name of Project Manager. All the system generated emails pertaining to that order shall be sent to the assigned Project Manager.

4.5.5 **Schedule and Progress Reporting**

Contractor shall submit monthly progress report and updated procurement, engineering and manufacturing status (schedule vs. actual) every month. First report shall be submitted within 2 weeks from FOA/LOA. In case of exigencies, EIL/Owner can ask for report submission as required on weekly/fortnightly/adhoc basis depending upon supply status and contractor shall furnish such reports promptly without any price implication. Format for progress report shall be submitted by the contractor during kick off meeting or within one week of receiving FOA/LOA, whichever is earlier.

4.5.6 **Quality Assurance Plan/Inspection and Test Plan**

Inspection and test plans attached if any, to the tender are generic and indicative only. Immediately after receipt of the order, contractor shall submit within one week of receiving FOA/LOA, job specific ITPs based on the indicative ITPs. Further, contractor shall also submit Quality Assurance Plan for project activities in the scope of contract, starting from manufacturing to handing over/ commissioning, these plans shall cover/identify the activities, relevant procedure, if any, code of conformance, resources for performance and checking/monitoring, approval requirements and authority, records to be generated and audit scope by EIL/Owner.

For EPCC/LSTK/Package contracts, the contractor shall prepare a list of items/ equipments and their inspection categorization plans for all items included in the scope of supply immediately after receipt of order and obtain approval for the same from EIL. The items shall be categorized into different categories depending upon their criticality for the scope of inspection of TPIA and/or EIL.

4.5.7 **Inspection Release Note (IRN)/ Inspection Certificate (IC)**

Contractor shall ensure that all documents viz. documents reviewed, manufacture's test certificate etc., mentioned in Inspection Release Note(IRN), issued by EIL/third party against the materials supplied by contractor., are sent to EIL along with the IRN.

IRN/ IC shall be issued by EIL Inspector/ third party inspection agency only after all the drawings/documents as per DCI are submitted and are accepted under review code-1 & code R. Material/Equipments dispatch from contractor's/sub vender's works shall not commence till above condition is met.

Note: Non fulfilling above requirement shall result into appropriate penalty or with-holding of payment as per conditions of Tender/Contract.

4.6 Final Documentation

4.6.1 As built Drawings

Shop/Site changes made by contractor after approval of drawings under 'Code 1' by EIL and deviations granted through online system , if any, shall be marked in hard copies of drawings which shall then be stamped 'As-built' by the contractor. These 'As-built' drawings shall be reviewed and stamped by EIL Inspector/Site engineer/TPIA also. Format for completeness of final documents (Format No. 3-78-0004) is attached with this specification. Contractor shall prepare scanned images files of all marked – up 'As – built' drawings. Simultaneously contractor shall incorporate the shop/site changes in the native soft files of the drawings also.

4.6.2 As built Final Documents

As built final documents shall be submitted as listed in Tender/Contract.

4.6.3 Packing/Presentation of Final Documents

Final Documents shall be legible photocopies in A4, A3 size only. Drawings will be inserted in plastic pockets (both sides transparent, sheet thickness minimum 0.1 mm) with an extra strip of 12 mm wide for punching so that drawings are well placed.

Final Documentation shall be bound in hard board plastic folder(s) of size 265 mm x 315 mm ($10^1/_2$ inch x $12^1/_2$ inch) and shall not be more that 75 mm thick. It may be of several volumes and each volume shall have a volume number, index of volumes and index of contents of that particular volume. Where numbers of volumes are more, 90mm thickness can be used. Each volume shall have top PVC sheet of minimum 0.15 mm thick duly fixed and pressed on folder cover and will have 2 lever clips. In case of imported items documents, 4 lever clip shall also be accepted. All four corners of folders shall be properly metal clamped. Indexing of contents with page numbering must be incorporated by contractor. Spiral/Spico bound documents shall not be acceptable. As mentioned above, books should be in hard board plastic folders with sheets punched and having 2/4 lever clips arrangement.

Each volume shall contain on cover a title block indicating Tender No., name of project, name of customer, package equipment tag no. & name (if applicable). Each volume will have hard front cover and a reinforced spine to fit thickness of book. These spines will also have the title printed on them. Title shall include also volume number (say 11 of 15) etc.

4.6.4 Submission of Soft copies

Contractor shall submit to EIL, the scanned images files as well as the native files of drawings/documents, along with proper index.

In addition to hard copies, contractor shall submit electronic file (CD-ROM) covering soft copies of all the final drawings and documents, all text documents prepared on computer, scanned images of all important documents (not available as soft files), all relevant catalogues, manuals available as soft files (editable copies of drawings/text documents, while for catalogues/manuals/proprietary information and data PDF files can be furnished).

All the above documents shall also be uploaded on the EIL eDMS portal.

4.6.5 Completeness of Final Documentation

Contractor shall get the completeness of final documentation verified by EIL/TPIA and attach the Format for Completeness of Final Documentation (Format No. 3-78-0004) duly signed by EIL or TPIA as applicable to the document folder.

COMPLETENESS OF FINAL DOCUMENTATION

Name of Supplier/Contractor	:	
Customer	:	
Project	:	
EIL's Job No.	:	
Purchase Order No./ Contract No.	:	
Purchase Requisition No./ Tender No.	:	Rev. No. :
Name of the Work/ Equipment	:	
Tag. No.	:	
Supplier's/ Contractor's Works Order No.	:	

Certified that the Engineering Documents/ Manufacturing & Test Certificates submitted by the supplier are complete in accordance with the Vendor Data Requirements of Purchase Requisition.

Signature	:	Signature	: .....
Date	:	Date	: .....
Name	:	Name	: .....
Designation	:	Designation	: .....
Department	:	Department	: .....

Supplier/Contractor

EIL/TPIA

अनुमोदित/APPROVED
हस्ताक्षर/Sign: M.P. JAIN
नाम/Name:
दिनांक/Date: 12-3-2015

METHODOLOGY OF DRAWING & DOCUMENT REVIEW PROCEDURE

CAPTIVE POWER PLANT PACKAGE

TENDER NO. B016-606-02-43-PG-T-7810

PROJECT	:	VISAKH REFINERY MODERNISATION PROJECT
UNIT No.	:	606
OWNER	:	M/s HPCL, VISAKHAPATNAM
LOCATION	:	VISAKHAPATNAM, INDIA
PMC	:	M/s ENGINEERS INDIA LIMITED
EIL JOB No.	:	B016

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by
A	24.05.2017	ISSUED FOR TENDER	SD	NP	JKM

CONTENTS

1.0 GENERAL

This chapter details out the type of drawings and documents to be generated by the CONTRACTOR at different stages of the Project.

