

(TECHNICAL SPECIFICATIONS (NUMERIC PROTECTION RELAY FOR FEEDERS))

		4. Any foreign Relay manufacturer through his Indian partner or subsidiary company in India shall provide application, testing, commissioning and other necessary support for minimum of 15 years to customer. They shall also maintain adequate inventory of each type of relay or spares to meet the requirement arising during project execution and plant operation. Relay manufacturer shall possess a signed MOU with their Indian partner/ subsidiary company for providing customer support and this shall be produced even if not specifically asked for.		
23	Relay Earthing	The relay shall work reliably with connection of switchgear earthing to the relay only.		
24	Interface with PC	It shall be possible to carry out and retrieve settings and configuration of the relay through Laptop PC. It shall also be possible to retrieve all fault disturbance records & oscillographic waveforms from the relay through Laptop PC. The software used for PC Interface shall be user-friendly and menu based and shall be supplied as a part of the relay. Five (05) nos. of communication cables with port converter sets, for communication of relay with Laptop PC, shall be supplied with this lot of relays.		
25	Testing and Acceptance	1. The Relay shall have been type tested as per relevant Indian/ international standards and witnessed by independent test authority/ agency of country of origin. Type tests shall include as minimum but not be limited to the following:		
		a. Temperature withstand		
		b. Disturbance immunity		
		c. Electromagnetic compatibility (EMC)		
		d. HV withstands test for insulation		
		e. Impulse voltage test		
		f. Functional tests and Communication integrity		
		g. Relay characteristics verification		
		h. Degree of protection		
		i. Mechanical stress/ vibration test		

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		2. During assembly, owner or his authorized representative shall be permitted to assess the progress of work as well as to ascertain that quality of raw material is used for the same. All assistance as required during inspection shall be given to inspector.		
		3. Final acceptance tests shall be carried out at manufacturer/ assembler's works under his care and expense. Manufacturer shall also arrange instruments and equipment as required for testing. Manufacturer shall furnish test certificates indicating test results along with supply of material. Acceptance tests shall include visual checks, insulation checks, heat run tests and functional tests as a minimum or as per the manufacturer's quality plan.		
		4. In case of fully assembled and tested relays from abroad, manufacturer shall furnish type, routine and acceptance test certificates along with the supply of numerical relays for owner's perusal.		
26	Other Requirements	1. The Vendor shall quote with complete technical literature, Operating Manual and Laptop interface software. Specific Model meeting the above requirements shall be mentioned.		
		2. The vendor shall provide minimum one year warranty period of the relay for free service / replacement.		
		3. The Vendor shall quote with point-wise confirmation of the above specifications and mention the deviation if any.		
		4. The Vendor shall give the details of after sale/service facilities available in India and approximate time for repair jobs.		
		5. The Vendor shall provide at least three (03) original complete O&M Manual as well as Application Guide of the offered Relay printed at the origin of manufacture of the relay and at least one (01) soft copy of the O&M Manual and Application Guide.		
		6. vendor has to furnish the technical data sheet of the relay offered and give their confirmation/deviation(if any) in same sequence as per the technical specification given in indent. The party should also supply detailed technical catalogue of the relay along with the offer.		

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~~TECHNICAL SPECIFICATIONS FOR ITEM NO~~

S. No.	Feature	Scheme Feature Description	Confirm	Deviation
			Yes / No	s, if any
1.1	Application	The proposed scheme shall be suitable for use as a single comprehensive scheme for achieving fast bus transfer Feature on High motor load buses also having load of Capacitor bank and synchronous motors -		
1.2		The Fast Bus Transfer System (FBTS) shall be provided complete with panels and necessary wiring in order to meet the intended specification. Scope of supply is inclusive of all devices/ relays, panel, internal wirings, all auxiliary contactors/ relays, terminal block etc required to develop the complete scheme. Only external feedback / supply/ output (digital and analogue) will be provided at respective TB in panel.		
1.3		FBTS scheme shall be suitable for ~~33 KV~~ ^{22.5} KV power distribution scheme, ~~having configuration as detailed in annexure 2.~~ It shall be suitable for 3 CB configuration (2 incomer and 1 bus coupler). In all 4 different PT inputs will be available for checking and monitoring of FBTS (2 Line PT and 2 Bus PT).		
1.4		FBTS scheme shall be developed suitable for following different operating contingencies – a- Tripping on any Incomer on under voltage (delayed trip of around 1-1.5 seconds) and bus coupler shall close in FBT mode b- Tripping of any incomer on inter trip logic (fast trip in approximate time of 100 mili seconds and bus coupler shall close in FBT mode.		
1.5		The Fast Bus Transfer System (FBTS) shall be microprocessor based which shall facilitate fast and safe transfer of supply from Incomer-1 to 2 and vice versa under Manual & Automatic modes. The FBTS shall have following features to provide Fast bus transfer A Fast Bus transfer B- In-phase transfer C Slow changeovers or residual voltage based transfer The priority of transfer attempts shall be in the above order and Scheme/		

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		device automatically select the mode of transfer in above priority depending upon network conditions.		
1.6		The fast transfer shall be break before make type where old source breaker trips before new sources breaker closes. The transfer shall be done on the basis of comparing the phase angle between the transfer bus and the new source to be within a settable limit (like 20 degrees), while the bus voltage should be at least with in settable limit like 80% of its nominal value (settable) The in-phase transfer shall be to safely transfer the bus when fast transfer is blocked. It shall be an open circuit transfer based on detecting that the old source breaker has tripped and at the next available slip cycle synchronization within an acceptable band of phase angle and voltage. Multiple attempt option shall be available in " in phase mode" till the parameters of both the modes are with in settable limits of voltage and frequency.		
1.7	Applications	When both the above transfers fail, slow transfer shall take place. The new breaker shall close after checking that the old source breaker has tripped and the Bus voltage has reached acceptable lower value for safe transfer typically in the range of 40%.		
1.8		In addition a momentary paralleling mode is to be provided for manual transfer by taking system in manual mode and following 2 modes of operation shall be available for manual bus transfer – 1- Paralleling of 2 incomers through bus coupler if both bus voltages are in synch. 2- Dead bus closing if any one incomer is Off and respective bus voltage is not available.		
1.9		The FBTS shall have facilities to continuously monitor the system conditions & healthiness through various binary and voltage inputs. Every transfer event shall be recorded with all associated binary signals and waveforms for the purpose of detailed analysis. The FBTS shall have self-diagnostic features which shall initiate alarms in case of any failure. Failure of the FBTS shall not result in operation of any		

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		of the associated breakers.		
1.10		Vendor shall conduct a pre bid site visit to ascertain exact system configurations and technical requirement		
2	Auxiliary Voltage	The offered FBTS system shall be suitable for working with auxiliary power supply for 110 VDC to 220 VDC (+ 20%)		
3	FBTS device Current Input	- The FBTS device shall have three phase CT input of both 1A and 5A (Selectable to either 1 or 5 A) - The FBTS device shall have minimum one earth fault CT input of both 1A and 5A (Selectable to either 1 or 5 A)		
4	FBTS PT input	The FBTS device shall have at least two three phase PT input and two 1/2/3 phase PT input for fast bus transfer condition checks / synchronization checks . The nominal PT input voltage is 110 V AC.		
5	FBTS device Binary Inputs	1. The FBTS device shall have minimum (16 nos) of freely configurable binary inputs 2. All Binary Inputs shall have galvanic isolation. Analog inputs shall be protected against switching surges, harmonics etc. 3. All Binary Inputs the same voltage level as that of the device auxiliary power supply. The Binary Inputs shall work only in the voltage range of the auxiliary power supply i.e., 110V DC $\pm$ 10% or 220 VDC $\pm$ 10% and shall not work in any other AC or DC Voltage range due to accidental occurrence of any voltage mixing, voltage superimposition or induced voltages in addition to the rated auxiliary supply mentioned above.		
6	FBTS device Binary Output	The FBTS device shall have atleast ten (10) freely configurable binary output relays for alarm and trip functions with at least four (04) fast speed relays of operating time less than 5 ms. The output relay contacts shall be rated for at least 5A continuously at 220 V AC/DC.		
7	FBTS device Programmin	1- The FBTS device shall have facility of programming the total control scheme in soft through logic blocks (Programmable soft logic) inside the		

