

4. EVENT, ALARM LOGGING, TREND DISPLAY & REPORTS

- 4.1. User friendly Event / Alarm display shall be available and each alarm/event shall be displayed on one line and shall contain the date, time, name of the event, alarm object, descriptive text along with the state or value of the object.
- 4.2. The information fields as detailed above shall be structured in columns for maximum readability and the software shall have provision to take print-out of the event/alarm as per the requirement.
- 4.3. The software shall have feature to filter out the event/alarm as per the user requirement.
- 4.4. Two successive alarms/events shall be distinguished separately (preferably with different colour) for reading clarity with sufficient gaps between two alarm/event.
- 4.5. Software provided shall be user friendly to configure any required alarm/event for any tag during the normal use of operation.
- 4.6. The software shall also provide trend display for all the metered data with the least possible resolution possible. Resolution & data update for the trend display shall be as low as possible and should not be more than 1s.
- 4.7. User shall have flexibility to select required data to be displayed in the trend and provision for taking the print out of the same shall be available.
- 4.8. Software shall also have feature to display the value of the metered data at any user selected instant.
- 4.9. The trend display shall have feature to zoom in / zoom out for better understanding & analysis of the collected data.
- 4.10. Report generation shall be user friendly. Following default reports i.e., Hourly, Daily, Weekly & monthly shall be generated on a regular basis in the format prescribed and approved during the design engineering.

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- 4.11. The system shall have sufficient storage to store alarms/events for a minimum period of 6 months. There should be a provision to take necessary back-up of the same for future requirement.
- 4.12. The system shall also store all the trends for various electrical parameters for at least a period of six months. Necessary data storage or increase in the data storage capacity in the existing system for achieving the above shall be provided.
- 4.13. User shall be able to create any customised report required for any electrical parameter for the panels connected to the system.

5. USER AUTHORITY LEVELS

- 5.1. Access of the data being captured from the connected feeders shall be based on user authority levels.
- 5.2. Generally, following levels shall be provided, however, these may get revised during detailed engineering and site commissioning based on the plant requirement
- Guest Login only for viewing
 - Operator Login with limited access
 - Engineer Login
 - System Administrator
- 5.3. The access rights shall be defined by passwords assigned during the log-in procedure.
- 5.4. Adding or Removing users and changing access rights for various parameters shall be in the control of only System Administrator.

6. SYSTEM RELIABILITY

- 6.1. The overall system shall be designed & suitably integrated with existing system to ensure and satisfy very high demands for reliability and availability concerning:
- Solid mechanical & electrical design
 - Security against EMI
 - High Quality components & boards
 - Modular, well tested hardware
 - Thoroughly developed and tested modular hardware
 - Wasy-to-understand programming language for application programming
 - Detailed graphical documentation of the application software
 - Built-in supervision and diagnostic functions
 - Prompt After Sales service
 - Security
 - Panel grounding immune against transient ground potential rise

[Type text]

6.2. Bidder shall furnish guaranteed technical particulars & performance details with the bid.

7. PANELS & RACKS

- 7.1. RTU/Data Concentrator cabinets shall be self standing type suitable for floor mounting. Panel shall house I/O cards, power supply units, CPUs, output relays etc as per the requirement.
- 7.2. It shall be responsibility of the bidder to assess the existing infrastructure and quote accordingly. Any site visit required for the same by any bidder can be suitably informed to the EIC ~~before the pre bid meeting~~. No escalation whatsoever shall be provided on account of this if any infrastructure has been missed by the bidder to include in the bid based on the tender requirement and necessity of the same arises during site commissioning.
- 7.3. Each control panel or rack, if provided, shall have 2 isolated ground buses.

8. I/O CARDS / RELAYS

- 8.1. I/O cards as per the tender requirement shall be supplied in accordance with the project requirement and this tender specification I/O list attached as reference & subsequent final requirement after detailed engineering.
- 8.2. Supplied cards shall be hot swappable type. No system shutdown shall be required for replacing any faulty cards. Same shall be suitable demonstrated during the FAT/SAT.
- 8.3. Any faulty card shall be immediately indicated on the card as well as HMI to take necessary corrective action.
- 8.4. Minimum 20% of the installed wired spares shall be provided for I/O cards, modules, power supply modules, data concentrator etc.
- 8.5. All PCBs provided in the system shall be suitable for harsh environmental conditions. Necessary test reports / performance certificates /Oil and Gas projects reference list for the same shall be provided or else same shall be provided with special coating conforming to G3 environment to prevent track damage/corrosion. PCB shall be protected from corrosive atmosphere.

[Type text]

9. DOCUMENTATION

9.1. Following documentation shall be provided at minimum for the system along with the bid

- Proposed system architecture
- Write up on control and operation philosophy

9.2. Following documents to be submitted during detail engineering & with the project work as required for approval of IOCL :

- List of Drawings
- Single Line Diagram (mimic)
- Block Diagram
- Circuit Diagram
- List of equipment
- List of labels
- FDS (Functional Design Specification)
- Test Plan for FAT & SAT
- Logic Diagram
- List of Signals & alarms
- Operator's Manual
- Product Manual
- Copy of all software

9.3. Final Documentation

- Two sets of standard hardware Operation/Instruction Manuals
- Two sets of final drawings (GA/BOM/Wiring Schematics)
- Two sets of Operator Help documents (project specific application software related)
- Copy of all software along with Serial Key for re-installation in future

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10. INSPECTION & TEST

10.1. Shop Test by OEM – ~~B22~~ contractor/ manufacturer of the system shall carry out all tests as per the approved Quality Control & Assurance Procedures. The results of the same shall be shared for OWNER's review at least 7 working days in advance of the Factory Inspection Test (FAT)

10.2. Factory Inspection Test (FAT)

- ~~B22~~ contractor shall coordinate/ arrange for FAT with at least 15 days advance notice. TPI will be done for the offered system as per approved QAP plan.
- Inspection & checks shall cover the following at minimum:
 - Appearance & Construction Check
 - Outline & Dimensional Checks
 - Type & Quantity Check
 - Dielectric Strength Check (review of test record only)
 - Overall system test including function test
 - Performance Test
- Communication test of controller shall be carried out during site acceptance test. The vendor shall share the responsibility for solving troubles in case of any communication failure.
- Communication speed & other critical timing as specified in the tender shall be insured and demonstrated during FAT.

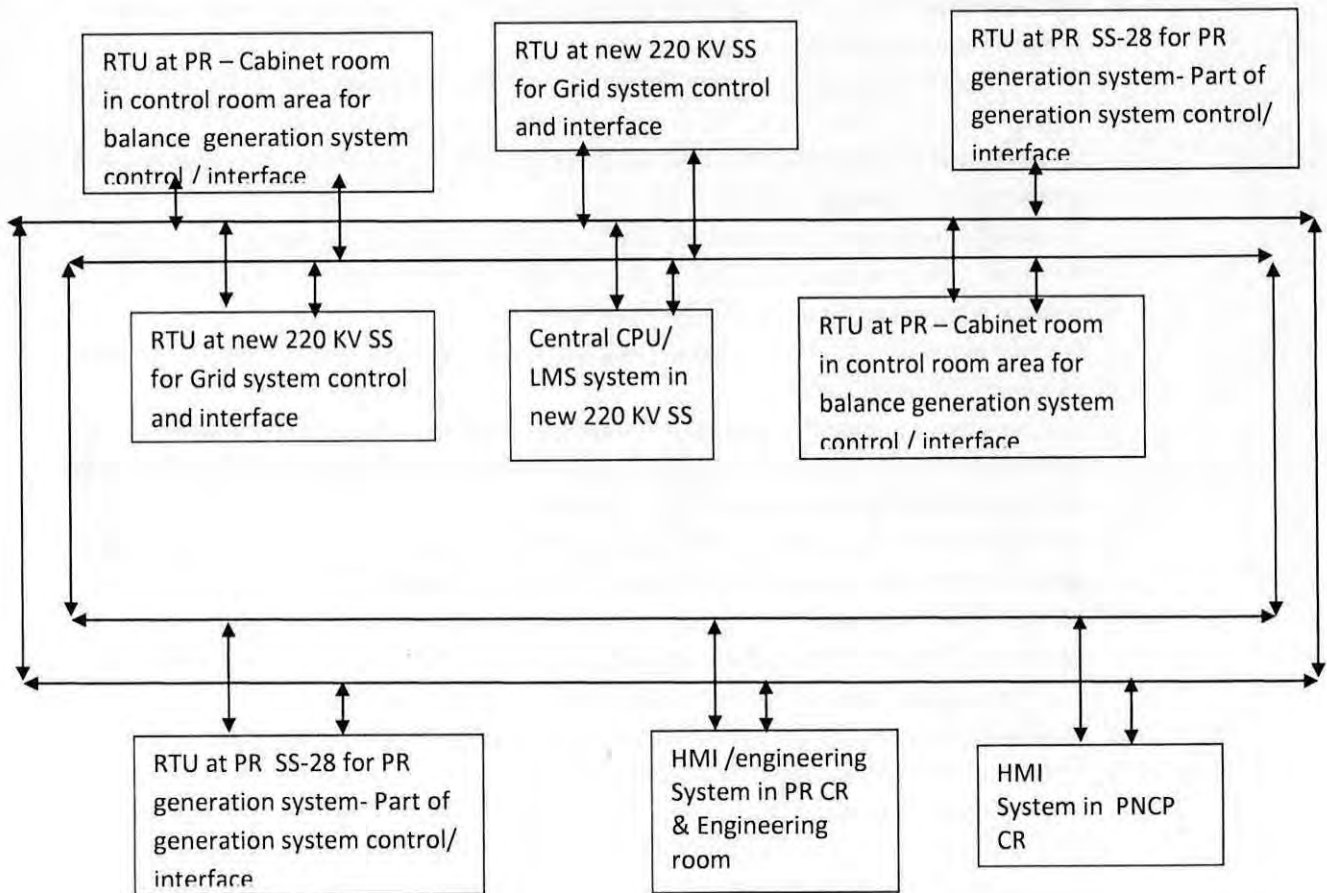
10.3. Site Inspection / Test and Acceptances:

- The ~~B22~~ contractor vendor shall perform site inspection / test and acceptances of the system in accordance with the approved procedures, QAP and OEM guidelines. All site testing and commissioning works shall be done under the supervision of OEM.

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Annexure- S-3/C9/3 – Typical Architecture -



PART C- Modification in existing ECS system for changes in Load shedding facility

- 1- Introduction – Presently Emerson make ECS system is used in Panipat refinery and ABB make ECS system is used at PNCP end for electrical system monitoring and Load shedding requirement. With the addition of grid facility, load shedding scheme needs to be modified both in hardware and soft ware level.
- 2- Scope or work – ~~ESTK~~ contractor scope of work is detailed below in two parts for modifications in existing ECS system for load shedding requirement –
Part 1- (work at PNCP SS-9 end)
 - a- One controller set/ RTU unit of existing ECS network of PR (of M/S Emerson) will be provided at PNCP Power plant (SS-9) end. The complete RTU unit with latest controller set in redundant configuration along with all hardware required for developing a control hub shall be supply by ~~ESTK~~ contractor of same configuration as of in existing system and procured

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from OEM of existing ECS system of PR side which is M/S Emerson process management for computability with existing system.