The CONTRACTOR must recognize that efficient handling of drawings and documents prepared by him under the contract is the key to the timely completion of the plant.

The CONTRACTOR shall ensure that all drawings and documents to be submitted by him to the Owner and/or PMC shall be of professional quality and conforming to the contractual requirements.

The CONTRACTOR shall institute a formal drawing control system, which will be documented and submitted to the Owner/ PMC for review or approval.

Compliance to the requirements as spelt in this document on drawings and documents is mandatory and is non-negotiable.

The drawings/ documents as generated by the CONTRACTOR at various stages of the Project will be in the category of

(i) Review
(ii) Information/ Records

The listing of drawings and documents required for submission under different categories is enclosed elsewhere in the Bid. However, submission of drawings/ documents under different categorization will in no way relieve the CONTRACTOR of his responsibility to conform drawings/ documents, specification to contractual requirements.

Computer aided design and drafting only shall be used, manual drafting is not permitted. Bidders shall commit in their Offer the extent (discipline-wise) to which Computer Aided Design (CAD) shall be used.

The CONTRACTOR / sub-vendors etc shall only use standard, approved and well-established PC based computer programs/ software packages available in the market. CONTRACTOR shall bring out the list of all such packages in the Offer, for each discipline, Minimum requirements of the software to be used for engineering and documentations are specified in the tender document needs to be complied by the CONTRACTOR. Additional software if required to be utilized by the CONTRACTOR during execution of the project shall needs to be indicated by the Bidders along with the offer in the Format provided with this document. CONTRACTOR are required to execute complete project in the software as specified or suggested by the Contractor in the offer and deviation against that will not be entertained by OWNER/PMC during project execution. In case it is felt that there is a requirement of any change with respect to software during execution, same shall be permitted only after approval of OWNER/PMC.

DOCUMENTS to be submitted by CONTRACTOR for review to the Owner/ PMC are to be uploaded through PMC Web portal along with hardcopies. Two (2) complete sets (A4 & A3) and four (4) Complete set for Document size above A3 of the Document/ Drawing are to be submitted in hard copies along with all input/output data, soft file of these documents in native also needs to be submitted by CONTRACTOR. Each CAD document should specify the

name of the software package used and it shall be ensured that the CD is operable on any PC system.

NO Manual Drafted Calculations and documents are permitted.

The CONTRACTOR shall vet all documents, including documents of his sub-vendors before submission to the Owner/ PMC for review. Contractor shall duly stamp & sign the hardcopies of documents submitted by him as proof of his vetting. .Document received without contractor's vetting will be returned without review / approval. Also, the CONTRACTOR will not only rectify any inaccuracies / mistakes found during review but the CONTRACTOR shall remain liable for bearing charges towards efforts spent by Owner / PMC for discussing the same. Delay owing to these shall be to the account of CONTRACTOR.

Review of the drawings/ documents by the Owner/ PMC would be only limited to the review of compatibility with basic designs and concepts. The review by the Owner/ PMC shall not be construed by the CONTRACTOR as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and drawings.

Only AUTOCAD release 2011 as minimum or later versions shall be used for drawings, data sheets and all graphic works. For all text related documents, MS Word 2011 as minimum only shall be used.

CONTRACTOR shall furnish 3D modeling of plant with dynamic walk-through facility to check any interference, requirement of safety, operation and maintenance for getting approval from Owner/ PMC. Contractor shall demonstrate their capability through walk-through of one of such 3D models developed by them. CONTRACTOR shall carry out the 3 D Modelling in accordance to the specification provided in the tender document.

Such modelling could be done through an agency approved, which has proven track record for 3D modelling of packages of similar complexities.

Drawings shall be prepared on the DRAWING FORMAT as provided to successful bidder. Excepting the Title block of (A0, and A1 sizes) drawings which shall be bi-lingual (English and Hindi) all notes, markings and dimensioning on the drawings shall be in English.

All the dimensions shall be in metric units.

Subsequent submissions of reviewed (commented) Drawings/ Documents by the CONTRACTOR shall be along with a document-wise compliance report, with separate listing of compliance/ status for each of the comments. If required comments given by the Owner/ PMC shall be discussed and finalized within agreed schedule.

The schedule of submission of Drawings/ Documents shall be in accordance with Project plans only. The detailed list of documents/ documents proposed to be submitted for the Owner/ PMC review (for different categories) shall be prepared by the CONTRACTOR for review of Owner/ PMC. **This activity is to be completed within one month of placement of the order.**

Sequence of submission of all drawings and documents is essential for proper review of documents and timely completion of the Project and is to be strictly adhered to. In case sequence is not maintained, Owner/ PMC will not review the documents submitted and responsibility of timely execution of Package shall be to CONTRACTOR's accounts.

The CONTRACTOR shall maintain latest record of drawings & document status and make regular issue of drawing/ documents index ***(discipline wise)***, *on fortnightly/ monthly basis, as agreed, with copies to PMC Site, HO and Owner* indicating schedule date of submission, submission date of various revisions and date of review with code.

2.0 Category of Documents and Cycle Time

The handling of documents by Owner/PMC/CONTRACTOR shall be as follows:

2.1 Owner's/ PMC's Review

A detailed document list clearly identifying the class of review to be performed against each document shall be developed. Following classes of review shall be followed for all the documents engineered by the CONTRACTOR:

Review

The documents shall be reviewed by OWNER/PMC with respect to specifications guidelines and details provided in the Tender package. Upon review of the documents approval review codes will be indicated the documents based on the compliance to tender requirements. Code-1/Code-2/Code-3 will be accorded to such documents.

Information/Records

The CONTRACTOR shall submit documents for Owner's/ PMC information/ records and proceed with the work. Inadequacies/ inaccuracies noticed at any stage of the Project on such documents/ drawings shall be brought to the attention/ notice of the CONTRACTOR for corrections and incorporation in works. These corrections, as made by the Contractor, shall be to the Contractor's account and would not have any cost or time impact to the Owner.

The documents falling under review category shall in general, except for drawings requiring multi-disciplinary review, be returned with comments within 10 working days.

Documents submitted without meeting pre-requisite requirements will be returned without review.

The period of ten working days shall be reckoned from the date of receiving the documents at Owner/PMC Review centre. Receiving date shall be considered as date entered by PMC.

However, documents where multi-disciplinary activity is involved, the CONTRACTOR, shall visit Owner / PMC design office for discussion for expeditious review of documents, after submission of these for Owner/ PMC review.