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	g	device through communication software. The software should have necessary building blocks for the control scheme which can be used freely for implementation of desired scheme. Vendor shall develop the logics & drawing as per the IOCL requirement. 2- The FBTS device shall have Programmable scheme logic to customise the protection and control functions by programming the functionality of the optically isolated inputs, relay outputs and LED indications. The programmable scheme logic shall comprises gate logic and general purpose timers with the ability to invert the inputs and outputs, and provide feedback. 3- Facility of blocking functions using digital/binary inputs should be available.		
10	FBTS Diagnostic Features	The FBTS device shall have following diagnostic features:		
	a) Fault Records	Shall be able to record minimum 5 fault records containing the details such as the nature of fault, fault current & faulted phase with date and time stamping.		
	b) Event Records	Shall be able to record minimum 50 events with date and time stamping. Events shall be time-stamped at a resolution of a maximum of 3 milliseconds.		
	c) Disturbance Records	1. The FBTS device shall be capable of capturing fault waveforms for at least 2.5 seconds. The device disturbance record shall be provided with at least 4 channels consisting of minimum 2 analog and 2 digital inputs for disturbance recording. The date and time stamping shall be available for each disturbance fault record. 2. All disturbances/ events shall be displayed with time stamp. 3. The FBTS device should be capable of downloading the data to PC via serial link for further analysis. Fault recording Starting Signal can be either Instantaneous or time delayed tripping or activation of a logic input.		

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11	Memory	The FBTS device/ scheme shall be equipped for retention of data like parameter settings, programming, status, events and fault data information and shall not be lost on failure of auxiliary power supply.		
12	Front Display	The FBTS device shall have a backlit alphanumeric LCD display and shall be able to provide key information like settings, measurement, fault data and records. Side-lit LCD screens are not acceptable.		
13	LED Display	The Scheme /device shall be provided with LEDs for indicating at least the bus transfer status, synch- out of synch and Healthy indications. Additional minimum 4 nos of LEDs, to be provided, and shall be freely programmable separately at least for status of Digital Inputs & status of system.		
14	Watchdog & Self Monitoring	The scheme shall monitor the healthiness of its circuits and components by a continuous self-monitoring system. In case of any problem, alarm shall be generated without tripping the feeder. An output relay with changeover contact shall be provided for remote annunciation of the scheme fault. This alarm shall also be communicable through the RS-485 port to the connected SCADA system.		
15	Other Features of FBTS	1. All terminals shall not be plug-in type. The wires to the system shall be able to be connected with the help of screws. Terminals shall be suitable for termination of 2.5/4 sq. mm. wires. All necessary hardware required for connection of the wires to all the terminals shall be supplied along with as part of the scheme.		
		2. The relevant software & hardware for setting, data downloading and waveform analysis shall be supplied along with the scheme as a part of the scheme . The licensed copy of software supplied shall be licensed in the name of IOCL. All future upgrades from time to time shall be provided immediately to IOCL free of cost.		
		3. At least five (05) sets of necessary tool kits for installation, connection and commissioning of the system including standard communication cable at site shall be supplied along with this lot as part of the scheme .		
		4. It shall be possible to program or change the settings and configuration of the device on-line when the feeder is ON and in service without disturbing or tripping the feeder.		

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		5. The scheme shall be suitably housed in sheet steel panels and shall be fabricated with 2 mm thick cold rolled sheet steel. The panel shall be suitable for indoor installation, if not otherwise specified. The panel shall be free standing with degree of protection as IP-41. The maximum and minimum operating height shall be 1900 mm and 300 mm respectively. Panel shall be complete in all respect including all required internal control/ power wiring.		
		6. Bolted undrilled gland plate shall be provided at bottom with double compression type cable gland		
		7. All the control wiring shall be enclosed in plastic channel. Each wire shall be identified at both ends by self-sticking wire marker tapes or PVC ferrules. Power and control wiring inside the panel shall be done with BIS approved, PVC insulated, fire retardant, copper conductor wire. 1.5 mm ² size wire shall normally be used provided the control fuse rating is 10 Amps or less and 2.5 mm ² size for control fuse rating above 16 A		
		8. Panel shall be provided with illuminating lamp/11 W CFL with switch and fuse. 5/15A, 240V power socket with switch and fuse shall be provided. Each panel shall have space heater with switch fuse and variable setting thermostat		
		9. The setting and configuration of the device shall have the feature to directly set from the menu of each feature in alphanumeric format and not indirectly through a set of binary digits and summation codes. The setting and configuration shall be user-friendly.		
		10. The warnings, alarms, faults & trips in the device shall be displayed directly in alphanumeric format on the backlit LCD screen and not indirectly in the form of summation codes.		
16	Conformity to Standards	1. The equipment shall comply with the requirements of latest revision of following standards, unless otherwise specified.		
		• IEC 60068-2-1/2 Temperature range in service, during transport and storage		
		• IEC 60068-2-3 Damp heat recycle test		
		• IEC 60255 DC and AC power interruption and short circuit test		
		• IEC 60255 Class 3 General performance requirement		

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		• IEC 60255-5 Voltage withstand test, insulation resistance test, Dielectric impulse test, Impulse voltage withstand test		
		• IEC 60255-6 Measurement of accuracy, rated burden, thermal requirement		
		• IEC 60255-11 Auxiliary DC Power supply requirement		
		• IEC 60255-21-1/2/3 Mechanical performance requirement; vibration, shock, bump and Seismic test		
		• IEC 60255-22-1 High frequency disturbance test		
		• IEC 60255-22-2 Electrostatic discharge test		
		• IEC 60255-22-3 Radiated, radio frequency and electromagnetic field immunity test		
		• IEC 60255-22-4 Fast transient disturbance test		
		• IEC 60255-22-25 Conducted and radiated radio frequency emission tests		
		• IEC 60255-23 Contact performance requirement		
		• IEC 60529 Degree of protection by enclosure		
		• IEC 61000-4-5 Surge immunity test		
		• IEC 61000-4-6 Immunity to conducted disturbance induced by radio frequency field		
		• IEC 61000-4-8 Power frequency magnetic field immunity test		
		• IEC 61000-4-9 Pulse magnetic field immunity test		
		• IEC 61000-4-10 Damped oscillatory magnetic field immunity test		
		• IEC 61000-4-11 AC auxiliary supply requirement		
		• IEC 61000-4-16 Immunity to conducted, common mode disturbances		
		• ENV 50204 Radiated electromagnetic field disturbance test		
		• EN 55022 class A Radio interference test		
		2. In case of imported equipment, standards of the country of origin shall be applicable, if these standards are equivalent or stringent than the applicable Indian standards.		
		3. The equipment shall also conform to the provisions of Indian Electricity rules and other statutory regulations currently in force in the country.		
		4. In case Indian standards are not available for any equipment, standards issued by IEC/BS/VDE/IEEE/NEMA or equivalent agency shall be applicable.		