- b- Network switches, fan out switches, media convertor as per system configuration shall be provided by ~~LSTK~~ contractor as compatible with existing system of ECS OEM requirement.
- c- Redundant OFC connectivity shall be provided from main network devices at PR power plant with new RTU unit at PNCP SS-9 end. Supply, laying, termination of OFC cables is in the scope of LSTK contractor.
- d- The existing Generator & new grid status and data of PNCP power plant as listed below needs to be extended up-to new RTU unit –
 - i)- Generator breaker On/ OFF status for all 8 generators in redundant mode as a hardwired inputs.
 - ii)- Generator running MW and MVAR signal in 4-20 ma in redundant configuration for all 8 machines as a hardwired inputs.
 - iii) Identified load shedding feeders of PNCP (around 20 nos) On/ OFF status and running MW data from existing ABB ECS DO & AO to DI & AI of new RTU point in PNCP SS-9 ECS room as a hardwired inputs or as a OPC interface data.
 - iv) PNCP grid incomers On/ OFF status , MW and MVAR reading extension upto new RTU in SS-9 in PNCP SS-9 ECS room.
 - iv) Connection of new RTU DO & AO up-to ABB ECS DI point in PNCP SS-9 ECS cabinet room. The required IO cards at new RTU end and at ABB ECS end (if any) shall be supplied by ~~LSTK~~ contractor through OEM for ensuring compatibility.
- e- All required control and signal cabling for above IO connectivity shall also be in the scope of ~~LSTK~~ contractor including supply of all required material & cables
- f- All kind of hardware addition in existing panel like contact multiplier, transducer in existing generators, load shedding feeders, new grid incomer at PNCP end shall be in the ~~LSTK~~ contractor scope including its supply, installation and commissioning.
- g- Hardware like gateway PC/ server required for developing the OPC connectivity between new Emerson RTU with existing ABB ECS system
- h- Supply & installation of 2 nos of HMI at PNCP CPP control room which will be compatible with Emerson ECS system. This Operator HMI shall be industrial grade and shall be strictly as per specification of ECS OEM (M/S Emerson). All communication cable required for HMI interface and associated hardware shall also be supplied by ~~LSTK~~ contractor through or as per requirement of PR ECS OEM.
- i- All kind of furniture for operator HMI for PNCP end shall be supplied by LSTK contractor.
- j- A tentative architecture is attached as annexure S-3/C9/4
- k- RTU shall be fully designed in line with existing ECS RTU design and concept.
- l- All kind of software modification , logic modification as required for hook up of new feeders, load shedding scheme shall be arrange by IOCL through OEM. ~~LSTK~~ contractor to ensure required IO interface development as per ECS vendor and IOCL requirement for this project.

Part 2- (work at PR- SS-28 end)-

- a- The New grid 220 KV system needs to be fully interfaced with existing PR ECS system as listed below needs to be extended up-to existing IO interface panels of ECS in PR SS-28 –
 - i)- 220 KV all bays breaker & isolator On/ OFF status in redundant mode and as a hardwired input

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ii)-220 KV all bays running MW and MVAR signal in 4-20 ma in redundant configuration and as a hardwired inputs.

Any additional hardware & IO cards at new existing IO interface of PR ECS end (if any) shall be supplied by ~~LSK~~ contractor through OEM for ensuring compatibility.

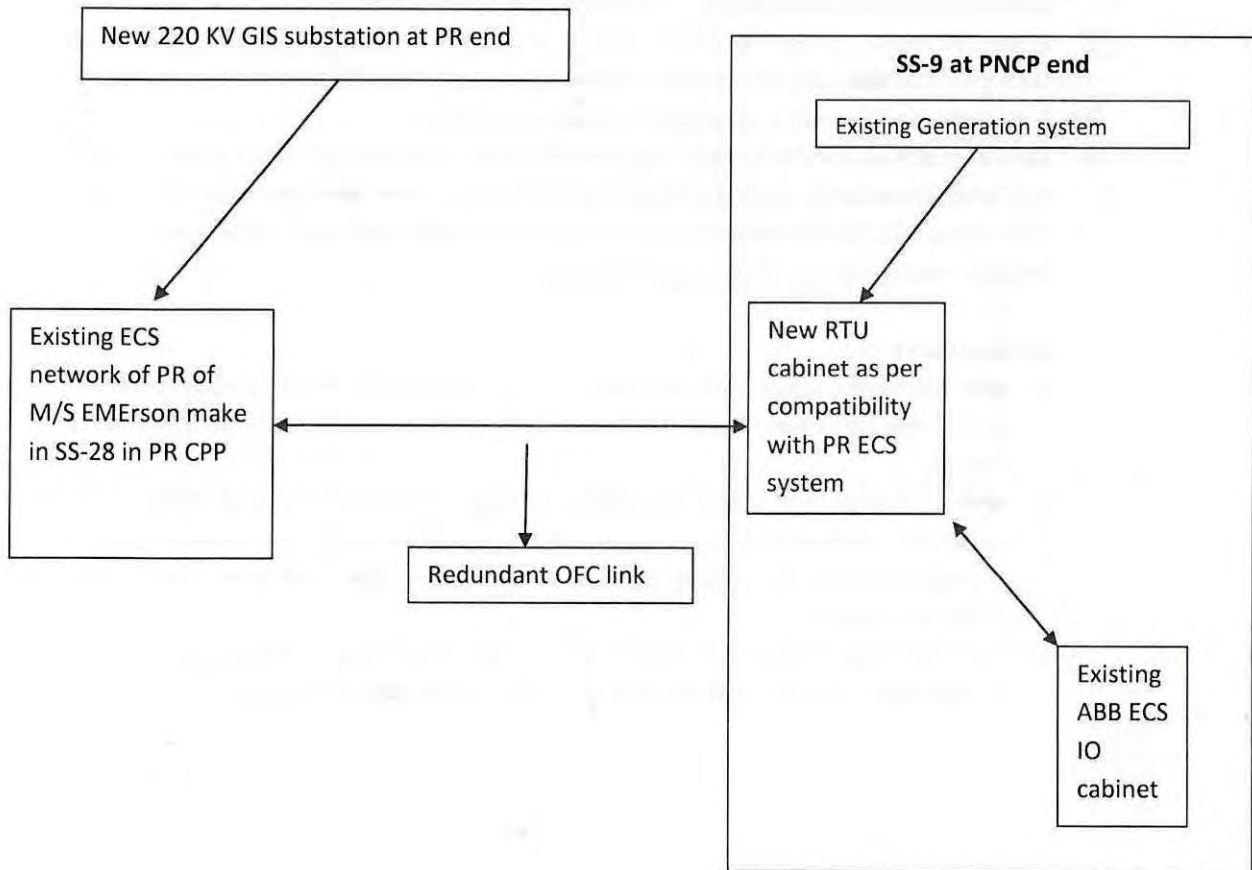
- b- All required control and signal cabling for above IO connectivity shall also be in the scope of ~~LSK~~ contractor including supply of all required material & cables
- c- All kind of hardware required in new 220 KV GIS system like contact multiplier, transducers shall be in the ~~LSK~~ contractor scope including its supply, installation and commissioning.
- d- A tentative architecture is attached as annexure S-3/C9/4
- e- All kind of software modification , logic modification as required for hook up of new feeders, load shedding scheme shall be arrange by IOCL through OEM. ~~LSK~~ contractor to ensure required IO interface development as per ECS OEM/vendor and IOCL requirement for this project including supply of all required material.

General Point –

- 1- ~~LSK~~ contractor shall ensure development of all required IO interface cable schedule interconnection chart as per project requirement, including OFC and communication cables
- 2- ~~LSK~~ contractor shall ensure all required cabling, termination , hot and cold loop checks as per ECS OEM and IOCL requirement for this interface work. Time bound execution is mandatory so adequate resources shall be arranged by ~~LSK~~ contractor as per instruction of EIC.
- 3- The detail BOM of new RTU panel shall be as per requirement of existing ECS configuration requirement. Same shall be ensured by ~~LSK~~ contractor.

[Type text]

Annexure – S-3/C9/4



- Section marked in Red are in LSTK scope of work.

[Type text]

~~PART-B~~
**TECHNICAL SPECIFICATION
FOR INDUSTRIAL
PARALLEL REDUNDANT
UNINTERRUPTED POWER SUPPLY
SYSTEM
WITH
BATTERY BANK AND ACDB**



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Abbreviations:

AC	:	Alternating Current
ACDB	:	AC Distribution Board
Ah	:	Ampere-hour
Amp	:	Ampere
BS	:	British Standard
CD	:	Compact Disk
CFL	:	Compact Fluorescent Lamp
CRCA	:	Cold Rolled Cold Annealed
DC	:	Direct Current
DCS	:	Distributed Control System
DG	:	Diesel Generator
EMC	:	Electromagnetic Compatibility
Hz	:	Hertz
IEC	:	International Electrotechnical Commission
IEEE	:	Institute of Electrical and Electronics Engineers
IGBT	:	Insulated Gate Bipolar Transistor
IP	:	Ingress Protection
IS	:	Indian Standards
LCD	:	Liquid Crystal Display
LED	:	Light Emitting Diode
MCCB	:	Moulded Case Circuit Breaker
MR	:	Material Requisition
NEMA	:	National Electrical Manufacturers Association
Ni-Cd	:	Nickel Cadmium
PC	:	Personal Computer
PCB	:	Printed Circuit Board
PIV	:	Peak Inverse Voltage
PO	:	Purchase Order
P.u.	:	Per Unit
PVC	:	Poly Vinyl Chloride
RFI	:	Radio Frequency Interference
ROM	:	Read Only Memory
RS	:	Recommended Standard
SMPS	:	Switch Mode Power Supply
SPN	:	Single Phase Neutral
UPS	:	Uninterrupted Power Supply
v	:	Volt
VDE	:	Verband Deutscher Electrotechniker
VRLA	:	Valve Regulated Lead Acid

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1.0 SCOPE

This specification covers the design, submission of drawings for approval, manufacture, carrying out FAT, inspection, packing, supply, transportation, installation, site testing, carrying out of pre-commissioning checks and final commissioning of the 50 KVA (minimum) parallel redundant industrial Uninterrupted Power Supply (UPS) system and its accessories along with battery bank of 2 X 220 AH capacity (minimum) with all accessories and A.C. distribution boards (with 2 incomers and one bus-coupler configuration) as well as supply of mandatory spares.

The total number of feeders, ratings and cable sizes will be finalized during detailed engineering. However, Bidder shall design the UPS system in the view of following:

- Minimum of 2 Hrs of battery backup in case of failure of AC supply.
- Minimum of one spare feeder for each type of O/G feeders.

The broad scope has been defined as below:

~~ESTK~~ contractor's Scope:

- r) Complete design, preparation of design drawings for approval. The indicated capacities of UPS and batteries is minimum requirements. The overall design and sizing of the system is the sole responsibility of the ~~ESTK~~ contractor. Any increase in capacity during detailed engineering will be in the scope of ~~ESTK~~ contractor without any extra financial implication to owner.
- s) Fabrication of the UPS, battery banks, A.C Distribution boards strictly in line with the approved drawings.
- t) Carrying of the FAT acceptance test and owners inspection of the materials at shop and supply of material.
- u) Installation & commissioning of UPS, ACDB and its battery bank.
- v) Carrying out pre-commissioning checks, testing and commissioning of the UPS system. **(ONLY SUPERVISION OF INSTALLATION & COMMISSIONING IS IN BIDDER'S SCOPE)**
- w) Installation and commissioning including site testing shall be done under the supervision of OEM. OEM shall certify the commissioning of system.
- x) Installation of the battery banks, assembly of individual cell, Electrolyte -top up and carrying out the first time charging and discharging of the battery system. Generation of the test reports. Supply of charger system for initial charging is also in vendor's scope. Battery, connectors, electrolyte, battery stand and all other associated material required for successful commissioning of system shall be in vendors scope
- y) Submission of the final test reports to Engineer-In charge deputed by IOCL for overall supervision of the project.