In absence of visit of CONTRACTOR'S engineering team at Owner's/ PMC office

review time shall be 15 working days.

The information/ records category documents/ drawings shall be retained for records only.

2.2 CONTRACTOR'S Review

The following cycle time shall be adopted for the incorporation of comments by CONTRACTOR

- Review of comments by CONTRACTOR: 7 days
- Owner/EIL/CONTRACTOR discussion on comments, if required: 7 days
- Incorporation of comments in drawings and resubmission: 7 days

CONTRACTOR shall revert on unacceptable comment, if any, within 10 days from the date of release of documents by Owner/PMC In absence of any rebuttal by CONTRACTOR all comments will be deemed as acceptable to CONTRACTOR .

3.0 Review of Bid Evaluation Report

1.2.1 The CONTRACTOR shall ensure that all equipments are ordered on vendors who are capable of supplying the equipments and meet all specifications.

1.2.2 CONTRACTOR shall submit a comprehensive bid evaluation report and recommendation for procurement of major equipment to OWNER/PMC prior to award of purchase order.

The report shall incorporate, but is not limited to:

- Names and addresses of the companies invited to quote or bid.
- Recommended supplier.
- Reason for selection.
- Evaluation of Vendor quality system.
- Scheduled award date.
- Quoted delivery date.
- Reason(s) for rejecting unsuccessful bidders whether it is technical, commercial, delivery, etc.

1.2.3 Review of Purchase Requisition

CONTRACTOR shall forward Purchase Requisition (Technical Part) for items as mentioned in the VDR, together with attached documentation, without pricing details, to OWNER/PMC for review .Such review by OWNER / PMC shall not relieve CONTRACTOR of any of his obligations under the Contract.

All subsequent changes to purchase requisition following review of the original shall be subject to prior APPROVAL. Where requisitions specify a

particular make or brand of equipment to be used followed by the statement "or PURCHASER approved equal", any such "equal" proposed by the suppliers shall be submitted for APPROVAL of OWNER/PMC.

4.0 Control and Monitoring of documents review and submission

Owner's review

A document logging system shall be established within PMC through Web Portal (Electronics Data Management System) to monitor the review cycle. This log shall be updated on real time basis.

In case review requires more than stipulated cycle time for any document, CONTRACTOR shall be informed for the same

Submissions

- PMC is using electronic document management system for document workflows and storage.
- All vendor documents shall be submitted and reviewed through web portal. To facilitate document exchange with the vendors a separate vendor portal for the successful bidder will be provided at the time of award.
- Discipline wise Document Control Index (DCI) based on VDR in Tender will be created by vendor through the vendor portal in the format available in the portal.
- DCI shall be submitted and will be approved by PMC. All document submission on the vendor portal shall be against the approved DCI only.
- During the course of engineering any unscheduled documents if required to be submitted shall be as approved by EIL.
- Drawing schedule shall indicate the following as minimum:
  - Schedule/Actual submission to Owner/ PMC
  - Category of submission
  - Receipt of comments from Owner/PMC
  - Category of return status from Owner/PMC
  - Issue date for Construction

Detailed listing of documents (discipline-wise) that are scheduled to be submitted or resubmitted incorporating Owner / PMC's comments, shall be provided by CONTRACTOR in the weekly meetings. Contractor may ensure that drawings / documents are submitted as per the agreed schedule only. Bunching of documents / out of sequence submissions and consequential delay of documents and approval there of shall be exclusively attributable to CONTRACTOR.

Details regarding PMC Web portal shall be furnished to Successful bidder.

Documents to Boiler Regulation authorities shall be submitted on getting the documents reviewed by Owner / PMC. To any other agencies, documents shall be submitted under intimation to Owner/ PMC.

5.0 As-Built Drawings

As built drawings and documents will have to be generated within one month of completion of activities on respective items of work.

CONTRACTOR shall furnish electronic files of all the drawings under their scope to Owner / PMC certified as "As Built Issue." These documents also need to be submitted through PMS web Portal.

Upon completion of identifiable units or components of the fabrication, construction and installation phase of the project, the CONTRACTOR will complete all the related plans to the "as built" stage including all Vendor drawings and furnish Owner/ PMC with the following:

a) 6 complete sets of full size prints of the drawings and 4 sets of reduced size prints.

b) 6 complete bound sets of Manufacturer's specifications including design calculations.

c) As Built drawings generated specifically for this job in electronic media (AutoCAD 2011 or above).

d) All vendor drawings & documents either in AutoCAD or in scanned images stored in electronic media.

e) All operating & maintenance instructions in electronic media or in scanned images converted in electronic media.

f) 6 complete sets in hard binders of the Manufacturer's data book including certified prints and data for all items including test reports. Data Book shall be complete with index as tag numbers associated with Manufacturer's data shown. Equipment data shall include as a minimum requirement the principal and description of operation, drawings and dimensions, spare parts lists and un-priced purchase orders and bill of materials.

g) 6 bound copies each of the Spare Parts data book and the Lubricants inventory schedule.

h) The CONTRACTOR'S and Owner's representatives at the site shall sign 6 complete sets of field records.

i) Original approvals and related drawings and documents from the statutory authority.

j) Copies of correspondence with the statutory authorities.

6.0 Pre-Requisites Needed from Contractor

1.6.1 At the kick-off meeting, the CONTRACTOR must submit discipline wise list of documents and drawings index in the specified format.

1.6.2 The **Drawing Index** (discipline wise) shall include description of drawings/ documents, category of drawings, scheduled date of submission, actual date of submission, review code received with dates. This shall be updated fortnightly / monthly, as agreed by CONTRACTOR and copies issued to PMC site and H.O. as well as Owner. Drawings submitted before finalization of drawing index shall be rejected.

1.6.3 CONTRACTOR shall separately submit list of drawings/documents involving **multi- disciplinary** reviews, considering the PMC departmental activities furnished in the contract during the kick off meeting itself. They are also highlighted in the discipline- wise document list.

1.6.4 Critical and typical drawings/documents having impact on schedule and quality should only be identified for such timely reviews. This shall be adopted after receipt of drawings/documents indexes from the CONTRACTOR at the kick-off meeting with mutual understanding of the CONTRACTOR/concerned specialist/Owner.

1.6.5 All requirements specified in the Bid Package/contract is with the intent of providing a safe, user-friendly plant conforming to all applicable codes, standards, regulations, etc.

It is CONTRACTOR'S responsibility to comply with the bid package. To monitor the same, Owner/PMC shall select a few critical documents/drawings for review and leave the rest as Information/Record Category.