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		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		
		• This specification		
		• Codes and standards		
17	Operating Climatic conditions	The scheme shall be suitable for satisfactory operation when installed in a panel located in a pressurized substation with restricted natural air ventilation, in tropical humid and corrosive atmosphere. The scheme shall be suitable for operation at a maximum ambient temperature of 55 degrees Celsius and at a relative humidity of 75% continuous and 90% intermittent.		
19	General Requirement	1. The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.		
		2. Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment for at least 10 years from the date of supply.		
		3. After at least ten (10) years from the date of supply, Vendor shall give a notice of at least one (01) year to IOCL before phasing out the product/ spares to enable IOCL to take action for placement of order for spares and services.		
		4. Any foreign component manufacturer through his Indian partner or subsidiary company in India shall provide application, testing, commissioning and other necessary support for minimum of 10 years to customer. They shall also maintain adequate inventory of each type of spares to meet the requirement arising during project execution and plant operation.		
20	Earthing	The FBTS scheme shall work reliably with connection of switchgear earthing to the scheme only.		
21	Interface with PC	It shall be possible to carry out and retrieve settings and configuration of the scheme through Laptop PC. It shall also be possible to retrieve all fault disturbance records & oscillographic waveforms from the FBTS scheme through Laptop PC. The software used for PC Interface shall be user-friendly and menu based and shall be supplied as a part of the scheme. Five (05) nos. of communication cables with port converter sets, for communication with Laptop PC, shall be supplied with this lot		

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23	Other Requirements	1. The Vendor shall quote with complete technical literature. Specific Model meeting the above requirements shall be mentioned.		
		2. The vendor shall provide minimum one year warranty of the system/ scheme for free service / replacement .		
		3. The Vendor shall quote with point-wise confirmation of the above specifications and mention the deviation if any.		
		4. The Vendor shall give the details of after sale/service facilities available in India and approximate time for repair jobs.		
		5. The Vendor shall provide at least three (03) original complete O&M Manual as well as Application Guide of the offered scheme including all components, and at least one (01) soft copy of the O&M Manual and Application Guide.		
		6. The FBTS scheme shall have programmable control, Protection & fast bus transfer Scheme based on Digital Inputs and using logic gates of the device. In the event of an order, the complete control scheme & panel drawing shall be furnished to the VENDOR by IOCL. Vendor shall develop the logics & drawing as per the IOCL requirement.		
		7. vendor has to furnish the technical data sheet of the FBTS offered and give their confirmation/deviation(if any) in same sequence as per the technical specification given in indent. The party should also supply detailed technical catalogue of the device and / scheme along with the offer.		
		8. Vendor has to quote separately for the retrofitting charges and price evaluation will done on the basis of cumulative material price and retrofitting charges for the FBTS (N/A)		

Note: Vendor shall provide point-wise confirmation to all the points given above in the Specification for FBTS scheme, failing which the offer will not be evaluated and is liable to be rejected.

TECHNICAL SPECIFICATIONS FOR NUMERICAL FEEDER DIFFERENTIAL PROTECTION RELAY

1. The offered relays shall be suitable for communication between relays at both end of the feeder through single mode fibre cable with a distance of upto 6.0 KM.

2. PROTECTION FEATURES

a. FEEDER DIFFERENTIAL PROTECTION (87L)

Phase segregated biased differential protection

Setting range (recommended): 0.2 In (Minimum)

The feeder differential must be low impedance biased differential protection with different stages of the slope selection. Following minimum features shall be offered in the specification:

- a) CT ratio correction feature to be provided
- b) CT polarity correction feature to be offered.
- c) Multi-stage slope selection feature to be provided.
- d) Provision of high set stage for differential protection.

The protection shall not operate during communication failure/ relay Aux supply failure between the relays at two ends, due to any reason.

b. BACK UP OVERCURRENT PROTECTION (50N/51N)

Two stage over-current protection with Definite time and IDMT selection. IDMT curves shall be as per IEC standard.

IDMT curve: IEC Short time inverse, Standard Inverse, Very Inverse, Extremely Inverse, Long Time inverse

c. BACK UP EARTH FAULT PROTECTION (50N/51N)

Two stage earth fault protection with Definite time and IDMT selection. IDMT curves shall be as per IEC standard.

IDMT curve: IEC Short time inverse, Standard Inverse, Very Inverse, Extremely Inverse, Long Time inverse

3. RELAY RATINGS:-

a) ANALOG INPUTS : Relay shall have 3 phase current input, 1 earth CT input

AC phase current input: both 1A and 5A with burden < 0.5 VA & same shall be site selectable.

AC earth current input: both 1A and 5A with burden < 0.5 VA & same shall be site selectable

b) CT RATIO: Primary Programmable from 5 Amp to 9999 Amp.

CT ratio correction in cases where different CT ratio are used at the two ends of the feeder shall be possible in the relay settings.

c) FREQUENCY: Nominal frequency 50 Hz, Operating range 47.5 to 52.5 Hz

d) LOGIC PROGRAMMABLE INPUTS: Minimum 8 or more, Optically isolated inputs with the burden of less than 10 mA and response time of less than 5 mS. The interrogation supply for the Digital Inputs shall be 154-264 V DC either same as the Relay auxiliary voltage or shall be internally self generated by the relay.

e) LOGIC PROGRAMMABLE OUTPUTS: 8 or more programmable outputs with relays of rating as below

Continuous current rating : 5 Amp DC.

Make and carry - 30A for minimum 0.5 sec

Break - 40W DC (Resistive) & 25W (Inductive with L/R<50ms)

f) SELF DIAGNOSTIC: The relay should have self-diagnostics features. Failure of internal hardware / software should be indicated on the front panel and on the dedicated output relay in the form on volt free contact.

g) AUXILIARY SUPPLY: 220 V +/-10% DC

h) DATA BACK UP: The Relay shall be equipped for retention of settings programming, status, events with date and time, Fault and disturbance records in event of auxiliary supply failure.

i) Relay terminals : The Relay terminals shall not be plug-in type. The wires to the relay shall be able to be connected with the help of screws. Relay terminals shall be suitable for termination of 2.5/4 sq. mm. wires. All necessary hardware required for connection of the wires to all the relay terminals shall be supplied along with each relay as part of the relay.

j) Binary Signal Transfer- there should be provision to share atleast six signal transfer from receiving end to sending end and vice versa over OFC.

k) The relay shall have facility of programming the total control scheme in soft through logic blocks (Programmable soft logic) inside the relay through communication software. The software should have necessary building blocks for the control scheme which can be used freely for implementation of desired scheme. Vendor shall develop the logics & drawing as per the IOCL requirement.

l) The relay shall have Programmable scheme logic to customise the protection and control functions by programming the functionality of the optically isolated inputs, relay outputs and LED indications. The programmable scheme logic shall comprises gate logic and general purpose timers with the ability to invert the inputs and outputs, and provide feedback.

4.ACCURACY:-

a) Protection

Current : +/- 3% of setting

Delay times: +/- 3%

b) Measurement :

Current : +/- 0.5% at In

5. EVENT AND FAULT RECORDING:-

a) Fault Recording: The relay should be capable of storing last 5 nos. fault in its internal memory.

i) Date and time of fault.

ii) Type of protection operated.

iii) Faulty Phase

iv) Magnitude of the quantity which lead to the fault.

v) Voltage and current magnitude for each Phase at the time of fault

c) Event Recording: Any change in the state of logic inputs, outputs or protection function should be recorded in the memory of relay with 1 msec time resolution. The relay shall store at least last 50 events. Each event should be displayed on the front panel display or shall be available on laptop after extraction from relay front port.