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- z) All kind of engineering manpower/ expert manpower/ skilled and unskilled manpower required for completion of project shall be arrange by bidder including its sub vendors with any extra financial implication.
- aa) All kind of lodging, boarding, travelling including local movement shall be arranged by bidder without any extra financial implication including any foreign expert if required.
- bb) Execution of job may be required multiple site visit. Same shall be ensured by vendor without any extra financial implication.
- cc) Vendor shall ensure deputation of required manpower as job execution may be planned wit unit shutdown. Vendor to submit detail bar chart after receiving order for approval of owner.
- dd) ~~Design & erection of minimum 2 nos. of electronic earth pit including its connection up to UPS by use of required size copper cables.~~
- ee) ~~Normal earthing requirements for UPS/ ACDB/ battery system shall be in vendor's scope including supply of materials as per applicable IS standards/ IE rules.~~
- ff) Any special tools, testing instruments required for successful commissioning shall be in vendor's scope.
- gg) Supply of mandatory spares.
- hh) ~~Supply and laying the interconnecting cables for between UPS, Battery Banks and ACDBs. Also the supply and laying of the outgoing cables to different feeders. All kind of loop cabling requirement between UPS & associated auxiliaries shall be in vendor's scope including its supply.~~
- ii) ~~Termination of the interconnecting as well as outgoing cables including supply of glands, lugs etc.~~
- jj) Providing necessary directive and liasoning support among various departments of Panipat Refinery.

2.0 CODES AND STANDARDS

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

IS-5	:	Colours for ready mixed paints and enamels
IS-1248	:	Direct acting indicating analogue electrical measuring (Part 1, 2, 4 and 9) instruments and their accessories.
IS-2147	:	Degree of protection provided by enclosures for low voltage switchgear and control gear
IS: 3700 (Part 1 to 11)	:	Essential ratings and characteristics of semi-conductor devices.
IS: 3715 (Part 1 to 4)	:	Letter symbols for semi-conducting devices.
IS: 4411	:	Code for designation of semi-conductor devices.
IS: 5001	:	Guide for preparation of drawings of semi-



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(Part 1 & 2):	:	conductor devices and integrated circuits.
IS: 5469 (Part 1 to 3)	:	Code of practice for the use of semi-conductor junction devices.
IS: 7204 (Part 1 to 4)	:	Stabilized power supplies D.C. output
IS: 12021	:	Control transformers for switchgear and control gear for voltages not exceeding 1000V AC
IS: 13314	:	Solid state inverters run from storage batteries
IS: 13703 (Part 1 to 4)	:	Low voltage fuses for voltage not exceeding 1000V AC or 1500V DC
IS: 13947 (Part-4/ Sec-1)	:	Specification for low voltage switchgear and control gear.
IEC: 146 :		Semi-conductor converters
IS: 10918		Vented type Nickel Cadmium batteries

- 2.2 In case of imported equipments, standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian standards.
- 2.3 The equipment shall also conform to the provisions of Indian Electricity rules and other statutory regulations currently in force in the country.
- 2.4 In case Indian standards are not available for any equipment, standards issued by IEC/ BSNDE/ IEEE/ NEMA or equivalent agency shall be applicable.
- 2.5 In case of any contradiction between various referred standards/ specifications/ data sheet and statutory regulations, the following order of priority shall govern:
- Statutory regulations
 - Data sheets
 - Job specification
 - This specification
 - Codes and Standards

All conflicts between the requirements of this specification & other relevant documents shall be referred to principal for resolution.

3.0 GENERAL REQUIREMENTS

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

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- 3.2 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.
- 3.3 Vendor shall give a notice of at least one year to the IOCL, Panipat Refinery before phasing out the product/spares to enable the end user for placement of order for spares and services
- 3.4 The UPS system shall be an integrated system comprising IGBT based rectifiers, battery, static inverters, static switches, manual by pass switch, AC distribution board, voltage stabilizer in bypass, isolating and protection devices and all other equipment/ accessories required for completeness of the system whether specifically mentioned herein or not, but necessary for completeness and satisfactory performance of the system.
- 3.5 The UPS system shall be suitable to feed all loads connected to the output which are primarily instruments, DCS, computers, disc drives and other SMPS equipment leading to high crest factor of the load.
- 3.6 The inverter shall be transistorized (IGBT) type or with the latest proven technology. All components shall be of a high quality and reliability that satisfy with the requirements of a secure AC power to vital equipment with respect to performance, controlling, monitoring and safeguarding function in continuously operating petrochemical process units, petroleum refineries, gas processing facilities, utility and other miscellaneous industrial plants. Components shall be capable of withstanding the thermal and dynamic stresses resulting from internal and external short circuits and switching surges etc.
- 3.7 The design of the UPS shall be such as to minimize the risk of short circuits and shall ensure human and operational safety.
- 3.8 The vendor shall be responsible for design, engineering and manufacturing of the complete system to fully meet the intent and requirements of this specification and enclosed data sheets. Selection, sizing and suitability of all equipment and components used for UPS system shall be vendor's responsibility.
- 3.9 The UPS output shall be single phase system as indicated in the data sheets attached as Annexure-S-3/C-7/1
- 3.10 The batteries shall meet the requirement of battery Data Sheet/ battery specifications attached with the bid document as Annexure-S-3/C-7/2

4.0 SITE CONDITIONS

The UPS system shall be suitable for installation and satisfactory operation in a closed substation with restricted natural air ventilation in tropical, humid and

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corrosive atmosphere. The UPS system shall be designed to operate under site conditions with design ambient temperature of 50°C and altitude not exceeding 1000 m above MSL.

5.0 TECHNICAL REQUIREMENTS

5.1 Input Power Supply

5.1.1 The UPS shall be suitable for 3 (three) phase input power supply

Voltage : 415V $\pm$ 10%
Frequency : 50 Hz $\pm$ 5%

In addition to above variations, the input voltage may be subject to transient variations comprising voltage dip to 80% of normal voltage during motor start-up and voltage interruption during short circuit as well as frequency variations due to large motor start up. UPS system shall be designed to operate satisfactorily.

UPS system shall also operate satisfactorily on input power supply having:

5.1.2 The ratio of negative to the positive sequence components not exceeding 5% and total harmonic distortion of not more than 5% or as per applicable standards of IEEE 519 or equivalent. Total Harmonic Distortion is the ratio in percentage of r.m.s. value of the harmonic content to the r.m.s. value of the fundamental component of alternating quantity.

5.1.3 The incoming power supply to UPS will be provided by 3 Nos. feeders as per configuration specified in the UPS data sheet. Two feeders shall feed the rectifiers while one feeder shall supply power to stabilized bypass supply.

The manufacturer shall specify the current rating of input feeder to UPS from client switchboard based on 150% overload at minimum battery voltage and including the UPS efficiency.

5.2 UPS Configuration and Operational requirements

The UPS system shall have the following basic configuration as specified in data sheet and drawings.

5.2.1 **Parallel Redundant UPS, with bypass, and 2 X 50% battery, independent battery bank– For all other load applications including critical ones**

In UPS system having these configuration two sets of rectifiers and inverters shall be provided with two independent sets of battery banks with 2 X 50%



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configuration. Under normal conditions, when AC mains power is available, both the rectifiers shall operate in parallel and supply DC power for float/ rapid charging the battery to its rate capacity within 10 hours and simultaneously to inverters. In case of failure in one rectifier, the other rectifier shall feed the complete load and the battery without any interruption.

In case of incoming supply failure or failure of both rectifiers the battery shall feed both the inverters without any interruption. Each rectifier shall be designed for simultaneously feeding complete inverter load and float/rapid charging of the battery to its rated capacity. Each rectifier shall be equipped with 'On Line' automatic as well as manual charging facility. **Each rectifier shall have on load battery capacity test feature which can be initiated by front control/ display panel.**

Normally both inverters will be synchronized with each other and with stabilized bypass supply. Both inverters shall operate in parallel and share the load equally.

The load sharing controls shall not be subject to common mode failure and any failure of the load sharing controls shall not result in the loss of vital power.

When a disturbance/fault occurs in any one of the inverters, the faulty unit shall automatically get disconnected and the entire load shall be fed from the other inverter. In case both the inverters develop a fault, the complete load shall be transferred to stabilized bypass supply through the static switches and retransfer of load from stabilized bypass supply to the inverter shall be possible in auto as well as in manual mode.

- 5.2.2 The UPS shall have static switch feature in both inverter output and bypass circuit for each UPS module.

5.3 UPS Design and Performance Requirements

- 5.3.1 Incoming AC supply shall be converted to DC through three phase full wave fully controlled rectifiers.

The rectifiers shall operate according to the constant voltage current limiting principle and shall incorporate a "Soft Start" feature to gradually accept load on initial energizing.

- 5.3.2 The rectifier section of the UPS system shall be capable of precise regulation to prevent damage to the battery. The output voltage of rectifier's DC bus without the battery shall be stabilized to within $\pm 1\%$ of set value during load variation between 0 to 100% of the rectifiers and specified mains input supply voltage variation.



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- 5.3.3 Suitable protection shall be provided in the control circuits to guard against instability of phase controlled rectifiers due to electrical oscillations which may be present in the input supply as caused by emergency DG set.
- 5.3.4 The UPS system including the stabilized by-pass shall be galvanically isolated from input power supply system by providing double wound transformers. All transformers shall be natural air cooled, dry type suitable for location inside the panel with minimum insulation class -F. All rectifiers shall also have a double wound transformer at its input.
- 5.3.5 An RFI filter shall be provided. The production of radio frequency interference voltage shall not exceed the value of suppression grade N' as defined in VDE-0875. The performance of UPS system shall not get affected or in any way be degraded by the use of portable radio transmitter receiver in the vicinity of the UPS system and or UPS room.
- 5.3.6 Transient/surge protection circuit shall be provided in the input circuit to rectifiers to protect the UPS from surges & voltage spikes.
- 5.3.7 The UPS system shall be designed to draw power from mains supply at a minimum power factor of 0.85 while working at rated load in normal operating UPS configuration.
- 5.3.8 In all UPS configurations, the facility for uninterrupted manual transfer in either direction through static switches shall also be provided.
- 5.3.9 For ease of maintenance, it shall be possible to isolate inverters and static switches from load through manually operated make before break switches. In case of larger rating UPS, where it is not possible to provide one power switch with make before break feature, combination of breakers with the control scheme having make before break logic may be provided which ensures momentary paralleling before tripping of selected breaker
- 5.3.10 The UPS shall be provided with automatic sequence and power walk in circuit(s) with time delay of up to 15 sec. such that the rectifiers and inverters can start operating automatically when incoming AC power is restored allowing the UPS to be loaded automatically.
- 5.3.11 Facility for initial charging of batteries shall also be provided at a voltage level recommended by the battery manufacturer. The inverters may be disconnected during initial charging of the battery.
- 5.3.12 For battery capacity shall be provided as per its data sheet attached as Annexure-S-3/C-7/2. Total DC bus voltage to be specified by vendor as per its system design.

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5.3.13 It is to be noted that discharging cycle design of the batteries shall be such that after C10/C5 discharges, the end cell voltage shall not be less than 1.16 V.