Any deviation on such Information/Record category drawings/documents and on review category drawings observed later or in execution at site during site visit/technical review by Owner/PMC shall be taken seriously. Contractor shall rectify the same at his own cost and time.

1.6.6 CONTRACTOR shall plan submission progressively so that no bunching takes place in any discipline.

1.6.7 Review period shall be reckoned from the **"Date of Receipt"** of documents/drawings at PMC Office to the **"Date of Receiving"** the reviewed documents by the CONTRACTOR at PMC Review Center. CONTRACTOR shall monitor submission and receipt.

1.6.8 Documents/drawings received prior to holiday/week end shall be accounted as received on the following working day and the review period committed shall include only working days.

1.6.9 Quality of drawings / documents is essence for a timely review. If major comments / deviations to the agreed design basis are noticed, the drawing shall be rejected in Code-3. (CONTRACTOR cannot proceed with construction with Code-3 approval/review).

1.6.10 **Sequence of submission** of drawings is essential for proper review of documents and timely completion of the project and the same is to be adhered to. In case sequence is not maintained, the documents submitted shall not be approved / reviewed by Owner/ PMC and the responsibility of timely execution of the plant shall remain to CONTRACTOR'S accounts.

1.6.11 Piping/Instrument & other engineering drawings/documents shall be issued only after the corresponding P&IDs & Process documents coming under approval/ review category are first approved/ reviewed by the concerned department in code-2 as a minimum.

1.6.12 **In principle. CONTRACTOR is not expected to revise drawings/ documents already reviewed in Code-1.**

a) If it is of utmost necessity to revise or add some minor details in Code-1 drawings, CONTRACTOR shall highlight such revisions by marking "CLOUD" to such additions/alterations. CONTRACTOR is also needed to provide a "BLOCK" in the drawing indicating reasons of such changes and to insert another "Review Block". PMC shall put relevant code for such revisions only "Code marking given by PMC on such revisions shall not change the category of drawing.

b) Any major change in Code-1 drawing shall call for preparation of new drawing.

1.6.13 Based on the confidence gained on CONTRACTOR'S quality of drawings/ documents already submitted, "Review Category" drawings could be retained as Information/Records and vice versa at the discretion of Owner/PMC. This however, does not change the category of drawings.

1.6.14 Once a document is already reviewed in Code-2, subsequent submission due to non- incorporation of comments shall not be accounted for any contractual commitment of approval/review period from PMC. CONTRACTOR is expected to comply with PMC's comments in the next revision after Code-2 and is required to submit a compliance report accordingly

1.6.15 Deviation permit, submitted for seeking deviation, shall be separately identified and shall not be considered as a document for timely approval/review.

1.6.16 When PMC deploys engineers at the CONTRACTOR'S work centre following shall be satisfied:

- Reviews limited to identify long delivery/schedule critical items only.
- Readiness of documents/drawings shall be ensured by the CONTRACTOR.
- Presence of lead engineers of all disciplines of the CONTRACTOR.

1.6.17 If Owner / PMC highlights any necessary rectifications required in the construction at the time of Technical Review/Audit, construction executed based on Reviewed drawings not complying with Bid requirement, CONTRACTOR shall rectify without

any impact of time and cost to Owner.

1.6.18 CONTRACTOR shall submit designs drawings for review only after the corresponding GA/Equipment data sheets etc. have been co-coordinated in his office and reviewed by Owner/PMC engineers at least in Code 2. Such Owner/PMC reviewed drawings shall be furnished along with drawings/designs for timely review.

1.6.19 CONTRACTOR shall open an engineering office in India for speedy document submission and to help faster review of the drawings & documents:

7.0 Approved for Construction Drawings

Drawings approved / reviewed under Code 2 & Code 1 required for execution at site shall be arranged by CONTRACTOR to PMC (RCM), CONTRACTOR'S RCM and HPCL-Visakhapatnam (site).

- "**Approved for Construction**" stamped / sticker drawings shall be issued by CONTRACTOR for execution.
- "**Approved for Construction**" stamp / sticker separately on the reviewed print and not on the Title block.
- Without changing **Revision Number**, CONTRACTOR to arrange adequate number of prints of documents and drawings to CONTRACTOR'S RCM, 2 copies to PMC RCM and one copy to HPCL-Visakhapatnam (site) with transmittal.
- Copies of only reviewed or final documents like design calculations, design basis etc. shall be sent to PMC site for records.
- Copy of such transmittal shall be sent to PMC (HO) & HPCL for records.

8.0 Activity Sequence for Drawing Approval

CONTRACTOR shall establish an electronic mail system compatible with that of Owner/PMC for document/data transfer.

The drawings requiring Owner/ PMC's review shall be uploaded on Web Portal of PMC and E-mail intimation, regarding uploading to be forwarded to Owner / PMC.

CONTRACTOR shall establish a local office having facility of telephone, fax and electronic mail system for receiving documents and drawings from outstation.

On uploading the drawings/documents through Web Portal, CONTRACTOR shall send and Email Intimation for the same to Owner/PMC. However, hard copies in numbers as mentioned in section 1.0 of this document, shall be sent by CONTRACTOR to Owner/PMC by courier or by hand delivery.

After review, Owner/PMC shall send back the drawings/ documents through Web Portal with Email intimation to CONTRACTORS.

It shall be the responsibility of CONTRACTOR'S representative to transmit the drawings/documents to their design office/vendor works.

CONTRACTOR shall also establish electronic system at site to receive all drawings and documents with all printing and scanning facilities

The reviewed drawings shall be transmitted to site by CONTRACTOR.

Necessary printing / plotting and distribution of documents and drawings to RCM (CONTRACTOR), RCM (PMC) and HPCL-Visakhapatnam (site) is the responsibility of CONTRACTOR.