- d) Disturbance Recording: The relay should have triggerable disturbance recording feature for capturing at least 3 disturbances of upto 3 seconds and store it in its internal memory with the sampling rate of at least 20 samples per cycle. The relay should be capable of downloading the data to PC via front port for further analysis. Fault recording Starting Signal can be either Start/Trip of any protection function or activation of a Binary input or Output.

6. COMMUNICATION:-

- a) Relay shall have one front port for connecting it to PC or Laptop.
Five sets of cables for communication between relay and PC are to be supplied along with the relays. The cables must have relay compatible plug at one end for connection to the relay and USB Plug on other end for connection to PC/Laptop.
- b) ECS/SCADA based communication: The relays shall be integrated with the ECS/SCADA on IEC 61850 protocol. All relays must be provided with 2 Nos. of port for IEC 61850 communication.
- b) MS Windows based operating and analysis software for configuring, parameter setting, downloading events and fault records and measurement of online parameters on standard PC.

7. HMI:-

- a) DISPLAY : LCD back lit alphanumeric display for parameterisation and display of current data on the front panel of the relay. The local and remote end relay current and differential current shall be available on the relay display.
- b) LED : At least 6 no programmable LED indication on front panel .

8. ENVIRONMENT:-

- a) Relay operating temperature range: - 0 Deg C to +55 Deg C
- b) Relative Humidity: As per IEC 600-68-2-3, 56 days at 93% RH and 40 °C

9. MOUNTING:-

- a) Relay should be suitable for flush mounting on the panel.

10. STANDARDS:-

- a) Insulation test as per IEC 60255-5 or equivalent standard.
- b) EMC compliance as per EN-50082-2 standard.
- c) IEC- 61850 compliance for communication protocol

11. GENERAL:-

- a) The relevant software & hardware for relay setting, data downloading and waveform analysis shall be supplied along with the relay as a part of the relay. The licensed copy of software supplied shall be licensed in the name of IOCL. All future upgrades from time to time shall be provided immediately to IOCL free of cost.
- b) At least five (05) sets of necessary tool kits for installation, connection and commissioning of the relay including standard communication cable at site shall be supplied along with this lot as part of the relays
- c) Vendor has to furnish the technical data sheet and catalogue of the relay offered and give their confirmation/deviation(if any) in same sequence as per the technical specification given above.

**TECHNICAL SPECIFICATION FOR
SUBSTATION AUTOMATION SYSTEM
, LOAD MANAGEMENT SYSTEM, ECS MODIFICATION.**

PART A - TECHNICAL SPECIFICATION FOR

SUBSTATION AUTOMATION SYSTEM

1.0 GENERAL:

The Substation Automation System (SAS) shall be installed to control and monitor all the sub-station equipment from remote control centre (RCC) as well as from local control centre. The SAS shall contain the following main functional parts:

- i) Bay control Intelligence Electronic Devices (IED s) for control and monitoring.
- ii) Station Human Machine Interface (HMI) at Sub-station Operator room (2 Nos.), PR Control Room (2 nos.), PNC Control Room (Total 2 Nos.) and Engineering /Cabinet Room (1 No.)
- iii) Station LED television of not less than 60" (60 inch) at PR & PNC control room.
- iii) Redundant managed switched Ethernet Local Area Network communication infrastructure with hot standby.
- iv) Peripheral equipment like printers (minimum 3 nos. : 1 No. each in Engineering room, PR control and PNC control room), display units, key boards, Mouse etc.

1.1 It shall enable local station control via a PC by means of human machine interface (HMI) and control software package, which shall contain an extensive range of supervisory control and data acquisition (SCADA) functions.

1.2 It shall include communication gateways, intelligent electronic devices (IED) for bay control and inter IED communication infrastructure. Indicative architecture drawing for SAS is enclosed at Annexure-S-3/C-9/1.

1.3 The communication gateways shall facilitate the information flow with remote control centres. The bay level intelligent electronic devices (IED) for protection and control shall provide the direct connection to the switchgear without the need of interposing components and perform control, protection, and monitoring functions. All IEDs shall be compatible for communication IEC-61850 platform without any interfacing hardware. The ring main type of architecture is proposed for the sub-station automation system.

1.4 The extent of the coverage under the SCADA system shall be:

- a) Monitoring of all electrical parameters for feeders of 220KV switchboards.
- b) Monitoring healthiness of GIS system, 33 KV generation bus breakers of new system, battery chargers, UPS etc.
- c) Shift wise, day wise, month wise report generation as per user defined formats. Generation of energy reports on daily, weekly and monthly formats.
- d) Existing generator's MW, MVAR recording and generation summary reports preparation for complete system including PR and PNCP.
- e) Lighting control, PF control for new 220 KV GIS switchgear and switchyard area.
- f) An integrated system can also be provided with the feature of LMS and SCADA.

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g) Design, supply, installation, cabling of all required interface is also in the scope of ~~1872~~ contractor.

- i. Modem, switches, Gateway PCs, Ethernet cables, FO cables, media converters etc for communication interface.
- ii. Control cablings and Hardware IO interface units for digital IOs.
- iii. Transducers, CT/PT cabling and analog IO interfaces units for analog IOs.

All modifications including addition of hardwares at existing switchboard end is in the scope of ~~1872~~ contractor including its installation.

2.0 SYSTEM DESIGN:

2.1 GENERAL SYSTEM DESIGN:

The Substation Automation System (SAS) shall be suitable for operation and monitoring of the complete substation including future extensions as per project requirements.

The systems shall be of the state-of-the art suitable for operation under electrical environment present in extra high voltage substations, follow the latest engineering practice, and ensure long-term compatibility requirements and continuity of equipment supply and the safety of the operating staff.

The offered SAS shall support remote monitoring from Remote Control centres via gateways.

The system shall be designed such that personnel without any background knowledge in Microprocessor-based technology are able to operate the system. The operator interface shall be intuitive such that operating personnel shall be able to operate the system easily after having received some basic training.

The system shall incorporate the self- monitoring, signalling and testing facilities, measuring as well as memory functions, event recording and evaluation of disturbance records.

Maintenance, modification or extension of components may not cause a shutdown of the whole substation automation system. Self-monitoring of components, modules and communication shall be incorporated to increase the availability and the reliability of the equipment and minimize maintenance.

~~1872~~ contractor shall develop the system to optimise the cabling and field inputs requirements for all the related systems like LMS, SCADA, SCAP, ECS and load shedding system.

2.2 SYSTEM ARCHITECTURE:

The SAS shall be based on a decentralized architecture and on a concept of bay-oriented, distributed intelligence.

Functions shall be decentralized, object-oriented and located as close as possible to the process.

The main process information of the station shall be stored in distributed databases. The typical SAS architecture shall be structured in two levels, i.e. in a station and a bay level. At bay level, the IEDs shall provide all bay level functions regarding control, monitoring and protection, inputs for status indication and outputs for commands.

The IEDs should be directly connected to the switchgear without any need for interposition or transducer.

Each bay control IED shall be independent from each other and its functioning shall not be affected by any fault occurring in any of the other bay control units of the station.

The data exchange between the electronic devices on bay and station level shall take place via the communication infrastructure. This shall be realized using fibre-optic cables, thereby guaranteeing

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disturbance free communication. The fibre optic cables shall be run in G.I conduit pipes. Data exchange is to be realized using IEC 61850 protocol with a redundant managed switched Ethernet communication infrastructure.

The communication shall be made in 1+1 mode, excluding the links between individual bay IEDs to switch, such that failure of one set of fibre shall not affect the normal operation of the SAS. However it shall be alarmed in SAS. Each fibre optic cable shall have four (4) spare fibres.