5.3.14 rectifiers/chargers shall be designed to completely charge the Nickel cadmium batteries in a maximum time of 10 hours after complete discharge and at the same time meeting the inverter input requirements when the inverter is delivering its rated output at 0.8 p.f. Facilities shall be provided to initiate battery rapid charge operation by manual & automatic means. An auto charging sequence should be provided for the rapid and float charging based on current sensing. In addition to above, the charging shall be transferred from rapid to float mode after a preset time adjustable through 0-24 hour's timer as back up protection against overcharging.

5.3.15 The rectifiers shall be sized based on the maximum inverter input load when inverter is delivering its rated output at 0.8 rated p.f. and recharge the battery to nominal rated capacity of the battery. The DC load imposed by the inverters shall be considered under the most severe operating conditions where only one rectifier is operating but the UPS load is equally shared by all the inverters. The rating of each rectifier shall be not less than the value calculated as follows:

For Nickel- Cadmium Batteries= Inverter input current*+ 0.2Ah (5 hr. Rating of the battery)

$$\text{* where Inverter input current} = \frac{\text{Rated kVA capacity of UPS X Rated load power factor}}{\text{Battery charging voltage X Inverter efficiency}}$$

5.3.16 The DC rectifiers shall sense the battery charging current and adjust the DC bus voltage to maintain the charging current to preset level. A separate current limit circuit shall also be provided for adjustment of battery current. The rectifiers shall be protected against reverse battery connection at DC link voltage bus. Subsequent to a discharge cycle when battery is connected to rectifier, the battery current shall be monitored, controlled and limited to set value automatically irrespective of the inverter input current.

5.3.17 The battery may be taken out of service for maintenance, during which period it shall be possible for the inverter to continue operation by drawing power from the rectifier. Ripple content at the DC link shall not exceed 2% even with battery disconnected.

5.3.18 Battery/ DC link shall be provided with sensitive earth leakage detection.

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- 5.3.19 The inverter shall be of the current limiting type (short circuit proof) and have nominal output voltage and frequency as specified in the data sheet. The inverter output voltage and frequency shall not exceed the operational tolerances, as measured at the output terminals of the unit during the following conditions of UPS loading:

Load variations between 0-100% of the rated output of UPS Load power factor over the range of 0.7 lagging to unity.

Load current waveform having a relative harmonic content varying between zero and 50%, the latter waveform having a crest factor not exceeding 2.5 and individual harmonics not exceeding the following values:

3 rd harmonic	:	44% of fundamental
5 th harmonic	:	33% of fundamental
7 th harmonic	:	18% of fundamental
9 th harmonic	:	7% of fundamental
11 th harmonic	:	10% of fundamental

The Relative harmonic content is the ratio of the r.m.s. value of the harmonic content to the r.m.s. value of the total non-sinusoidal periodic waveform i.e. relative harmonic content = rms value of the fundamental component of current or voltage.

DC input voltages over the range corresponding to battery rapid charge and battery discharge operation during the specified discharge times.

The UPS output voltage waveform shall be sinusoidal with a relative harmonic content not exceeding 5% for both linear and non linear loads.

- 5.3.20 The inverter shall control the output voltage of the UPS such as to maintain synchronism with the mains bypass voltage during variations in mains frequency up to the limits specified.

During variations in mains frequency exceeding these limits, the inverter shall revert to internal frequency control.

- 5.3.21 It shall be possible to vary the inverter output voltage steplessly within $\pm 5\%$ of the specified output voltage. This adjustment shall be possible to be made when the inverter is in operation.

- 5.3.22 The steady state output voltage and frequency (free running) variation of inverters shall not exceed $\pm 1\%$ from the set value for specified input power supply conditions from no load to full load condition and load power factor variation from 0.7 lag to 1.0.



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- 5.3.23 The UPS system shall be able to operate satisfactorily on rated loads (in kVA) with power factors in the range of 0.7 lag to 1.0. The overall efficiency of the UPS system shall not be less than 80% at rated load and 0.8 pf.
- 5.3.24 The UPS shall have capacity to deliver a minimum overload of 125% for 10 minutes and 150% for 1 minute. UPS shall be provided with current limit circuit to avoid excessive loading beyond its permissible overload withstand capability.
- 5.3.25 The inverters shall be 'phase locked' to the stabilized bypass power supply as long as stabilized bypass supply frequency remain within $\pm 4\%$ of nominal. When bypass supply frequency variation exceeds the above limits, the inverters shall be de-linked from mains. Free running frequency tolerance limit shall not exceed $\pm 1\%$. Facility shall also be provided for adjustment of range of synchronising frequency.
- 5.3.26 Unless otherwise specified, the UPS system output voltage variation shall not exceed $\pm 10\%$ and complete recovery to normal steady state shall be within 0.1 Sec. The phase angle disturbance shall be less than $120^\circ \pm 3\%$ in case of 3 phase inverter. The above requirement shall be complied for following transient disturbances.
- 50% step load (for parallel redundant UPS)
 - Momentary interruption in power supply
 - Load transfer to stabilized bypass supply
 - Complete load transfer to other healthy inverter when one of the two parallel inverters develop a fault.
- 5.3.27 For 3 phase UPS system, the maximum output voltage and angle variation between the phases should not exceed 6% and 3 degrees respectively even under the condition of 100% unbalanced loading of the 3 phase output.
- 5.3.28 UPS system shall be suitable both for floating output or earthing of one leg.
- 5.3.29 The stabilized bypass supply shall be designed to regulate the output voltage within $\pm 2\%$ of the rated voltage over complete range of load from no load to full load and for specified input supply voltage variation. The type of Voltage stabilizer in stabilized bypass supply shall be as indicated in data sheet.
- 5.3.30 The stabilized bypass supply shall have a continuous current rating equivalent to the rated output of the UPS unit and be capable of conducting a current ten times the rated output for the duration more than the fault clearing time of the type of fuse provided. The load transfer devices shall comprise of continuously rated static elements in both inverter and stabilized bypass supply.



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5.3.31 Adequately rated static switches in required number & configuration shall be provided in the inverter(s) output and stabilized bypass supply to ensure positive isolation of faulty inverter section such that the other inverter and bypass circuits do not feed into the fault leading to under voltage/ trip. The short time rating of all the static switches shall be at least 10 times the rated output for the duration more than the fault clearing time of the type off use provided.

5.3.32 Facility shall be provided to manually and automatically initiate transfer of the load from inverters to the stabilized bypass supply and from stabilized bypass supply to the inverters. Under voltage and over voltage sensing levels to initiate transfer shall be adjustable. The maximum transfer time between inverters and bypass supply shall not exceed 4 millisecond and 20 millisecond in synchronous and asynchronous mode respectively. Manual transfer between inverter and bypass shall only be permitted when voltages & frequency are within limit.

5.3.33 The criteria for load transfer:

A. Load transfer from inverter to the stabilized bypass supply shall be as follows:

i. The load transfer shall only be possible when:

The stabilized bypass output voltage is within $\pm 5\%$ of rated UPS output voltage and

The mains bypass frequency is within $\pm 4\%$.

ii. Auto-transfer of the load from inverter to stabilized bypass supply shall be initiated when:

The inverter output voltage drops below 95% of nominal output voltage under steady state condition and/or if the inverter output voltage falls below 90% of the nominal value under transient conditions.

OR

The inverter output voltage exceeds 105% of the nominal output voltage under steady state condition and/or if the inverter output voltage reaches 110% of the nominal value under transient conditions.

OR

The inverter output current exceeds its tolerable limits.

B. Retransfer of load from stabilized bypass supply to the inverter shall be as follows:

i. The load transfer shall be possible when-

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The inverter output voltage is within $\pm 5\%$ of nominal output voltage for more than 5 sec. and inverter output and stabilized bypass supply are synchronized

Retransfer of load from stabilized by pass to the inverter shall be done manually as well as automatic (site selectable)

If automatic retransfer of load to the inverter is specified in the data sheet, then the retransfer of load to the inverter shall be inhibited following four automatic transfers of load to stabilized by pass within a period of 5 minutes.

C. The following transfer & retransfer operations shall be provided by static bypass switch (SBS)

- Uninterrupted transfer to standby power initiated by output overload, DC voltages out of limits, over temperature.
- Transfer to reserve power with 20 msec delay when the inverter & standby power source are not synchronized, in order to avoid damage to loads due to phase reversal.
- Uninterrupted manual transfer to standby power shall be initiated from control panel.
- All no break transfer & retransfer shall be inhibited when, voltage of inverter or standby power is out of limits, or frequency synchronisation is out of limits

5.3.34 Suitable rating MCCBs with monitoring features shall be provided in UPS input, bypass, battery and output circuit. Suitable fast acting semi-conductor fuses shall be provided for rectifier and inverter section.

5.3.35 All breakers shall be adequately rated for continuous rating as well as breaking capacity as applicable. Paralleling of breaker/ switch/ contactor poles to achieve the required current rating is not acceptable. All output isolating device shall be double pole type.

5.3.36 All electronic power devices including thyristors, transistors (IGBTs), diodes etc. shall be rated under operating conditions for approximately 200% of the maximum current carried by the device. All other electrical components such as transformers, reactors, breakers, contactors, switches, bus bars etc. shall be rated for at least 125% of the maximum required rating. No electronic device shall be subjected to PIV greater than 50% of its rated value.

5.3.37 All the thyristors, power transistors, diodes and other electronic devices of UPS shall be protected with high speed semiconductor fuses. Ft co-ordination between fuse and semi-conducting power devices shall be ensured.



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- 5.3.38 The outgoing circuits of ACDB shall be protected by semiconductor fuses. Each inverter shall be designed to clear a fault in any of the branch circuits up to a maximum rating of 25% of the system capacity without the assistance of the stabilized bypass supply. In case of any fault in branch circuits, the load connected to the healthy circuits shall not get affected. The fault clearing time shall be less than 4 msec.
- 5.3.39 All PCBs shall be provided with a transparent epoxy coating/ conformal coating for environmental protection and tropicalisation. They shall be suitably located away from heat sources.
- 5.3.40 All electronic control and monitoring printed circuit cards shall be installed in standardized electronic equipment frames and shall be fitted with suitable means for easy removal. The frames shall incorporate guides for PCB's to facilitate correct insertion of PCB's and shall allow access to the wiring side of the connectors. All PCBs shall be placed in a manner to avoid replacement of a PCB by a wrong spare PCB. Monitoring points shall be provided on each of the PCB's and the PCB shall be firmly clamped in position so that vibration or long usages do not result in loose contacts. Failure of each PCB shall be indicated by visual alarms. Visual fault diagnostics shall preferably identify faults up to various sections in the card.
- 5.3.41 Forced ventilation of panel, if provided, shall be supplemented by 100% redundant fan. In normal operation, normal & redundant fans shall run together. The power supply for the fans shall be tapped from the inverter output. However, the rating of the UPS as specified in the data sheet shall be the net output of UPS after deducting power consumption for fans etc. However in case of non-operation of 50% of running fans the UPS output shall not be affected. The fans shall be arranged to facilitate removal of faulty fan for maintenance without requiring system shutdown. All fans shall be equipped with monitoring facilities to provide an alarm in the event of fan failure.
- 5.3.42 Maximum noise level from UPS system at 1 metre distance, under rated load with all normal cooling fans shall not exceed 75 dBA
- 5.3.43 Online battery monitoring and testing

For all battery types the UPS shall also provide for on-line battery testing by means of a short duration battery discharge into the load, either manually or automatically. All UPS units shall be provided with online battery circuit monitoring facilities which maintain a continuous assessment of the overall condition of the battery string under normal operating conditions and provide an alarm when this falls outside prescribed limits. The monitoring system shall compare the discharge values with the actual pre-programmed battery discharge characteristics and shall be capable of providing a detailed analysis of the battery condition. Additionally,

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provision shall be included to manually select a full battery discharge test by manually disabling the rectifier output.