9.0 Requirement of Project Document Handover

As a part of Overall Project document Handover OWNER/PMC intends to use integrated documentation & Handing over system with a focus on engineering information integrity for final handover. For the specific purpose and specific requirements of document integration & Handing over it is required that CONTRACTOR to utilize the latest generation software , utilize the formats, templates, numbering system as specified, in this tender document without any deviation. Further details like additional formats, templates if required shall be provided to the successful bidders. For the requirement of Final Documentation in the integrated & Smart platform OWNER/PMC shall be engaging a agency and Project document integration shall be carried out the other. However for carrying out the activities related to document integrations by others certain activities are required to be performed by the the CONTRACTOR during execution of the project is covered in this part of the document

9.1 Proposed Software's for detailed engineering to be utilized by the CONTRACTOR

Sr. No.	Deliverable List	Software
1	Project Scheduling	Primavera
2	3D Design	PDS/PDMS/SP-3D
3	P&ID	Smart P&ID's or Equivalent
4	Power Plant Configuration	GATE Cycle or Equivalent
5	Process Simulation	Hysys or equivalent
6	Heat Exchangers	HTRI or equivalent
7	Electrical System Configuration	ETAP

Sr. No.	Deliverable List	Software
8	Instrumentation	Smart Plant Instrumentation(SPI-INTools)
9	Datasheets & Line list	In house tools with compatible output in PDF/ Excel
10	Documentation Handling	eDMS or Equivalent (For centralization of documents with vendor , client and consultant interface)
11	Vessels, Columns	PVELITE
12	Piping Stress Analysis	CESEAR-II
13	Structural Analysts	STAAD PRO
14	Finite Element Analysis(if Required)	ANSYS and Equivalent
15	Al Text Data	MS Word in Words
16	All Spread Sheet work	MS Excel in Windows
17	Final Drawings	In PDF as well as in Original Format

9.2 Contractor's Responsibility With Respect To Document Handover for Document Integration and Document Handover

For ensuring Integration & smart Document handover LSTK contractor to ensure following during execution of the project till final document handover.

1. CONTRACTOR should strictly comply to the project standards, specifications and templates issued by OWNER/PMC. Any standard documents equivalent to those referred too herein shall not be substituted without written approval from OWNER/PMC. Approval of equivalent standard documents will not, in any way release/relieve responsibility from the CONTRACTOR to meet the best practices and/or requirement of the standard Engineering Documents referred herein, in the event of conflict.

2. Where differences and/or conflicting issues occur, the requirements released by OWNER/PMC shall overrule unless otherwise advised. However major conflicts shall be

reported in writing to the OWNER/PMC for the project along with the engaged third party for information management for the resolution of the conflict. Owner/EIL will reserve the right of final approval/rejection on the differences/conflicts. Any such deviations will be recorded for the documentation clearance at the time of stage review (30%, 60%, 90% and 100% of engineering completion).

3. Quality assurance will be a part of completion for the stage review (30%, 60%, 90% and 100%). Non-adherence to data quality standards may impact the milestone completion and further to the release of the milestone payments of the CONTRACTOR.

4. During execution of the project, CONTRACTOR is required to depute their persons either at OWNER/PMC office and/or at Third party office for document handling at various stages of the document integration, checking for correctness, validation and correction of document if found not validated during process of integration.

5. During Execution of the Project it is expected that the detailed engineering documents shall be submitted as generated using following software as minimum

Sr. No.	Deliverable List	Software
1	Project Scheduling	Primavera
2	3D Design	PDS/PDMS/SP-3D
3	P&ID	Smart P&ID's or Equivalent
4	Drawings	AutoCAD
5	Electrical System Configuration	ETAP
6	Instrumentation	Smart Plant Instrumentation(SPI-INTools)
7	Datasheets & Line list	In house tools with compatible output in PDF/ Excel
8	Piping Stress Analysis	CESEAR-II
9	Al Text Data	MS Word in Words
10	All Spread Sheet work	MS Excel in Windows
11	Final Drawings	In PDF as well as in Original Format

6. CONTRACTOR to make sure that their Sub Contractor or Sub vendors shall also be comply with the requirement of the Integrated and smart documentation as outlined above.

7. As a part of proposal Contractors are required to provide extent of data / Drawing/ document volume which are expected during project execution

10. OTHER DOCUMENT REQUIREMENTS

1. Operating Manuals- CONTRACTOR & PACKAGE SUPPLIER shall prepare a detailed operating manual Process unit as part of Documentation. OWNER/PMC shall review the documents for the completeness and compliance to PSM compliant Operating Manual requirement. Format PSM-GL-4.1 and 4.2 are attached.
2. CONTRACTOR shall also develop supervisory operating manual including concise SOP (pocket booklets) for the assigned units

FORMAT TO BE FILLED IN BY CONTRACTOR FOR DOCUMENATION

(To be filled in by Contractor and needs to be submitted along with the bids)

Sr. No.	Deliverable List	Software	Data Volume in Numbers, Size
1	Project Scheduling		
2	3D Design		
3	P&ID		
4	Power Plant Configuration		
5	Process Simulation		
6	Heat Exchangers		
7	Electrical System Configuration		
8	Instrumentation		
9	Datasheets & Line list		
10	Documentation Handling		
11	Vessels, Columns		
12	Piping Stress Analysis		
13	Structural Analysts		
14	Finite Element Analysis(if Required)		
15	Al Text Data		
16	All Spread Sheet work		
17	Final Drawings		

Section 4:
Annexures

The Break-up for section is as follows,

1. Annexure A-Compliance Certificate for Technical Specification
2. Annexure B-Deviation/ Change Request for Technical Specification
3. Annexure C-Guaranteed Technical Particulars for GIS & its accessories
4. Annexure D-Technical Checklist

ANNEXURE-A:
COMPLIANCE CERTIFICATE OF TECHNICAL SPECIFICATION

The bidder shall confirm compliance to the following by signing/ stamping this compliance certificate and furnishing same with the offer.

1. The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusion/ deviation with regard to same.

2. There are no deviation(s) with respect to specification other than those furnished in the 'schedule of deviations'.

3. Only those technical submittals which are specifically asked for in NIT to be submitted at tender stage shall be considered as part of offer. Any other submission, even if made, shall not be considered as part of offer.

4. Any comments/ clarifications on technical/ inspection requirements furnished as part of bidder's covering letter shall not be considered by BHEL, and bidder's offer shall be construed to be in conformance with the specification.

5. Any changes made by the bidder in the price schedule with respect to the description/ quantities from those given in 'BOQ' of the specification shall not be considered (i.e., technical description & quantities as per the specification shall prevail).

Date: Bidder's Stamp & Signature

ANNEXURE-B:
DEVIATION/ CHANGE REQUEST OF TECHNICAL SPECIFICATION

Bidder shall list out all technical potential deviation/ change request (s) along with clause with respect to technical specifications. It is also to be noted that bidder shall provide the Impacts of Potential Deviation(s) without any failure. In case, details have not been furnished, such requests shall not be considered.

Sl. No.	Contract requirement with clause No.	Potential deviation/ change request(s)	Impacts of Potential Deviation(s)		
			Technological (Inferior/ Equal/ Superior)	Schedule Impact (Delay/ NIL/ Acceleration)	Cost Impact (Increase/ NIL/ Decrease)

Any deviation not specifically brought out in this section shall not be admissible for any commercial implication at later stage. Except to the technical deviations listed in this schedule, bidder's offer shall be considered in full compliance to the tender specifications irrespective of any such deviation indicated / taken elsewhere in the submitted offer.