It shall also be possible to control and monitor the bay from the bay level equipment at all times.

The GPS time synchronizing signal for the synchronization of the entire system shall be provided including hardwares ,softwares and connecting communication cables, its laying, installation and commissioning. The offered GPS system shall be complete in all respect for achieving the time synchronisation all for system like SAS, LMS, protection relays etc.

Hardware requirement of the server/operator station and engineering station shall be as:

- i. Industrial grade CPU
- ii. Dual power supply ports with 110V/230VAC selector switch
- iii. Controller – Intel Core-i7 2.8 GHz or higher
- iv. RAM - 32 GB
- v. Harddisk-1 TB SATA or higher
- vi. Gigabit Ethernet Network Ports - 2 nos.
- vii. USB Ports - 4 Nos.
- viii. Keyboard & Optical Mouse with Pad
- ix. Speakers for audible annunciation of alarms – 1 Set with each Work Station
- x. A4 Laser Printer, Scanner & Copier (Paper feed: Auto, Black 16 ppm or more & Colour 4ppm or more, Print Quality 600 x 600 dpi, Duplex Printing, Hi-speed USB & Ethernet port,).
- xi. Windows Server 2008/Windows 7 Professional or higher operating system
- xii. Microsoft Office 2010 Professional or higher
- xiii. Industrial grade ^{32"}~~30"~~ or higher LED Display Monitor
- xiv. Software for Power System Monitoring/SCADA as per Technical Specifications and project requirements
- xv. Engineering Software for SCADA system as per Technical Specifications and project requirements
- xvi. Engineering Software for RTU/Data Concentrator as per Technical Specifications and project requirements

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xvii. Software for upload/download settings, configuration & extraction of recorded data IEC-61850 relays.

xviii. Latest & full version of reputed Antivirus Software inclusive of lifetime License with updates

xix. Other required hardware/software for complete functioning of the system as per Technical Specifications and project requirements

xx. Supply, laying & installation of control cable / LAN/FO cable/ communication cable as per requirement.

2.3 FUNCTIONAL REQUIREMENTS:

The new project electrical systems shall be operated/monitored from different places:

- i) **Remote** control at two locations through SCAP.
- ii) Station HMIs (Only monitoring)
- iii) Local Bay controller IED (in the bays)

Operation shall be possible by only one operator at a time. The operation shall depend on the conditions of other functions, such as interlocking, synchro check, etc. (see description in "Bay level control functions").

2.3.1 SELECT-BEFORE-EXECUTE:

For security reasons the command is always to be given in two stages: selection of the object and command for operation under all mode of operation except emergency operation. Final execution shall take place only when selection and command are actuated.

2.3.2 COMMAND SUPERVISION:

BAY/STATION INTERLOCKING AND BLOCKING

Software interlocking is to be provided to ensure that inadvertent incorrect operation of switchgear causing damage and accidents in case of false operation does not take place.

In addition to software interlocking hardwired interlocking are to be provided for:

- a) Bus Earth switch Interlocking
- b) Transfer Bus interlocking (if applicable)

It shall be a simple layout, easy to test and simple to handle when upgrading the station with future bays for software interlocking the ~~2323~~ contractor shall describe the scenario while an IED of another bay is switched off or fails.

A software interlock override function shall be provided which can be enabled to bypass the interlocking function.

2.3.3 RUN TIME COMMAND CANCELLATION

Command execution timer (configurable) must be available for each control level connection. If the control action is not completed within a specified time, the command should get cancelled.

2.3.4 SELF-SUPERVISION

Continuous self-supervision function with self-diagnostic feature shall be included.

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2.3.5 USER CONFIGURATION

The monitoring, controlling and configuration of all input and output logical signals and binary inputs and relay outputs for all built-in functions and signals shall be possible both locally and remotely.

It shall also be possible to interconnect and derive input and output signals, logic functions, using built-In functions, complex voltage and currents, additional logics (AND-gates, OR gates and timers).

(Multi-activation of these additional functions should be possible). The Functional requirement shall be divided into following levels:

- a) Bay (a bay comprises of one circuit breaker and associated disconnector, earth switches and instrument transformer) Level Functions.
- b) System Level Functions.

2.3.6 TIME SYNCHRONISATION EQUIPMENT:

- i) The Time synchronisation equipment shall receive the co-coordinated Universal Time (UTC) transmitted through Geo Positioning Satellite System (GPS) and synchronizes equipments to the Indian Standard Time in a substation.
- ii) Time synchronisation equipment shall include antenna, all special cables and processing equipment etc.
- iii) It shall be compatible for synchronisation of Event Loggers, Disturbance recorders and SCADA at a substation through individual port or through Ethernet realized through optic fibre bus.
- iv) The synchronisation equipment shall have 2 micro second accuracy. Equipment shall give real time corresponding to IST (taking into consideration all factors like voltage & temperature variations, propagation & processing delays etc).
- v) Equipment shall meet the requirement of IEC 60255 for storage & operation.
- vi) The system shall be able to track the satellites to ensure no interruption of Synchronisation signal.
- vii) The output signal from each port shall be programmable at site for either one hour, half hour, minute or second pulse, as per requirement.
- viii) The equipment offered shall have six (6) output ports. Various combinations of output ports shall be selected by the customer, during detailed engineering, from the following:
 - Voltage signal : Normally 0-5V with 50milli Seconds minimum pulse duration. In case any other voltage signal required, it shall be decided during detailed engineering.
 - Potential free contact (Minimum pulse duration of 50milli Seconds.)
 - IRIG-B
 - RS232C
 - IEC 61850
- ix) The equipment shall have a periodic time correction facility of one second periodicity.
- x) Time synchronisation equipment shall be suitable to operate from 220V DC as available at sub station.
- xi) Equipment shall have real time digital display in hour, minute, second (24 hour mode) & have a separate time display unit to be mounted on the top of control panels having display size of approx. 100 mm height.
- xii) Time synchronisation shall update online time & date of all protection relays installed in 220 KV sub-station within 10 ms SCAN time.

3.1 BAY LEVEL FUNCTIONS:

In a decentralized architecture the functionality shall be as close to the process as possible. In this respect, the following functions can be allocated at bay level:

- a) Bay control functions including data collection functionality. b) Bay protection functions

Separate IEDs shall be provided for bay control function and bay protection function.

3.1.1 BAY CONTROL FUNCTIONS:

3.1.1.1 Over View:

Functions:

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- i) Control mode selection
- ii) Select-before-execute principle
- iii) Command supervision:
 - a) Interlocking and blocking b) Double command
- iv) Synchro check, voltage selection
- v) Run Time Command cancellation
- vi) Transformer tap changer control (for power transformer bays)
- vii) Operation counters for circuit breakers
- viii) Isolator Indication
- ix) Display of interlocking and blocking
- x) Breaker position indication per phase
- xi) Alarm annunciation
- xii) Measurement display
- xiii) Local HMI (local guided, emergency mode)
- xiv) Interface to the station HMI.
- xv) Data storage for at least 2000 events
- xvi) Extension possibilities with additional I/O's inside the unit or via fibre-optic communication and process bus.

3.1.1.2 CONTROL MODE SELECTION: BAY:

As soon as the operator receives the operation access at bay level the operation is normally performed via bay control IED. During normal operation bay control unit allows the safe operation of all switching devices via the bay control IED.

EMERGENCY OPERATION:

It shall be possible to close or open the selected Circuit Breaker with ON or OFF push buttons even during the outage of bay IED.