If specified by the Principal, for UPS units with large batteries in critical service, the battery monitoring facilities shall also incorporate provision for individual cell measurement, recording and alarm.

- 5.3.44 UPS shall have a facility to hook up with any third party system for data acquisition. The available protocol shall be Modbus RTU/ Webpage (HTTP)/ Modbus/TCP/ IEC 61850 or any other open protocol.

5.4 Construction

- 5.4.1 Rectifier/ charger and inverter, stabilized bypass supply and static switch sections shall be suitably housed in sheet steel panels complete with all interconnections.

UPS panels shall be fabricated from structural/CRCA sheet steel. 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.

The panels shall be free standing, fitted with suitable louvers for ventilation and cooling fans as required. Hinged doors shall be provided at the front and back with dust tight gaskets. Inter-panel sheet steel barriers shall be provided. The enclosure shall provide minimum IP-41 or better degree of protection. The maximum and minimum operating height of the switches shall be 1800 mm and 300 mm respectively.

- 5.4.2 Power cables shall be with aluminium/ copper conductors and control cables shall be with copper conductors. All the cable connections shall be from bottom and front of the panel. A removable bolted gland plate shall be provided along with single compression type nickel plated brass cable glands for external cable connections. Clamp type terminals shall be used for connection of all wires up to 10 mm². Bolted type terminals suitable for cable lugs shall be provided for wire size above this. Tinned copper lugs for all external connections shall be provided with the panels. Terminals shall be provided for all external connections. Interconnection cables for cubicles located side to side shall be supplied. All interconnecting cables, as required between UPS system and batteries shall be in the scope of vendor. The sizes of the cables shall be provided in event of order during detailed engineering stage.

- 5.4.3 Bus bars shall be used in all power circuits which are rated above 100 Amp. Copper conductors PVC insulated cables or wires of 660V grade shall be used for power circuits rated less than 100 Amp. Bus bars shall be colour coded and live



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parts shall be shrouded to ensure complete safety to personnel intending routine inspection by opening the panel doors. All the equipment inside the panel and on the doors shall have suitable name plate and device tag numbers as per the schematic diagram. All wires shall be ferruled and terminals shall be numbered.

- 5.4.4 MCCBs and load break power switches shall be mounted inside the panel. The control switches shall be rotary type, mounted on the door and shall be externally operable. A 7W LED lamp controlled through a door switch shall be provided for illumination in each panel. All instruments shall be analogue/ digital, switchboard type, back connected, 72x72 mm. square (Analogue type) of reputed make. Analogue instruments' scale shall have red mark indicating maximum permissible operating rating. Separate test terminals shall be provided for measuring and testing of the equipment to check the performance.
- 5.4.5 A suitably sized earth bus shall be provided at the bottom of the panels including ACDB (if asked in the datasheet) running through the panel's line up with provision for earth connection at both ends to purchaser's main earth grid. The minimum size of earth bus shall be 25 x 3 mm² copper (or equivalent aluminum). All potential free metallic parts of various equipments shall be earthed suitably to ensure safety.
- 5.4.6 All panels shall be of same height so as to form a panel line up which shall have good aesthetic appearance. ACDB (if asked in the datasheet) can be of different height.
- 5.4.7 Inside the panels, the controls connections shall be done with 660V grade PVC insulated wires having stranded copper conductors. 1.5 mm² size wires shall normally be used for circuits with control fuse rating of 10 Amp. or less. For control circuit having fuse of 16 Amps, 2.5 mm² size wires shall be used. Control wiring for electronic _circuits shall be through flat ribbon cable or through copper wire minimum of 0.5 mm dia.
- 5.4.8 All control wiring shall preferably be enclosed in plastic channels or otherwise neatly bunched together. Each wire shall be identified at both ends by PVC ferrules. Ferruling of wires shall be as per relevant IS.
- 5.4.9 All metal surfaces shall be thoroughly cleaned and de-greased to remove mill scale, rust, grease and dirt. 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 under-surface shall be made free from all imperfections before undertaking the finished coat.
- 5.4.10 After preparation of the under-surface, the panels shall be spray painted with two coats of epoxy- based final paint or shall be powder-coated. Spray painted

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finished panels shall be dried in staving ovens in a dust-free atmosphere. Panel finish shall be free from imperfections like pinholes, orange peels, runoff paint, etc.

5.5 Online Cell Booster

- 5.5.1 Cell booster shall be suitable for charging not only the new cells before being introduced to the battery bank but also any kind of online treatment to be given to the individual weak cells. Quantity of such boosters shall be one (1) per battery bank, making a total of two (2) in this context. Cell booster shall be suitable for 240 V $\pm$ 10%, 50 Hz $\pm$ 3% SPN input power supply. Cell booster output voltage shall be in the range of 0-18V and 0-12V for Lead Acid and Nickel Cadmium batteries respectively. Cell booster current rating shall be as under:

For Ni-Cd battery = 0.2 x Ah of cell (5 hr. Rating of the cell)

Cell booster shall have heavy duty switch fuse or MCCB on AC incomer and DC output, AC voltmeter, DC ammeter and voltmeter, indicating lamp for AC/ DC power ON. The output voltage and current of cell booster shall have manual control using a suitably rated variac or a full wave controlled rectifier bridge. Suitable interlock shall be provided so as to ensure that the variac/ controlled rectifier is at its minimum position while switching on the cell booster. Cell booster shall be portable type with wheels. Each cell booster shall be supplied with 5 m long flexible copper conductor, PVC insulated and braided cable for AC incomer power supply and DC output connection to the battery.

Cell booster shall be suitable to boost the cells online with the complete bank remains connected with the load and UPS. Necessary internal protection and control to be provided for online cell boosting.

5.6 A.C. Distribution Board

Sheet steel enclosed AC distribution board shall be provided. It shall accommodate AC feeders as per approved drawing and feeder list. The distribution board shall be floor mounted fixed type with fully compartmentalized construction unless. It shall be possible to operate the switches without opening the doors. Switches shall be provided with door interlock. Vertical cable alley of minimum 200mm width with suitable supports shall be provided for the termination of outgoing cables. Suitable supports shall be provided for supporting incoming and outgoing cables. All outgoing switches shall be air insulated load break type. Fuses on outgoing feeders shall be fast acting semiconductor type and cable entry shall be from bottom. The gland plate of the distribution board shall be non-magnetic type where single core cables are used. Cable glands shall be of brass and single compression type and cable lugs shall be of tinned copper.



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The design of the A.C distribution board shall be such that the rating of each feeder shall be at-least 125% of the full load rating. The full load rating requirements shall be finalized by the ~~ESR~~ contractor and submit to IOCL for approval during detailed engineering based on the assessment of the different critical loads.

5.7 Alarm, Control, Indication and Metering Requirements

The following schedule shall be followed for alarm, control, indication and annunciation. Any additional devices/ features considered necessary for reliable operation and maintenance shall also be included in various panels and same shall be highlighted separately. An illuminated one line diagram indicating operational status shall be provided on the front of the panel. Metering, indications, audio-visual alarm shall be provided. Parameters/ information indicated shall be available by menu driven LCD display or by other means directly or indirectly.

5.7.1 Metering

5.7.1.1 Rectifier

- Incoming line voltages (For all the three phases).
- Input line currents.(For all the three phases)
- DC voltage at each rectifier output.
- Battery current.

5.7.1.2 Inverters

- AC voltage at each inverter output (AC voltages for 3 phase inverter)
- AC current at each inverter output (AC currents for 3 phase inverter)
- Frequency meter at each inverter output

5.7.1.3 Stabilized bypass supply

- Frequency meter for incoming supply.
- Voltmeter with selector switch for incoming supply.
- Ammeter with selector switch for incoming supply.

5.7.1.4 ACDB

ACDB shall be of single bus configuration with two incomers and one bus-coupler scheme as per requirement. Following shall be provided for each of the ACDB incomers:

- Voltmeter

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- b. Ammeter
- c. Power factor meter
- d. Analog earth fault indicator

5.7.2 Indications

All indicating lamps shall be LED type. LEDs provided for indication shall be cluster type with adequate brightness and minimum 2Nos LEDs chips per light. LEDs shall be connected in parallel and each LED chip having diameter not less than 3mm. LEDs shall be provided for following:

- a. AC mains 'ON' – Rectifier
- b. AC mains 'ON'- Bypass.

5.7.2.1 Rectifiers (for each rectifier)

- a. Rectifier output 'ON'
- b. Battery on float charge
- c. Battery on rapid charge

5.7.2.2 Inverters (for each inverter)

- a. DC input 'ON'
- b. Load on inverter.
- c. Inverter synchronised with mains.

5.7.2.3 Load on bypass.

5.7.3 Audio-Visual Alarm (separately for each circuit)

5.7.3.1

- a. Mains failure
- b. Battery charger failure
- c. Battery fault
- d. Inverter temperature high
- e. Low voltage from inverter
- f. Load on bypass
- g. Inverter overloaded
- h. All power Fuse failures
- i. DC earth fault

5.7.3.2 2 nos. changeover contacts shall be wired to the terminal strip, 1 no. for common remote alarm of 'UPS fault' in owner's panel and 1 no. for 'load on bypass supply' annunciation.



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5.7.4 Controls

- a. All the switches for starting, shut down and testing sequence.
- b. Primary input circuit breakers for feeding chargers, bypass line and de bus from battery including backup protection.
- c. Inverter ON/OFF switch (to initiate inverter operation)
- d. Static switch transfer test Push Button.

5.8 Reliability

All necessary care shall be taken in selection, design, manufacture, testing and commissioning of the equipment for ensuring high system reliability. Following design consideration shall be taken into account to ensure maximum availability of the system.

- 5.8.1 There shall be no common device, between main and redundant units (e.g. master oscillators etc.) in order to ensure that the failure of the same does not cause shutdown of more than one unit.
- 5.8.2 Each UPS in parallel redundant configuration shall be provided with static switch in the output to avoid failure of the UPS in the event of fault in one of the UPS.
- 5.8.3 It shall be possible to take out any individual power circuit for maintenance without affecting the total UPS supply.
- 5.8.4 Series-parallel combination of smaller devices to achieve required rating shall not be acceptable.
- 5.8.5 Vendors shall offer their nearest higher standard size that will meet the requirement of the specified UPS rating.

5.9 Fault Diagnostic Unit

Each UPS set shall have microprocessor based 'ON line' fault diagnostic unit. This shall supervise the UPS operation continuously. It shall identify and locate faults immediately so that corrective action can be taken. Fault Diagnostic unit shall be compatible to hook up with owner's PC through RS232/RS485 interface. The software shall be provided on a CD ROM. One handheld/ desktop **HMI system** shall be provided with UPS system with all required connecting cables, converters, software. Fault diagnosis unit shall able to store historical data of analogue and digital signals in its permanent memory system.



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The fault diagnostic unit shall have provision for automatic print out facilities for time, input/output voltages, currents, frequency as a minimum under the following conditions.

- UPS power source changeover from mains to battery.
- UPS power source changeover from battery to mains.
- Changeover from inverter to stabilized bypass supply and vice versa.
- Changeover from one inverter to other inverter.
- Changeover time in case of inverter to stabilized bypass supply and from one inverter to other inverter.
- UPS failure.
- Type of failure incident along with diagnostic report.