Date: Bidder's Stamp & Signature

ANNEXURE-C:
GUARANTEED TECHNICAL PARTICULARS

Sl. No.	Parameter	Units	Bidder's Data
1	Type/designation		
2	Nominal voltage, U_n	kV	
3	Highest voltage for Equipment, U_m	kV	
4	Rated Frequency		
4.1	Normal condition	Hz	
4.2	Exceptional Condition	Hz	
5	Power frequency withstand voltage, (One) 1 minute		
5.1	Phase to ground	kV_{rms}	
5.2	Phase to Phase	kV_{rms}	
6	Power frequency withstand voltage at atmospheric SF_6 gas pressure		
6.1	continuously	kV_{rms}	
6.2	for (one) 1 minute	kV_{rms}	
7	Lightning impulse withstand voltage		
7.1	against ground	kV_{peak}	
7.2	over isolating distance of isolators	kV_{peak}	
7.3	over isolating distance of circuit breakers	kV_{peak}	
8	Switching impulse withstand voltage		
8.1	against ground	kV_{peak}	
8.2	over isolating distances of apparatus	kV_{peak}	

Sl. No.	Parameter	Units	Bidder's Data
9	Maximum partial discharge of switch gear assembly at highest voltage for equipment, U_m	pC	
10	Maximum leakage rate in percent of the respective volume, per year	%	
11	Temperature rise	^0C	
12	Minimum symmetrical short-time withstand current, (One) 1 second	KA_{rms}	
13	Minimum dynamic short-circuit withstand current	kA_{peak}	
14	Corona extinction voltage	kV_{rms}	
15	Circuit Breaker		
15.1	Rated continuous current	A	
15.2	Rated short time withstand current	kA_{peak}	
15.3	Rated symmetrical short-circuit breaking current	kA_{rms}	
15.4	Rated asymmetrical short-circuit breaking current	kA_{rms}	
15.5	Rated short-circuit making current	kA_{peak}	
15.6	Line charging current breaking capability	A	
15.7	Small inductive current breaking capability (without producing excessive over voltages)	A	
15.8	Operating sequence		
Sl. No.	Parameter	Units	Bidder's Data

15.8.1	Breakers		
15.9	Mechanical opening time	ms	
15.9.1	Total breaking time	ms	
15.9.2	Total closing time	ms	
15.9.3	First pole to clear factor		
15.10	Isolator		
15.10.1	Rated continuous current	A	
15.10.2	Minimum make and break capability for capacitive current	A	
15.10.3	Total operating time (closing or opening cycle)	s	
15.10.4	Temperature rise	0C	
15.11	Fast Acting Grounding Switch		
15.11.1	Rated short-circuit making current	kApeak	
15.11.2	Rated switching capacity		
15.11.2.1	inductive currents	A	
15.11.2.2	capacitive currents	A	
15.11.3	Operating time		
15.11.3.1	Charging time of stored energy mechanism	s	

Sl. No.	Parameter	Units	Bidder's Data
15.11.3.2	fast acting time	ms	
15.12	Safety Grounding Switch		
15.12.1	Rated short time withstand current, (One) 1 s	kA	
15.12.2	Total operating time (closing or opening cycle)	s	
15.13	Bus Voltage Transformers		
15.13.1	Rated transformation ratio		
15.13.1.1	for protection	kV/V	
15.13.1.2	for metering	kV/V	
15.13.2	Accuracy class / rated burden		
15.13.2.1	for protection	-/VA	
15.13.2.2	for metering	-/VA	
16	Surge Arrestor		
16.1	system voltage	kV	
16.2	rated arrestor voltage	kV	
16.3	rated nominal discharge current	A	
16.4	minimum thermal capacity		
16.5	continuous operating voltage (COV)	kV	
16.6	MCOV as per ANSI test	kV	

Sl. No.	Parameter	Units	Bidder's Data
16.7	Temporary over voltage(TOV)		
16.7.1	1 sec	kV	
16.7.2	10 sec	kV	
16.8	One minute (dry) power frequency withstand voltage of arrestor housing	kV	
16.9	Impulse withstand voltage of arrestor housing with 1.2/50 ms wave	kV	
16.10	Discharge voltage	kV	
16.10.1	Switching surges		
16.10.1.1	at 1 kA	kV	
16.10.1.2	at 2 kA	kV	
16.10.1.3	at 3 kA	kV	
16.10.2	8/20 µs		
16.10.2.1	at 5 kA	kV	
16.10.2.2	at 10 kA	kV	
16.10.2.3	at 20 kA	kV	
16.10.2.4	at 40 kA	kV	

Sl. No.	Parameter	Units	Bidder's Data
17	Current Transformers	.	
17.1	Manufacturer		
17.2	Type / designation		
17.3	GTG Feeder CTs		
17.3.1	number of current transformers	Nos.	
17.3.2	rated primary current / secondary current	A/A	
17.3.3	accuracy class/burden of core 1 of CT1	-/VA	
17.3.4	accuracy class/burden of core 2 of CT1	-/VA	
17.3.5	accuracy class/burden of core 3 of CT1	-/VA	
17.3.6	accuracy class/burden of core 1 of CT2	-/VA	
17.3.7	accuracy class/burden of core 2 of CT2	-/VA	
17.3.8	accuracy class/burden of core 3 of CT2	-/VA	
17.3.9	rated short-time thermal current, 1 s	kA_{rms}	
17.3.10	rated dynamic current	kA_{peak}	
18.4	STG feeder CT's		
18.4.1	number of current transformers	Nos.	
18.4.2	rated primary current/ secondary current	A/A	
18.4.3	accuracy class/burden of core 1 of CT1	-/VA	
18.4.4	accuracy class/burden of core 2 of CT1	-/VA	
18.4.5	accuracy class/burden of core 3 of CT1	-/VA	
18.4.6	accuracy class/burden of core 1 of CT2	-/VA	
18.4.7	accuracy class/burden of core 2 of CT2	-/VA	
18.4.8	accuracy class/burden of core 3 of CT2	-/VA	