REMOTE MODE:

Control authority in this mode is given to a higher level (Remote Control Centre) and the installation can be controlled only remotely. Control operation from lower levels shall not be possible in this operating mode.

3.1.1.3 SYNCHRONISM AND ENERGIZING CHECK:

The synchronism and energizing check functions may be bay-oriented and distributed to the bay control and/or protection devices in addition to the interlocks available in the SCAP panels. These features are:

- a) Settable voltage, phase angle, and frequency difference.
- b) Energizing for dead line - live bus, live line - dead bus or dead line – dead bus with no synchrocheck function.
- c) Synchronizing between live line and live bus with synchrocheck function.

SYNCHRONISATION SCHEME:

3.1.1.3.1 Introduction

- a) Synchronisation of the two sources is required before paralleling them. Panipat refinery electrical system consists of various captive power generators and grid power supply. There is need of synchronisation of the incoming generators to the system voltage and frequency before switching the incoming generator breaker to the system. In case of paralleling the grid supply with the Panipat refinery system, there is need for synchronising the Panipat refinery system with the grid voltage and frequency.

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b) Synchronisation system shall be provided for assisting the operator with the synchronisation of the existing generation system with the grid supply.

c) Indicative list for which the synchronisation check facility is to be provided in the system for:

- 1) 220 KV Line-1 & Line-2 breaker
- 2) 220 KV Bus Coupler Breaker
- 3) 220 KV transformer feeders (7 Nos.)
- 4) 33 KV Transformer feeders (6 Nos.)

3.1.1.3.2 Modes of Synchronisation.

There shall be 3 modes of synchronisation:

- a) Auto mode (in SCAP)
- b) Manual mode (in SCAP)
- c) Dead Bus Mode (in SCAP)

The bay control unit shall also check the synchronisation conditions during breaker control operations of all the GIS breakers.

A) Auto Mode

When the auto synchronisation mode for the breaker is selected, Auto synchroniser shall take necessary action to bring the two systems into synchronism. The voltage raise/lower or speed raise/lower commands generated by the Autosynchroniser shall be extended to selected control generator(s) of PR & PNC to achieve synchronism automatically. When synchronising conditions are met, the Auto synchroniser releases the close command to the breaker through the check-synchronizing relay.

B) Manual Mode

In manual synchronising, the Autosynchroniser shall be in Manual mode. This means that the auto synchroniser shall only compare the voltage /frequency of systems to be synchronised and shall release close permissive once synchronism is reached. The necessary actions like giving voltage/speed raise/lower commands to the generator(s) of PR & PNC shall be performed by the operator from the MMI/keyboard with use of double voltmeter/double frequency meter and synchroscope. These parameters shall also be available on the OS display.

It should be noted here that in both, automatic and manual synchronising, the final close command to the breaker is released by the check synchronisation relay.

C) Dead Bus Mode

In this mode there is no need of the synchronisation as the bus to which breaker shall be closed is dead i.e. there is no voltage present. In such case, the operator shall select "Dead Bus mode" and after permission of the actual dead bus condition from SCAP only, the command from the operator shall be allowed.

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Necessary interlocks shall be provided for incorrect breaker or mode selection by the operator.

3.1.1.4 TRANSFORMER TAP CHANGER CONTROL:

Raise and lower operation of OLTC taps of transformer shall be facilitated through Bay controller IED.

3.1.2 BAY PROTECTION FUNCTIONS:

3.1.2.1 GENERAL:

The protection functions are independent of bay control function. The protection shall be provided by separate protection IEDs (numerical relays provided in the relay room) and other protection devices as per section Relay & Protection. IEDs, shall be connected to the communication infrastructure for data sharing and meet the real-time communication requirements for automatic functions. The data presentation and the configuration of the various IEDs shall be compatible with the overall system communication and data exchange requirements.

3.1.2.2 EVENT AND DISTURBANCE RECORDING FUNCTION:

Each IED should contain an event recorder capable of storing at least 200 time-tagged events. This shall give alarm if 70% memory is full.

3.2 SYSTEM LEVEL FUNCTIONS:

3.2.1 STATUS SUPERVISION:

The position of each switchgear, e.g. circuit breaker, isolator, earthing switch, transformer tap change etc., shall be supervised continuously. Every detected change of position shall be immediately displayed in the single-line diagram on the station HMI screen, recorded in the event list and a hard copy printout shall be produced. Alarms shall be initiated in the case of spontaneous position changes.

The switchgear positions shall be indicated by two auxiliary switches, normally closed (NC) and normally open (NO), which shall give ambivalent signals. An alarm shall be initiated if these position indications are inconsistent or if the time required for operating mechanism to change position exceeds a predefined limit.

The SAS shall also monitor the status of sub-station auxiliaries. The status and control of auxiliaries shall be done through separate one or more IED and all alarm and analogue values shall be monitored and recoded through this IED.

3.2.2 MEASUREMENTS:

Analogue inputs for voltage and current measurements shall be connected directly to the voltage transformers (VT) and the current transformers (CT) or through intermediate transducers. The values of active power (W), reactive power (VAR), frequency (Hz), and the rms values for voltage (U) and current (I) shall be calculated.

The measured values shall be displayed locally on the station HMI and in the control centre. The abnormal values must be discarded.

The analogue values shall be updated every

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2 seconds. Threshold limit values shall be selectable for alarm indications.

~~Suitable no. of Transducers shall be provided to facilitate the flow of 4-20mA Analogue signals as per Annexure S-3/C-9/2 from the bay level equipments (i.e. circuit breaker, AC Kiosks, Transformers, etc.) to its respective C&R Panel BCU and Station level equipments (i.e. ACDB, DCDB, Battery Chargers, L.T Transformer, Generator, etc.) to station auxiliary BCU, as per its respective approved drawings, for remote control & supervision at Station HMI's thereof by the OEM contractor.~~

3.2.3 EVENT AND ALARM HANDLING:

Events and alarms are generated either by the switchgear, by the control IEDs, or by the station level unit. They shall be recorded in an event list in the station HMI. Alarms shall be recorded in a separate alarm list and appear on the screen. All, or a freely selectable group of events and alarms shall also be printed out on an event printer.

The alarms and events shall be time-tagged with a time resolution of 1 ms.

3.2.4 STATION HMI:

3.2.4.1 REPORT GENERATIONS:

The system shall generate daily, weekly and monthly reports in user defined formats for user defined data. The system shall have a storage capacity to ensure availability of report data of atleast 6 months.

3.2.4.2 PRESENTATION AND DIALOGUES: GENERAL:

The operator station HMI shall be a redundant with hot standby and shall provide basic functions for supervision and control of the substation.

The HMI shall give the operator access to alarms and events displayed on the screen. Aside from these lists on the screen, there shall be a printout of alarms or events in an event log.

An acoustic alarm shall indicate abnormalities, and all unacknowledged alarms shall be accessible from any screen selected by the operator.

The following standard pictures shall be available from the HMI:

- a) Single-line diagram showing the switchgear status and measured values
- b) Control dialogues with interlocking and blocking details.

This control dialogue shall tell the operator whether the device operation is permitted or blocked.

- a) Measurement dialogues
- b) Alarm list, station / bay-oriented
- c) Event list, station / bay-oriented
- d) System status

3.2.4.3 HMI DESIGN PRINCIPLES:

Consistent design principles shall be adopted with the HMI concerning labels, colors, dialogues and fonts. Non-valid selections shall be dimmed out.