Vendor shall provide required communication connections with owner's PC. If any additional equipment (e.g. bin connector, adaptor cards etc.) are required for connecting this unit with UPS system as well as with the owner's PC, the same are also to be included in the vendor's scope.

6.0 INSPECTION, TESTING AND ACCEPTANCE

6.1 During fabrication, the equipment shall be subjected to inspection by IOCL and by an agency authorised by the IOCL. Manufacturer shall furnish all necessary information concerning the supply to IOCL, Panipat Refinery or/& approved TPI. Tests shall be carried out at manufacturer's works under vendor's care and expense.

6.2 UPS system shall be tested in accordance with applicable standards. The following acceptance tests shall be performed on each UPS system as a minimum. All tests shall be witnessed by owner and/ or its authorised representative and 4 weeks prior notice shall be given before the date of commencement of tests. The tests certificates indicating test results shall be furnished.

Following system acceptance tests shall be conducted on each UPS system:

6.2.1 Insulation tests

Insulation tests shall be performed as per IEC 60146-1-1.

The insulation tests shall be carried out using an AC power frequency voltage or by using DC Voltage at the choice of the vendor. In the case of AC power frequency voltage test, the test voltage at the frequency available in the test facility or at the rated frequency, but not exceeding 100 Hz, of the full value

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starting at a maximum of 0.5 p.u. The unit on test shall withstand the specified voltage for 1 minute.

In case DC voltage is used for the test, the value of DC voltage shall be equal to the crest value of the test voltage specified in the table.

$V_p / \sqrt{2}$ (V_p is the highest crest voltage to be expected between any pair of terminals)	Test Voltage (AC rms value)
≤ 60 V	500 V
≤ 125 V	1000 V
≤ 250 V	1500 V
≤ 500 V	2000 V

6.2.2 Interconnection cable check

The interconnection cables are to be checked for correct wiring, insulation and quality of the termination.

6.2.3 AC input failure test

The test is performed with the test battery and carried out by tripping AC incoming circuit breakers or by switching off rectifiers and bypass supply at the same time. Output voltage and frequency variations are to be checked for specified limits.

6.2.4 AC input return test

The test is performed by closing AC incoming circuit breakers or is simulated by energizing rectifiers and bypass supply. Proper operation of rectifiers starting and voltage and frequency variations of output are to be checked.

6.2.5 Simulation of parallel redundant UPS fault

The test is applicable for UPS with parallel redundant configuration. Fault of rectifier or inverter are to be simulated and output transients are to be recorded.

6.2.6 Transfer test

Transients shall be measured during load transfer from inverter to bypass supply caused by simulated fault and load retransfer after clearing the fault.

6.2.7 Regulation test

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This test shall be carried out by measuring input voltage, input current, output voltage, output current, DC link voltage, output distortion, input active power, output active power and frequency at no load, 50% load and 100% load at 0.7 and 0.8 p.f.

Following parameters of rectifiers and inverters are to be measured:

Measurement shall be carried out in the rectifier float charge mode and in rapid charge mode. Measurement shall be at nominal a.c. voltage and at no load, 50% load and 100% of rectifier full load. Rectifier measurement shall comprise of:-

- Input voltage, frequency, phase current and input power.
- DC output voltage and current.
- Ripple current at the DC link bus shall be recorded after isolating the test battery.

Inverter measurement shall also be at no load, 50% load and 100% load of inverter rated output current and shall be repeated for inverter DC input voltages corresponding to battery float charge operation as well as rated inverter maximum and minimum input DC voltage. Measurement shall comprise of:

- Input voltage, input current.
- Output voltage, frequency and waveform distortion, output power and current.

6.2.8 UPS efficiency

This shall be determined by the measurement of the active power input and output at rated p.f. for 50%, 75% and 100% load.

6.2.9 Current division in parallel UPS

Load sharing between UPS units shall be measured with a dummy load under parallel redundant UPS configuration.

6.2.10 Light load test

The test is to verify that all functions of the UPS system operate properly. The load applied is limited to some percentage of rated load. The following points are to be checked.

- Output voltage and frequency and correct operation of meters.
- Operation of all control switches and other means to put UPS system into operation.



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c. Functioning of protective and warning devices

6.2.11 Burn-in test for Printed circuit boards

PCB's and other electronic components sub assemblies shall undergo a burn- in test for 96 hours at 50°C at a voltage varied between the maximum and minimum supply voltage. In case of failure of any component during testing, the tests shall be repeated after replacement of the faulty component. Supplier's test certificates are also acceptable for this test.

6.2.12 Continuous full load test at 0.8 power factor with temperature rise measurement

The test is required to be performed by connecting resistive load or resistive and inductive load to the UPS system output. The load shall be placed outside the test room to avoid influences of its heat upon UPS ventilation. Supplier's test certificates are also acceptable for this test.

UPS system in this test shall undergo a complete full load test for 32 hours at 0.8 power factor. Out of these 32 hours, each inverter section shall be subjected to full load test for 8 hours, both invertors sections operating in parallel shall be subjected to full load test for 8 hours and the for remaining 8 hours; the by pass section shall be subjected to full load test. Steady state temperature of rectifier transformer, rectifier set, D.C. choke, inverter set, static switch etc. shall be recorded during the test. The temperatures of all UPS panels are also to be recorded.

6.2.13 Auxiliary equipment and control circuit tests

The correct functioning of all measuring instruments, alarms, indications, protection devices and controls are to be verified. The functioning of auxiliary devices such as lighting, cooling fans, annunciation etc. should be checked.

6.2.14 Synchronization test

Frequency variation limits of inverter are to be tested by feeding bypass supply incoming line by variable frequency generator and inverter synchronization limit is to be checked as specified.

6.2.15 Unbalanced load test (For 3 phase UPS only)

Unbalance load at specified limits is applied to the UPS system. The specified voltage and phase angle variation may be checked for compliance with specified values.



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6.2.16 Output voltage unbalance (For 3 phase UPS only)

Output voltage unbalance shall be checked under symmetrical load conditions and unbalance load conditions. Phase to phase and phase to neutral output voltage are to be observed. The voltage unbalance is the ratio of highest phase voltage minus lowest phase voltage to the average value. Phase angle variation may be measured for phase to phase and phase to neutral voltages

6.2.17 Overload capability test

Specified values of short time overload are to be applied for specified time interval. Values of output voltage and output current are to be recorded.

6.2.18 Short circuit current capability test

Specified short circuit current capability is to be tested by application of a short circuit to UPS output if necessary via a suitable fuse. Short circuit current is to be recorded.

6.2.19 Short circuit fuse test

Fuse tripping capability of the UPS system is to be tested by short circuiting the UPS system output via a specified rating of fuse. The test is carried out at an appropriate UPS load under normal operation.

6.2.20 Restart

Manual restart to be tested after complete shutdown of UPS system.

6.2.21 Output over voltage

Operation of output over voltage protection is to be checked.

6.2.22 Dynamic Response test

Output recording at different loads and operating condition to be done.

6.2.22.1 Dynamic Load Test

Measurement of inverter output voltage variations, in the form of oscillograms, shall be recorded in response to:

- Instantaneous load changes of 100% rated output.



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Measurements shall be recorded when the load is switched to/ from the inverter via the static bypass switch and via the load circuit switch.

- Application of a short circuit to the inverter output via a type gG or gR fuse or MCB (size as stated on the data/ requisition sheet), with both the bypass isolated and the unit switching to bypass to clear the fault.
- Application of a 150% short time overload on the unit output.

6.2.23 Harmonic components

Harmonic components of output voltage are to be recorded at no load, 50% load and 100% load conditions. Harmonic voltages caused by UPS system components in the AC incomer side shall be recorded at site.

6.2.24 Earth fault test

An earth fault is to be applied to the output terminal of UPS system. UPS output transients are to be measured. An earth fault is also to be applied to the battery terminal and UPS system output transient shall be measured.

6.2.25 Audible noise test

The audible noise is required to be measured at 1 meter distance from UPS system in at least 4 to 5 locations and its value shall be within permissible limit.

- 6.3 The detailed test schedule and test procedure shall be formulated in line with above. Before giving call for the witness of the tests, vendor shall get EIL's approval or equivalent agencies approval (in case of foreign vendors) on the test procedures. Vendor shall also indicate the max. allowable tolerance for each test result, along with the test procedures.

If tests show that certain requirements of the specifications are not met, 'vendor' shall make necessary corrections to the equipment so that it satisfies all the requirements before acceptance is made.

7.0 SITE ACCEPTANCE TESTS

Vendor shall furnish Site Acceptance Tests procedure to be followed. Final acceptance testing along with the batteries shall be done at site. It shall be Vendor's responsibility to arrange necessary instruments and tools as required by their commissioning engineer for these tests.

8.0 PACKING AND DESPATCH

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All the equipment shall be divided in to several shipping sections for protection and ease of handling during transportation .The equipment shall be properly packed for transportation by ship/rail or trailer. The equipment shall be wrapped in polyethylene sheets before being placed in wooden crates /cases to prevent damage to the finish. Crates /cases shall have skid bottoms for handling. Special notations such as 'Fragile', 'This side up', '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 installation. The packing shall be suitable for outdoor storage in areas with heavy rains and high ambient temperature unless otherwise agreed.

9.0 DOCUMENTATION & DRAWING

9.1 Technical Documents to be submitted during detailed engineering:

- 9.1.1 Detailed Single Line Drawing of the UPS, ACDB offered.
- 9.1.2 Completely filled, duly signed and stamped copy of the technical specification and datasheet with compliance of each point.
- 9.1.3 Detail Technical literature and catalogue of offered products for verification of the technical specification requirements.
- 9.1.4 Technical Details and brochure of the offered battery bank.
- 9.1.5 UPS, ACDB, battery system Schematic Drawings, GA drawings shall be submitted for approval of owner.

9.3 Technical Documents offered along with supply of material:

- 9.2.1 The Manufacturer shall provide technical manual(s) and drawings in accordance with the purchase order requirements, which shall include at least the following documents (preferably on a CD-ROM):
 - Single line diagram of the unit;
 - General arrangement drawings;
 - Main and control circuit schematic diagrams;
 - Equipment lists;
 - Recommended spare parts lists;
 - Test reports and performance curves, including oscillograms.
 - Operating manuals which incorporate installation, commissioning, operating and maintenance instructions & fault-finding procedures

- 9.2.2 CD-ROMs shall incorporate all viewer software necessary to access the information provided.

10.0 INSTALLATION AND COMMISSIONING

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The successful installation and commissioning of the UPS is in ~~100%~~ ^{supervision of} contractor's scope. This includes the installation and commissioning by a qualified commissioning engineer. The clearances required for installation shall be provided by IOCL to work. All the cost for hiring OEM personnel during installation & commissioning of UPS, ACDB, & Battery bank is in the scope of bidder.

11.0 TRAINING

Vendor has to provide minimum of one (1) full day on-site training to IOCL engineers on operation and troubleshooting of the new UPS system.