Sl. No.	Parameter	Units	Bidder's Data
18.4.8	rated short-time thermal current, 1 s	kA_{rms}	
18.4.9	rated dynamic current	kA_{peak}	
18.5	Bus Coupler & Bus Section CT's		
18.5.1	number of current transformers	Nos.	
18.5.2	rated primary current / secondary current	A/A	
18.5.3	accuracy class/burden of core 1 of CT1	-/VA	
18.5.4	accuracy class/burden of core 2 of CT1	-/VA	
18.5.5	accuracy class/burden of core 1 of CT2	-/VA	
18.5.6	accuracy class/burden of core 4 of CT2	-/VA	
18.5.7	rated short-time thermal current, 1 s	kA_{rms}	
18.5.8	rated dynamic current	kA_{peak}	
19.5	Outgoing Feeder CTs		
19.5.1	number of current transformers	Nos.	
19.5.2	rated primary current / secondary current	A/A	
19.5.3	accuracy class/burden of core 1 of CT1	-/VA	
19.5.4	accuracy class/burden of core 2 of CT1	-/VA	
19.5.5	accuracy class/burden of core 1 of CT2	-/VA	
19.5.6	accuracy class/burden of core 4 of CT2	-/VA	
19.5.7	rated short-time thermal current, 1 s	kA_{rms}	
	rated dynamic current	kA_{peak}	
20	Bus Voltage Transformers		
20.1	Manufacturer	-	
20.2	Number of potential transformers per line	Nos.	
20.3	Number of potential transformers per bus	Nos.	
20.4	Number of windings per PT	Nos.	

Sl. No.	Parameter	Units	Bidder's Data
21	On-line Monitoring System		
21.1	Manufacturer		
21.2	Parameters monitored		
21.3	Gas Density		
21.4	Gas Pressure		
21.5	Leakage		
21.6	Compatibility with Plant SCADA		
22	Gas System		
22.1	SF_6 gas pressure alarm level		
22.1.1	circuit breaker	kPa	
22.1.2	enclosures	kPa	
22.2	SF_6 gas processing unit		
22.2.1	make		
22.2.2	type		
22.2.3	rated capacity	L/m	
22.2.4	power supply voltage	V	
22.2.5	power consumption	kW	
25	Power consumption of heating elements		
25.1	per feeder	W	
25.2	at supply voltage	V	
26	Circuit Breaker		
26.1	Class of Breaker		

Sl. No.	Parameter	Units	Bidder's Data
26.2	Number of poles	Nos.	
26.3	Cable charging current breaking capability	A	
26.4	Rated opening time	s	
26.5	Difference in the instants of closing / opening of contacts		
26.5.1	Within a pole	s	
26.5.2	Between poles	s	
26.6	Corona extinction voltage	kV	
26.7	Rated transient recovery voltage for terminal faults	kV	
26.6	Maximum dynamic forces on foundation caused by circuit breaker (3 phases)		
26.6.1	at closing, vertical forces	kN	
26.6.2	at closing, horizontal forces	kN	
26.6.3	at opening, vertical forces	kN	
26.6.4	at opening, horizontal forces	kN	
26.7	Circuit breaker operating mechanism		
26.7.1	kind of stored energy mechanism		
26.7.2	power consumption of charging motor, if applicable	W	
26.7.3	at supply voltage	V	
26.8	Closing coil		
26.8.1	number of coils	no.	
26.8.2	power consumption	W	

Sl. No.	Parameter	Units	Bidder's Data
26.8.3	at voltage	V	
26.9	Trip coil		
26.9.1	number of coils	Nos.	
26.9.2	power consumption	W	
26.9.3	at voltage	V	
26.10	Operating mechanism		
27	Isolator		
27.1	Power consumption of		
27.1.1	drive motor	W	
27.1.2	at voltage	V	
27.2	Mechanical terminal load	kN	
27.3	No. / details of auxiliary contacts	Nos.	
28	Fast Acting Grounding Switch		
28.1	Operating mechanism		
28.1.1	kind of stored energy mechanism		
28.1.2	power consumption of charging motor	W	
28.1.3	at voltage	V	
29	Safety Grounding Switch		
29.1	Power consumption of		
29.1.1	drive motor	W	
29.1.2	at voltage	V	
30	Weights		

Sl. No.	Parameter	Units	Bidder's Data
30.1	Approx. weight of one complete 3-phase feeder bay	kg	
30.2	Maximum transportation weight	kg	
31	Dimensions		
31.1	Overall dimensions of one 3 -phase feeder bay(LxWxH)	mm x mm xmm	
31.2	Minimum space required for complete switchgear assembly considering requirements for testing and maintenance(LxWxH)	mm x mm xmm	
31.3	Cross section and section designation		
31.3.1	main bus	mm^2	
32	CB Panel		
32.1	Max. overall dimensions		
32.2	Width		
32.3	Depth		
32.4	Height		
33	Dummy/Adaptor Panel		
33.1	Overall dimensions		
33.1	Width		
33.2	Depth		
33.3	Height		
34	Largest Shipping Section		
34.1	Max. overall weight		
34.2	Overall dimensions		
34.3	Width		
34.4	Depth		
34.5	Height		
35	Max. size / no of cables that cab be terminated		
35.1	With rear extension		
35.2	Without rear extension		
36	Size of rear extension panel		
37	Horizontal main bus bar size		
37.1	(No of flats, size of each flat)		
37.2	Material		
38	Vertical dropper size material		
39	Earth bus size material		

Date: Bidder's Stamp & Signature

ANNEXURE-D:
TECHNICAL CHECKLIST

Sl. No.	Particulars	Confirmation by Bidder	
1	**Technical Qualifying Requirement**		
1.1	The bidder to furnish relevant documents for meeting the qualifying requirement. Performance certificates shall be submitted in English. Translated pages should be attested by the ultimate customer, if attested only by the bidder it shall be notarized.	Confirmed	Yes/No
1.2	The bid shall be submitted by the Manufacturer of GIS & its accessories in case of Indian Manufacturer, however agent may submit the technical offer in case of foreign manufacturer. The bidder's scope includes supply and services such as • Supervision of installation, • Testing and commissioning.	Confirmed	Yes/No
1.3	All the documents shall be submitted in English. Translated pages should be attested by the ultimate customer, if attested only by the bidder it shall be notarized.	Confirmed	Yes/No
2	**Un-priced BOQ**		
2.1	Confirm that all items have been quoted separately. (If any item has not been quoted, the same shall be specifically brought out with technical reasons thereof)	Confirmed	Yes/No
2.2	Any other supply/ service required for the execution for the complete work of GIS & its accessories is deemed to be included in the offer, whether specifically mentioned in the specification or not. Bidder to submit list of items along with their respective quantities required for completeness of GIS & its accessories.	List of items required to be attached.	Yes/No
2.3	**Building** for GIS shall be constructed by Civil contractor based on the input (configuration, structure loads etc.) provided by bidder. The supply of all structural material to be embedded including foundation bolts, plates etc. as well as consumables like grouting material etc. shall be in bidder's scope shall be in scope of bidder. The erection of structure shall be done by BHEL under supervision of bidder.	Confirmed	Yes/No
2.4	**Cable Connection module** - Interface for connecting XLPE cable, structures etc shall be provided by the bidder. Limit of supply/ services between GIS manufactures and cable termination shall be as per 62271-209 for cable termination. The typical arrangement drawing of interconnecting bus-duct from GIS bay module to XLPE cable termination end shall be submitted along with technical offer.	Confirmed. submitted	Yes/No
2.5	Confirm that the consumables (list to be enclosed by bidder during contract stage) with shelf life of fewer than two years shall be supplied before erection after specific clearance by BHEL/Owner/PMC.	Confirmed	Yes/No
2.6	Commissioning spares for testing & commissioning of GIS till handing over shall be under bidder's scope.	Confirmed	Yes/No
2.7	Detailed list of Tools & tackle & Testing Equipment to be supplied at site on returnable/ non-returnable basis.	List attached	Yes/No
2.8	The Switchgear shall be complete with all necessary terminal boxes, SF6 gas	Confirmed	Yes/No