The object status shall be indicated using different status colors for:

- a) Selected object under command
- b) Selected on the screen
- c) Not updated, obsolete values, not in use or not sampled
- d) Alarm or faulty state
- e) Warning or blocked
- f) Update blocked or manually updated

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- g) Control blocked
- h) Normal state

3.2.4.4 PROCESS STATUS DISPLAYS PROCEDURES:

The process status of the substation in terms of actual values of currents, voltages, frequency, active and reactive powers as well as the positions of circuit breakers, isolators and transformer tap-changers shall be displayed in the station single-line diagram.

3.2.4.5 SYSTEM SUPERVISION & DISPLAY:

The SAS system shall be comprehensively self-monitored such that faults are immediately indicated to the operator, possibly before they develop into serious situations. Such faults are recorded as a faulty status in a system supervision display. This display shall cover the status of the entire substation including all switchgear, IEDs, communication infrastructure and remote communication links, and printers at the station level, etc.

3.2.4.6 EVENT LIST:

The event list shall contain events that are important for the control and monitoring of the substation.

The event and associated time (with 1 ms resolution) of its occurrence has to be displayed for each event.

The operator shall be able to call up the chronological event list on the monitor at any time for the whole substation or sections of it.

A printout of each display shall be possible on the hard copy printer.

The events shall be registered in a chronological event list in which the type of event and its time of occurrence are specified. It shall be possible to store all events in the computer for at least one month.

The information shall be obtainable also from a printed event log. The chronological event list shall

contain:

- a) Position changes of circuit breakers, isolators and earthing devices
- b) Indication of protective relay operations c) Fault signals from the switchgear
- d) Indication when analogue measured values exceed upper and lower limits. **Suitable provision shall be made in the system to define two level of alarm on either side of the value or which shall be user defined for each measurand.**
- i) Loss of communication.

Filters for selection of a certain type or group of events shall be available. The filters shall be designed to enable viewing of events grouped per:

- a) Date and time b) Bay
- c) Device
- d) Function e.g. trips, protection operations etc. e) Alarm class.

3.2.4.7 ALARM LIST:

Faults and errors occurring in the substation shall be listed in an alarm list and shall be immediately transmitted to the control centre.

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The alarm list shall substitute a conventional alarm tableau, and shall constitute an evaluation of all station alarms. It shall contain unacknowledged alarms and persisting faults. The date and time of occurrence shall be indicated.

The alarm list shall consist of a summary display of the present alarm situation.

Each alarm shall be reported on one line that contains:

- a) The date and time of the alarm
- b) The name of the alarming object c) A descriptive text
- d) The acknowledgement state.

Whenever an alarm condition occurs, the alarm condition must be shown on the alarm list and must be displayed in a flashing state along with an audible alarm. After acknowledgement of the alarm, it should appear in a steady (i.e. not flashing) state and the audible alarm shall stop. The alarm should disappear only if the alarm condition has physically cleared and the operator has reset the alarm with a reset command. The state of the alarms shall be shown in the alarm list (Unacknowledged and persistent Unacknowledged and cleared, Acknowledged and persistent).

Filters for selection of a certain type or group of alarms shall be available as for events.

3.2.5 USER-AUTHORITY LEVELS:

It shall be possible to restrict activation of the process pictures of each object (bays, apparatus...) within a certain user authorization group. Each user shall then be given access to the monitoring functions.

For maintenance and engineering purposes of the station HMI, the following authorization levels shall be available:

- (i) No engineering allowed
- (ii) Engineering/configuration allowed
- (iii) Entire system management allowed

The access rights shall be defined by passwords assigned during the log-in procedure. Only the system administrator shall be able to add/remove users and change access rights.

3.2.6 REPORTS:

The reports shall provide time-related follow-ups of measured and calculated values. The data displayed shall comprise:

A. Trend reports:

- Day (mean, peak)
- Month (mean, peak)
- Semi-annual (mean, peak)
- Year (mean, peak)

B. Historical reports of selected analogue Values:

- Day (at 15 minutes interval)
- Week
- Month
- Year

It shall be possible to select displayed values from the database in the process display on-line. Scrolling between e.g. days shall be possible. Unsure values shall be indicated. It shall be possible to select the time period for which the specific data are kept in the memory.

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Following printouts shall be available from the printer and shall be printed on demand:

- i. Daily voltage and frequency curves depicting time on X-axis and the appropriate parameters on the Y axis. The time duration of the curve is 24 hours.
- ii. Weekly trend curves for real and derived analogue values.
- iii. Printouts of the maximum and minimum values and frequency of occurrence and duration of maximum and minimum values for each analogue parameter for each circuit in 24 hr period.
- iv. Provision shall be made for logging information about breaker status like number of operation with date and time indications.
- v. Equipment operation details shift wise and during 24 hours.
- vi. Printout on adjustable time period as well as on demand for MW , MVAR Voltage on each feeder and transformer as well as Tap Positions, temperature and status of pumps and fans of transformers.
- vii. Printout on adjustable time period as well as on demand system frequency and average frequency
- viii. Reports in specified formats which shall be handed over to successful LSTK contractor.

3.2.7 Trend display (historical data)

It shall be possible to illustrate all types of process data as trends - input and output data, binary and analogue data. The trends shall be displayed in graphical form as column or curve diagrams with a maximum of 10 trends per screen. Adjustable time span and scaling ranges must be provided.

It shall be possible to change the type of value logging (direct, mean, sum, or difference) on-line in the window. It shall also be possible to change the update intervals on-line in the picture as well as the selection of threshold values for alarming purposes.

3.2.8 Automatic disturbance file transfer

All recorded data from the IEDs with integrated disturbance recorder as well as dedicated disturbance recording systems shall be automatically uploaded (event triggered or once per day) to a dedicated computer and be stored on the hard disc.

3.2.9 Disturbance analysis

The PC-based work station shall have necessary software to evaluate all the required information for proper fault analysis.

3.2.10. IED Parameter Setting

It shall be possible to access all protection and control IEDs for reading the parameters (settings) from the station HMI or from a dedicated monitoring computer. The setting of parameters or the activation of parameter sets shall only be allowed after entering a password.

3.3 Gateway

3.3.1 Communication Interface

The Substation Automation System shall have the capability to support simultaneous communications with multiple independent remote master stations.

The Substation Automation System shall have communication ports as follows:-

(a) Two ports for Remote Control Centre/ existing ECS system working on open protocols suitable for data transfer.

(b) Two ports for Regional System Coordination Centre (RSCC)

The communication interface to the SAS shall allow scanning and control of defined points within the

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substation automation system independently for each control centre. The substation automation system shall simultaneously respond to independent scans and commands from employer's control centres (RCC & RSCC). The substation automation system shall support the use of a different communication data exchange rate (bits per second), scanning cycle, and/or communication protocol to each remote control centre. Also, each control centre's data scan and control commands may be different for different data points within the substation automation system's database.

3.3.2 Remote Control Centre Communication Interface

The communication channels between the Substation Automation System and the remote control centre will preferably PLCC based if possible otherwise other communication modes as available in the existing refinery set-up may be as utilised, post review and approval during detailed engineering. The supply and installation of required interfacing hardwares shall be in the scope of ~~owner~~ contractor.

3.3.3 Interface Equipment:

The ~~owner~~ Contractor shall provide interface equipment for communicating between Substation Automation system and Remote control centre and between Substation Automation system and Regional System Coordination Centre (RSCC). However, the communication channels to be used as specified in 3.3.2.

In case of PLCC communication any modem supplied shall not require manual equalization and shall include self-test features such as manual mark/space keying, analogue loop-back, and digital loop-back.

The modems shall provide for convenient adjustment of output level and receive sensitivity.

The modem (for both ends) should be standalone type complete in all respects including power supply to interface the SAS with communication channel.