Annexure-S-3/C-7/1

DATA SHEET I UPS SYSTEM

A Project Details					
1	Project name		3	Client	IOCL
2.	Location	Panipat Refinery	4	Unit	Above ground Facilities
B Site conditions					
1	Ambient temperature		3	Altitude	<1000m
	• Maximum	50°C	4	Atmospheric condition	Highly corrosive
	• Minimum	5°C	5	Location	Indoor-in air conditioned room
	• Design	50°C	6	Applicable Specification	IOC As per tender
2	Design temperature for battery sizing	10°C			
C Input power supply					
1	Voltage	415V $\pm$ 10%	3	Phase	• TPN
2	Frequency	50 Hz $\pm$ 5%	4	System fault level	50 kA
D System requirement					
1	Equipment tag no.	@	11	Type of battery	Ni-Cd
2	Type of inverter	Transistorized (IGBT)	12	Battery AH	As per project requirement
3	Rating	2X50 kVA (@0.8 P.F)		Description	kVA Backup time (mins.)
4	Phase	SPN		Instrumentation	60
5	Output voltage	* 110V $\pm$ 1%		Telecom	-
6	Output frequency	50 Hz $\pm$ 1%		PA system	-
7	Mode of operation	Parallel redundant		Lighting	-
8	Load power factor	@	13	Battery rack information	As per Annex-S-3/C-7/2
	• Rated	* 0.8 (lag)	14	Ingress protection of enclosure	IP 4X or better
	• Variation	* 0.7(lag)	15	Cable entry	From bottom
9	Fault diagnostic unit	Required	16	Colour shade	As per tender terms
10	Cell booster	Required			



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* (110V $\pm$ 1%), On, as suitable for the offered equipments.

E	Specific requirements	
	c. All interconnecting cables between all panels of UPS system are included in vendor's scope.	
	d. ECS Interface to be provided as per below	
	Normally open (NO) potential free contacts shall be wired upto terminal strip for connection by purchaser to ECS interface for the following conditions:	
	• Charger failure	• Battery discharged
	• Inverter failure	• Battery isolated

DATA SHEET II UPS SYSTEM (To be filled by Bidder and to be submitted along with bid)

A	UPS System			
1	Make		9	Noise level
2	Type designation		10	Guaranteed overall dimensions of UPS system except ACDB and battery
3	Rating	2 X 50 KVA at 0.8 p.f.		
4	Mode of operation			• Length mm
5	Output voltage distortion under the following conditions			• Depth mm
	• For 50% step load	V ± %		• Height mm
	• For 100% step load	V ± %	11	Efficiency of each rectifier and inverter module including input and output transformer
	• For 100% step unload	V ± %		• At 100% load %
	• Power supply interruption and restoration	V ± %		• At 75% load %
	• Load transferred to bypass line	V ± %		• At 50% load %
	• When one inverter gets fault and load transferred to healthy inverter	V ± %		• At no load %
6	Phase angle distortion under the following conditions, (for three phase inverter only)		12	Efficiency of bypass stabilizer including input transformer
	• For 50% step load	120° ± %		• At 100% load %
	• For 100% step load	120° ± %		• At 75% load %
	• For 100% step unload	120° ± %		• At 50% load %
	• Power supply interruption and restoration	120° ± %		• At no load %
	• Load transferred to bypass line	120° ± %	13	Heat loss for the total system kW
	• When one inverter gets faulty and load transferred to healthy inverter	120° ± %	14	Overall efficiency of UPS system (ratio of output load to input power drawn from mains when all charger and inverters are on and synchronized with bypass, operating at no load)
7	Maximum recovery time to reach steady state after above disturbances (clause nos. 5 & 6)	Milli sec.		• At 100% load %
				• At 75% load %
8	Redundancy of cooling system			• At 50% load %
B	Inverter			• At no load %



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1	Rating	kVA	10	Short circuit capacity & duration	
	No. of phase(s)		11	Output voltage/ phase angles (for 3 phase only)	
3	Steady state output voltage			• For 30% unbalance load	V/ deg
	• Nominal	V		• For 40% unbalance load	V/ deg
	• Variation	V		• For 50% unbalance load	V/ deg
4	Output voltage adjustment range at rated load			• For 100% unbalance load	V/ deg
5	Output DC voltage		12	Type of control circuit	
	• Nominal	V	13	Max allowable rating of outgoing feeders for fault clearance of feeder fault by UPS with mains bypass supply back up	
	• Range	V		• With fast acting semiconducting fuses	amps
6	Frequency variation limit for inverter when phase locked with mains			• With normal HRC fuses	Amps
7	Allowable unbalance between phases (for 3 phase only)		14	Max. allowable rating of outgoing feeders for fault clearance of feeder fault by UPS without mains bypass supply back up	
8	Harmonic distortion at inverter output at rated load			• With fast acting semiconducting fuses	Amps
	• For linear load			• With normal HRC fuses	Amps
	• For non linear load		15	• Load Crest factor	
9	Overload capacity & duration				
	• For 110% load	Min.			
	• For 125% load	Min.			
	• For 150% load	Sec.			
C	Static switches				
1	No of static switches in the UPS system including bypass also		3	Type of static switch	
2	Current rating at specified ambient		4	Transfer time	
	• Continuous	A		• Synchronized mode	Milli sec
	• Short time	A		• Unsynchronized mode	Milli sec
D	Battery charger				
1	Current rating	A	3	Output voltage range under	
2	Type of charger	IGBT based		• Float charging condition	V
				• Boost charging condition	V
4	Output voltage accuracy under specified input		6	Maximum harmonic content in input current	
5	Maximum ripple content on DC side with battery		7	• Input transformer rating	kVA
	• Connected			•	
	• Disconnected			•	
E	Manual transfer devices				
1	Make		3	Rating	
2	Type designation			• Continuous	
				• Short time	
F	Battery				
1	Make		11	Overall rack dimension	
2	Type designation			• Length	mm
3	Type	Ni-Cd		• Depth	mm
4	AH rating	2 X 220 AH		• Height	mm
5	End cell voltage	1.16	12	Battery charging requirements	
6	Nominal voltage	1.42 X 172 = 244 V		• Nominal voltage/ cell	V
7	Boost charging time	Hrs		• Float voltage/ cell	V
8	No of cells in each bank	172		• Boost charging voltage/ cell	V
9	No of battery banks	2	13	Container type	
10	No. of racks	As per project requirements	14	No of recommended air changes/ hour for battery room	M ³
F	Step-down bypass transformer with solid state voltage stabilizer				



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1	Make		5	Accuracy of stabilizer	%
2	Type designation		6	Type of control	
3	Rating	kVA	7	Type of cooling	
4	Voltage ratio	V	8	Type of stabilizer	



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**CHECKLIST OF SPECIFICATIONS FOR SUPPLY OF NICKEL-CADMIUM BATTERY BANK
(Ni-Cd Battery Bank)**

NOTE: All point should be answered. Any row left blank may result in rejection of the bid.

SL. NO.	Particulars		To be Completed by Bidders	
			Guaranteed Particulars	Deviations
1	Place where Equipment to be supplied	Panipat Refinery, Indian Oil Corporation Limited, Boholi, Panipat, Haryana-132140.		
2	GENERAL			
1		Supply, installation and Commissioning site of Ni-Cd KPH with 2 X 220 AH @ C5 Battery Bank complete with battery rack, commissioning spares and all accessories as per IOCL requirement mentioned below at Panipat Refinery site. (If this battery bank requirement is non standard for a bidder, they may quote a higher rated standard model that fulfills all given specification as per this sheet).		
2		The battery container shall be in Polypropylene translucent type container.		
3		The terminals shall be suitable for bolted connections to facilitate easy installation.		
4		Inter cell connectors shall be made from SS or Ni plated copper suitable for high current duties to bear load as per rated AH capacity. All nuts, bolts and washers shall be SS or Ni plated copper for protection against corrosion and sulphation.		
5		Marking and Packing: The batteries shall be embossed / marked with the following information : a) Manufacturer's name or Trade name b) Month & year of manufacture c) Nominal voltage d) Rated AH capacity e) Cell designation		
6		Battery should have life of around 20 Years.		
7		Discharge rate should be flat.		
3	BATTERY BANK TECHNICAL DETAILS			
1		AH Required : rated AH with high discharge capacity at 27 degree C (minimum)	2 X 220 AH	
2		Type: NI CAD		
3		No of cell in bank: As per system requirements (minimum)	172	
4		Design ambient: 10 DEGREE Celcius		
5		Volt/Cell: As per system requirements		
6		Float Voltage: As per system requirements		
7		Boost Voltage : As per system requirements		
8		Cell end voltage : As per system requirements		
9		Max Ripple Content: 0.5C peak to peak		
10		Container: As per system requirements		
11		IS : 10918		
12		Battery bank is to be supplied in dry uncharged condition. Capacity test (Charge/discharge cycle has to be performed at site).		
13		Transportation of new cell from IOCL store to site, erection, commissioning has to be carried out by the vendor.		
14		Removal/dismantling of old battery bank including transportation of old battery bank shall be carried out by the vendor.		

Prepared By

Checked By

Approved By

1

BATTERY BANK TECHNICAL DETAILS (Contd)				
3	1	Following Type test certificate to be provided for similar capacity battery: Charge Retention Test Life Cycle Test Low Temperature Test Storage Test		
	2	Factory inspection tests shall be done based on applicable routine and acceptance tests as per IS standards		
4	LIST OF ACCESSORIES TO BE SUPPLIED WITH EACH BATTERY BANK			
	1	10% battery accessories extra. (including VENT CAPS (BIG) (4 nos.) M10x20L SS HEX.BOLTS (4 nos.) or as required by the battery design, M10 BELLEVILLE WASHERS (30 nos) or as required by the battery design.)		
	2	Electrolyte (including 10% extra in Litres).		
	3	Anti Corrosion painted Mettalic Battery Rack for each battery bank.		
	4	Syringe type hydrometer(having graduation upto 0.005)-(2nos.)		
	5	Thermometer of range 0 - 60 deg c (having graduation upto 1 deg c) complete with the integral specific gravity correction chart (with wall mounted stand for hydrometer & thermometer) - (2nos.)		
	6	Cell testing voltmeter: 3-0-3 complete with leads (1 no.)		
	7	Rubber syringe (2 nos.)		
	8	Insulated spanner (2 nos.)		
	9	Acid resisting funnel (2 nos.)		
	10	Acid resisting jug /plastic filling bottle (2 nos.)		
	11	Petroleum jelly (2 kg)		
	12	Rubber gloves (2 pairs)		
	13	Rubber aprons (2 nos.)		
	14	Eye wash bottle (2 nos.)		
	15	Nylon brush with stout bristles (2 nos.)		
	16	GOGGLES (2 nos.)		
	17	User Manual		
5	VENDOR'S SCOPE OF WORK			
	1	Supply of new battery bank dry & discharged along with inter connecting link suitable to bear load as per rated AH capacity & standard accessories and installation of the new Ni-Cd Battery Bank. This includes erection of mettalic stand ,shifting of battery bank from IOCL store to worksite, putting the cells on the stand, fitting/fixing, termination of cables, conducting the tests, recording the data, commissioning, submission of Test reports etc. in all respect.		
	2	Supply of portable battery charger: Party to carry full charging/discharging/charging cycle including capacity test of battery bank at site. Since this is replacement of existing in service battery bank, IOCL CANNOT provide facility for battery charging. Supply of mobile portable battery charger of adequate capacity for the above purpose shall be in scope of vendor. Vendor to take note of this while submittig the quote.		
	3	The installation ,testing and commissioning of the battery banks shall be under the supervision of OEM. All kinds of co-ordination, liasoning including its cost shall be in the scope of LSTk contractor.		
	4	Filing the cells with electrolyte and conducting atleast one charge discharge test in front of IOCL officers at site comes under vendor's scope of work.		
	5	Responsibility of transport, lodging, food and medical requirements of the service personnel deployed for commissioning jobs shall be vendor's own. IOCL's responsibility shall be only till providing the service personnel with first aid medical help in case such situation arises.		