Sl. No.	Particulars	Confirmation by Bidder	
	filling, interconnecting power and control wiring, grounding connections, gas monitoring equipment and piping, support structures.		
2.9	The scope of supply shall also include all erection and mounting hardware and interconnecting cables within GIS.	Confirmed	Yes/No
2.10	Design philosophy of earthing submitted with the bid	Confirmed	Yes/No
2.11	Design of Earthing of GIS shall be in bidder scope. The items and accessories required for completeness of earthing shall be in bidder's scope. Mesh on floor shall be provided by BHEL as per bidder's design.	Confirmed	Yes/No
3	**Technical**		
3.1	Size of EOT crane , if required and GIS room size required submitted with the offer	Confirmed	Yes/No
3.2	Thermal rating for all current carrying parts shall be minimum 3 s for 40 kA.	Confirmed	Yes/No
3.3	Internal components maintenance free for at least 10 years	Confirmed	Yes/No
3.4	Material of enclosure – non-magnetic material	Confirmed	Yes/No
3.5	Requirement of AC and DC auxiliary loads	Enclosed with bid	Yes/No
3.6	Catalogues of GIS	Enclosed with bid	Yes/No
3.7	Catalogues of all Maintenance equipment. Bidder to confirm that offered equipment meets the requirements of specification.	Enclosed with bid	Yes/No
4	**Calculations**		
4.1	The design of the equipment shall be such that the agreed permitted movement of foundations and mechanical or thermal effects do not impair the assigned performance of the equipment.	Confirmed	Yes/No
4.2	Insulation co-ordination study shall be conducted and based on the same the number & location of surge arresters shall be decided. The number and location of surge arresters shall be indicated with the bid.	Confirmed	Yes/No
4.3	Measures to limit external overvoltages (e.g. surge arresters) should be considered and detailed out based on the site conditions etc.	Enclosed with bid	Yes/No
5	**Technical Deviations**		
5.1	Confirm that the Complete systems have been offered as per the requirements of Technical Specification and Technical Deviation sheet has been submitted. Deviations mentioned elsewhere in the bid will not be considered.	Confirmed	Yes/No
6	**Barchart**		
6.1	Bidder will submit detailed bar chart indicating all the milestones from Engineering till manufacturing/ testing, dispatch to site and commissioning based on the drawing & document schedule attached in section1.	Confirmed	Yes/No
7	**Conditions**		
7.1	Store shall be provided by BHEL for GIS and accessories. Confirm that the space required for the material being supplied, both indoor and outdoor has been indicated.	Details given with the bid.	Yes/No
8	**Site Test**		

Sl. No.	Particulars	Confirmation by Bidder	
8.1	Only special tools shall be in bidder's scope. Bidder to submit list of tools, tackle, slings, spanners, gauges, slings and other lifting devices, drills, instruments and appliances necessary for the complete assembly and erection at site of the GIS, required for installation, gas filling, maintenance, site testing of the GIS which shall be arranged by BHEL. HV Test kit shall be in scope of bidder. EOT cranes shall be provided by BHEL in GIS Hall as per size recommended by bidder.	Confirmed	Yes/No
8.2	Bidder to furnish detailed BOQ for non-returnable Tools and Tackles along with unit prices to be handed over to ultimate customer.	Details given with the bid.	Yes/No
8.3	All field tests including tests during installation, pre-commissioning, commissioning, field acceptance tests shall be conducted by the Contractor, in presence of representative of the Employer. No separate site test will be conducted by BHEL/Customer	Confirmed	Yes/No
9	**TYPE TESTS REQUIREMENTS**		
9.1	The 66kV GIS should have been type tested (as per relevant IEC). The GIS and equipment/components shall be of same make and type as that used in type test.	Confirmed	Yes/No
9.2	Type test report for 66 kV GIS shall be submitted alongwith the bid. Differences, if any, in the items offered and those which have been type tested shall be clearly brought out alongwith explanation for suitability.	Confirmed and enclosed with bid	Yes/No
9.3	In case the test reports are not found technically valid during contract stage by BHEL/ONGC, the bidder shall repeat these test(s) at no extra cost to the purchaser and no delivery implication. **Technical valid** - Any error or incompleteness (any/all additional type tests not carried out) or discrepancy in the test reports vis-à-vis offered equipment due to any design / manufacturing changes (including substitution of components) or non-compliance with the requirement stipulated in the Technical Specification.	Confirmed	Yes/No
9.4	The type tests conducted earlier should have either been conducted in an accredited independent laboratory (accredited base on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located). The short circuit test should have been conducted in a laboratory which should be a member of STL (Short-Circuit Testing Liaison - www.stl-liaison.org). If the laboratory is not a national laboratory and member of STL, relevant papers of accreditation shall be submitted in English. If the laboratory is in-house, the tests should have been witnessed by a client.	Confirmed. Details provided with bid.	Yes/No
9.5	The type test report shall be complete including the list of test objects, photographs, oscillographs, test arrangement, drawing of tested objects (GIS, equipment etc) and test connections. The type test report shall be in English. If it is in any other language, it should include an English version (Translation	Confirmed	Yes/No

Sl. No.	Particulars	Confirmation by Bidder	
	shall be attested by the Bidder). The English version should be complete with measured values and conclusion.		

Date:

Bidder's Stamp & Signature