RTF CHECKLIST HT DISTRIBUTION SYSTEM (Primary & Secondary)

Note - Vendor to give point by point compliance and ensure design and selection of equipment in compliance with below checklist point.

S.No.	Actual Sub Station Switch Board No.	Reliability check point
1		Adequacy of switchgears regarding phase barriers / HT tapes / sleeves.
2		Proper structural support / clamps provided for HT cables.
3		Provision of DC control supply for each HT section.
4		Has adequate back up control supply scheme provided in each switchgear
5		Provision of dedicated control supply for the numerical relays.
6		Provision of control supply failure alarm at manned locations.
7		Review of DC system for fuse proper coordination.
8		Labeling of control fuse rating in the panels above the fuse base
9		Confirm failure of the DC control supply shall not trip any breaker / process equipment
10		Use of ICT in Bus/ cable differential protection not to be provided
11		Availability of differential protection in all the HT switchgears.
12		Adequacy of the differential CT's w.r.t. knee point voltage.
13		Confirmation regarding similarity of CT characteristics.
14		Use of Dedicated CT for differential protection
15		Prominent marking on differential CT's for differentiation with other CT's.
16		Confirm that each sectionalize generation bus is provided with ONLY differential scheme with cross over zones
17		Review of differential scheme that entire switchgear including breaker is covered.
18		To confirm that bus differential is having overlapping with other differential zones.
19		To confirm that Differential protection is based on proven current balance principle.
20		Provision of numerical relays for differential protection with spill current display or practice of periodic spill current measurement available.
21		Adequacy of the differential scheme w.r.t. stabilizing resistance.
22		Provision of dedicated control supply for the differential protection relays.
23		Inter-tripping of upstream incomer on actuation of differential relay of the downstream switchgear.
24		Provision of tripping of each (Incoming and out going) breaker of a particular switchgear section on differential protection.
25		Provision of cable differential protection in all HT radial feeders.
26		Zone crossover of cable differential protection with bus differential protection in upstream / downstream switchgear.
27		Checking of adequacy of knee point voltage of cable differential CT's in line with relay vendor recommendation.
28		Confirmation regarding similarity of CT characteristics at both ends.
29		Proper CT connection configuration at both ends as per relay vendor guidelines.
30		Provision of window type CT's in differential protection schemes
31		Proper dressing / clamping of control wire in the panels.
32		Provision of transformer differential protection in transformer having HV primary & secondary windings
33		Ensuring that instantaneous (High Set) Over current protection in HT breaker of transformer feeders is in line.

S.No.	Areal/ Sub Station Switch Board No.	Reliability check point
34		Inter-tripping of upstream breaker from the master relay contact of the downstream incomer breaker.
35		Availability of trip circuit supervision thru continuous monitoring in all HT switchgears
36		Are binary inputs to numerical relays for critical interlocks, for long cable lengths, are provided directly or through interposing relays
37		Ensuring direct tripping of breaker from field PB and TNC switch at panel without involving Numerical relay
38		The breaker service position contact should not be included in the tripping logic of breakers
39		The control fuse ratings of protection schemes like CDV / bus bar differential scheme/under voltage scheme etc. to be reviewed and correct rating of the fuse to be ensured as per design requirement.
40		The master trip relay shall be VAJHT type only.
41		The surge arrestors provided in the vacuum circuit breakers of Motor Feeders shall be rated for maximum continuous operating voltage. The maximum continuous operating voltage should be equal to the highest system voltage i.e. equal to the line to line voltage plus 10%.
42		The surge arrestor installation in some cases are before the CTs that is in the event of surge arrestor failures bus differential protection shall trip the entire bus section which is not desirable. In new projects, the installation of surge arrestors to be done after the CTs so that in the event of surge arrestor failure particular motor feeder shall trip only without affecting other feeders. In the existing system wherever such type of surge arrestor is provided, necessary modification after suitable engineering / OEM consultation to be carried out.
43		Proper installation of numerical relays in the HT panels to be ensured and all fastening screws to be in position to prevent the draw out portion of the relays coming out from its operating position during breaker operation / panel door operation.
44		Availability of IR(Infra Red) windows in all HT switchgears
45		Control schemes for incomer, bus coupler, feeder incorporating the critical reliability aspects have been prepared as a standard scheme / philosophy. The same shall be utilized while finalizing engineering drawings, new procurements etc.

RTF RECOMMENDATION UNDER VOLTAGE MANAGEMENT AND BUS TRANSFER SCHEMES (HT)

[Note:- Vendor to give point by point compliance and ensure design and selection of equipment in compliance with below checklist point.

S.No.	Areal/ Sub Station Switch Board No.	Reliability check point	Compliance
1		All incomer breakers up to the PCC level are having Under Voltage Tripping Scheme	
2		Upstream (primary side) feeders for Transformer & MCC incomers are not provided with UV tripping	
3		The under voltage tripping scheme provided for entire distribution system at various voltage levels is time graded	
4		Under Voltage tripping of the incomer breakers shall be direct and not through the master relay.	
5		The under voltage tripping is initiated from the line side PT of the incomer breaker and not from bus PT	
6		Inputs from all three phases are used for UV tripping	

S.No.	Areal/ Sub Station Switch Board No. →	Reliability check point
7		Blocking of under voltage tripping in case both the Incomers are experiencing UV.
8		Blocking of under voltage tripping scheme in case of PT fuse failure
9		In order to achieve faster restoration of the system after total power failure, under voltage tripping relay contact multiplication (if required) shall be provided through self reset relays.
10		All critical distribution sections are provided with Bus Coupler Changeover Scheme
11		Provision of check sync. Relay for Manual mode
12		Reliable control Supply to bus coupler changeover scheme.
13		Blocking of bus coupler thru Master relay contact of incomers
14		Time out of B/C change over scheme
15		Inter tripping provided for downstream breaker
17		Breaker contact used for inter tripping
18		UV relay setting for Unhealthy bus (Dead Bus) is 40 % or less.
19		UV relay setting for Healthy bus is 80 %
20		No time delay in provided in Auto C/O scheme
21		Confirm provision of separate UV relays for detecting Bus healthy and bus unhealthy condition
24		Confirm Cable Differential Protection is not blocking the bus coupler auto change over at downstream substation
27		Adequacy of interlocks in Momentary paralleling scheme
29		Provision of " Auto C/O Supervision scheme" for Bus couplers through soft logic.

RTF CHECKLIST - Uninterrupted Power Supply		
Note - Vendor to give point by point compliance and ensure design and selection of equipment in compliance with below checklist point.		
S.No.		
1	Provision of separate UPS system for group of associated process units.	
2	The incoming power supply sources shall not fall on the same primary Generation / distribution source at 11 kV level	
3	UPS systems are parallel redundant type	
4	In case single UPS is feeding to large no. of units, feasibility of installation of two battery banks may be explored — New projects	
5	Confirmation regarding healthiness of battery bank based on last discharging.	
6	Date of last discharging to be furnished.	
7	Is the schedule and history record of battery testing available	
8	Type of power supply module for input feeders to the UPS	
9	Fuse coordination to be reviewed from ACDB to downstream distribution level	
10	Provision of critical UPS alarms at the manned location / control room	
11	Internal cooling fans are healthy	
12	Adequate inventory of internal cooling fans available	
13	UPS systems are installed in dust free air conditioned atmosphere.	
14	The power supply to auxiliary equipments e.g. tube light, fans, space heater etc. shall be provided from the normal plant supply	

RTF CHECKLIST- DC SYSTEM

S.No.	Areal Sub Station Switch Board No.	Reliability check point
Note:- Vendor to give point by point compliance and ensure design and selection of equipment in compliance with below checklist point.		
S.No.		
1		Provision of separate DC Charger system for each HT substation
2		Battery chargers are redundant with paralleling or changeover facility
3		The incoming power supply sources shall not fall on the same primary Generation / distribution source at 11 kV level
4		Incoming power supply to chargers is from SFUs / MCB's and not from contactors
5		Provision in battery charger to come into service automatically after voltage dips or after plant restoration.
6		DCDB provided with dual section with a bus coupler switch.
7		Single battery charger is feeding to large no. of units.
8		Feasibility of installation of dual battery banks or separate chargers
9		Availability of redundant DC supply for Critical DC loads.
10		Availability of emergency interconnection between DC systems to facilitate battery maintenance.
11		If not available, Feasibility of emergency interconnection between DC systems to facilitate battery maintenance.
12		Provision of DC ground fault alarm for all DC systems (220 / 125 / 110 V etc)
13		Review of the DC distribution system upto downstream level for proper fuse coordination
14		Marking of fuse ratings above fuse base inside the panels.
15		Availability and display of DC systems diagram for the sub station
16		Redundant DC control supply to each HT bus is available
17		Provision of boost charging alarm at the manned location / control room
18		Provision of critical battery charger alarms at the manned location / control room
19		Provision of Alarm / MIS for ripple measurement in output supply of battery charger.
20		Confirmation regarding healthiness of battery bank based on last discharging.
21		Date of last discharging to be furnished.
22		Maintaining record of Auto / Manual boost charging of battery bank
23		Provision of Separate battery bank for emergency lighting and process units instrumentation supply.

GENERAL TECHNICAL SPECIFICATION
OF OFC CABLES

SCOPE

1. Design, manufacturing, testing at works, inspection, packing, transportation, ~~storage at site, loading, unloading, laying~~, supply of HDPE pipes, terminations, jointing of OFC cables as per project requirements including supply of all accessories like LIUs, patch cords, coupler, T-joints etc.
2. Independent application specific OFC loops shall be provided as mentioned in the respective chapters.
3. HDPE pie shall meet the following requirements:
 - a. HDPE Pipe Type (As per IS: 4984
 - b. Outer Diameter : 40mm or more
 - c. Thickness: 3.5 mm or more
 - d. - HDPE shall be in compliance of latest IS standards as applicable.

Above values indicated are minimum. The sizing of HDPE shall be designed as per project requirements and shall be responsibility of ~~LOPK~~ contractor without any extra financial implication.

4. All kinds of splicing, jointing end terminations and site testing of OFC shall be done by specialized agencies. The credential of the same shall be submitted to Engineer in-charge for approval prior to start of the job. All kinds of materials/accessories required for jointing, terminations, final connection upto end equipments shall be in the scope of ~~LOPK~~ contractor including its execution.
5. The below specification are for reference purpose only. The selection of OFC shall be done strictly as per the requirements of OEM/main equipments. The proper selection and design of OFC is the responsibility ~~LOPK~~ contractor without any extra financial implications.
6. Site testing of OFC cables any repair and corrections based on the test reports shall be the responsibility of ~~LOPK~~ contractor including arrangement of testing instruments and agency.

1. DESIGN & CONSTRUCTION

Sr.No.	Parameter	Unit	Specification
1	Cable		Single Mode Armoured Loose Tub corrugated steel tape Outdoor Cab
2	Number of fibres (minimum)		6 (nos. to be finalised based on project requirements.
3	Attenuation	dB/Km	≤ 0.34 at 1310 nm
			≤ 0.22 at 1550 nm
4	Cladding Diameter	μm	125.0 ± 0.7
5	Cladding Non-Circularity	%	$\leq 1.0\%$
6	Coated Fibre Diameter	μm	235 to 254
7	Mode Field Diameter	μm	9.2 ± 0.3 @ 1310 nm
			10.4 ± 0.5 @ 1550 nm