The configuration of tones and speed shall be programmable and maintained in non-volatile memory in the modem. All necessary hardware and software shall also be in the scope of ~~owner~~ contractor except the communication link along with communication equipment between substation control room and Remote Control Centre.

3.3.3 Communication Protocol

The communication protocol for gateways to control centre must be open protocol and shall support both the telecommunication protocols i.e. IEC 60870-5-101 (Serial) & IEC 60870-5-104 (TCP/IP) and IEC 61850 for all levels of communication for sub-station automation such as Bay to station HMI, gateways to remote stations etc.

4.0 System Hardware:

4.1 Redundant Station HMI, HMI View Node, Remote HMI and Disturbance Recorder Work station:

The contractor shall provide redundant station HMI in hot standby mode.

It shall be capable to perform all functions for entire substation including future requirements as indicated in the SLD. It shall use industrial grade components.

Processor and RAM shall be selected in such a manner that during normal operation not more than 30% capacity of processing and memory are used. Supplier shall demonstrate these features.

The capacity of hard disk shall be selected such that the following requirement should occupy less than 50% of disk space:

1. Storage of all analogue data (at 15 Minutes interval) and digital data including alarm, event and trend data for thirty (30) days,
2. Storage of all necessary software,
3. 20GB space for OWNER'S use.

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Supplier shall demonstrate that the capacity of hard disk is sufficient to meet the above requirement.

4.1.1 HMI (Human Machine Interface)

The HMI shall show overview diagrams (Single Line Diagrams) and complete details of the switchgear with a color display. All event and alarm annunciation shall be selectable in the form of lists. Operation shall be by a user friendly function keyboard and a cursor positioning device. The user interface shall be based on WINDOWS concepts with graphics & facility for panning, scrolling, zooming, decluttering etc.

4.1.2 Visual Display Units: LED based

The contractor shall provide ten (10) display units, two for operator station, two for remote station at PR, Two at remote station at PNCP, one for Engineering station, One for Historian server, two for DR server . These shall have high resolution and reflection protected picture screen. High stability of the picture geometry shall be ensured. The screen shall be at least 60" diagonally in size and capable of color graphic displays at two locations.

The display shall accommodate resolution of 1280 X 1024 pixels.

The HMI shall be able to switch the key board and cursor positioning device, as unit among all the monitors at a console via push button or other controls.

4.1.3 Mass Storage Unit

The mass storage unit shall be built-in to the Station HMI. All operational measured values and indications shall be stored in a mass-storage unit of CD-ROM / DVD- ROM/ hard disk with 700 MB or more capacity. The unit should support at least Read (48X), Write (24X), and Re-Write (10X) operations, with Multi-Session capability. It should support ISO9660, Rockridge and Joliet File systems. It should support formatting and use under the operating system provided for Station HMI. The monthly back up of data shall be taken on disc. The facility of back up of data shall be inherent in the software.

4.1.5 Switched Ethernet Communication Infrastructure:

The ~~220kV~~ contractor shall provide the redundant switched optical Ethernet communication infrastructure for SAS. The ~~220kV~~ contractor shall keep provision of 100% spare capacity for employer use. Adequate no. of switches to be provided as per project requirement including spare as mentioned.

4.2 Bay Level Unit

The bay unit shall use industrial grade components. The bay level unit, based on microprocessor technology, shall use numerical techniques for the calculation and evaluation of externally input analogue signals. They shall incorporate select-before- operate control principles as safety measures for operation via the HMI. They shall perform all bay related functions, such as control commands, bay interlocking, data acquisition, data storage, event recording and shall provide inputs for status indication and outputs for commands. They shall be directly connected to the switchgear. The bay unit shall acquire and process all data for the bay (Equipment status, fault indications, measured values, alarms etc.) and transmit these to the other devices in sub-station automation system. In addition, this shall receive the operation commands from station HMI and control centre. The bay unit shall have the capability to store all the data for at least 24 hours.

One no. Bay level unit shall be provided for supervision and control of each 220kV bay (a bay comprises of one circuit breaker and associated disconnecter, earth switches and instrument transformer). The Bay level unit shall be equipped with analogue and binary inputs/outputs for handling the control, status

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monitoring and analogue measurement functions. All bay level interlocks are to be incorporated in the Bay level unit so as to permit control from the Bay level unit/ local bay mimic panel with all bay interlocks in place, during maintenance and commissioning or in case of contingencies when the Station HMI is out of service.

The Bay level unit shall meet the requirements for withstanding electromagnetic interference according to relevant parts of IEC 61850. Failure of any single component within the equipment shall neither cause unwanted operation nor lead to a complete system breakdown.

4.2.1 Input/Output (I/O) modules

The I/O modules shall form a part of the bay level unit and shall provide coupling to the substation equipment. The I/O modules shall acquire all switchgear information (i.e. data coming directly from the switchgear or from switchgear interlocking devices) and transmit commands for operation of the switchgear. The measured values of voltage and current shall be from the secondaries of instrument transformers. The digital inputs shall be acquired by exception with 1 ms resolution. Contact bouncing in digital inputs shall not be assumed as change of state.

4.4 Extendibility in future

Offered substation automation system shall be suitable for extension in future for additional bays. During such requirement, all the drawings and configurations, alarm/event list etc. displayed shall be designed in such a manner that its extension shall be easily performed by the employer. During such event normal operation of the existing substation shall be unaffected and system shall not require a shutdown. The contractor shall provide all necessary software tools along with source codes to perform addition of

bays in future and complete integration with SAS by the user. These software tools shall be able to configure IED, add additional analogue variable, alarm list, event list, modify interlocking logics etc. for

additional bays/equipment which shall be added in future.

5.0 Software structure

The software package shall be structured according to the SAS architecture and strictly divided in various levels. Necessary firewall shall be provided at suitable points in software to protect the system. An extension of the station shall be possible with lowest possible efforts. Maintenance, modification ~~and~~ an extension of components of any feeder may not force a shut-down of the parts of the system which are not affected by the system adaptation.

5.1.1 Station level software

5.1.1.1 Human-machine interface (HMI)

The base HMI software package for the operator station shall include the main SAS functions and it shall be independent of project specific hardware version and operating system. It shall further include tools for picture editing, engineering and system configuration. The system shall be easy to use, to maintain and to adapt according to specific user requirements. Systems shall contain a library with standard functions and applications.

5.1.2 Bay level software

5.1.1.1 System software

The system software shall be structured in various levels. This software shall be placed in a non-volatile memory. The lowest level shall assure system performance and contain basic functions, which shall not be accessible by the application and maintenance engineer for modifications. The system shall support the generation of typical control macros and a process database for user specific data storage. In case of restoration of links after failure, the software along with hardware shall be capable of automatically synchronizing with the remaining system without any manual interface. This shall be demonstrated by contractor during integrated system test.

[Type text]

5.1.1.2 Application software

In order to ensure robust quality and reliable software functions, the main part of the application software shall consist of standard software modules built as functional block elements. The functional blocks shall be documented and thoroughly tested. They form part of a library. The application software within the control/protection devices shall be programmed in a functional block language.

5.1.1.3 Network Management System:

The ~~1806~~ contractor shall provide network management system software for following management functions:

- a. Configuration Management
- b. Fault Management
- c. Performance Monitoring

This system shall be used for management of communication devices and other IEDs in the system. This NMS can be loaded in DR work-station and shall be easy to use, user friendly and menu based. The NMS shall monitor all the devices in the SAS and report if there is any fault in the monitored devices. The NMS shall

- (a) Maintain performance, resource usage, and error statistics for all managed links and devices and present this information via displays, periodic reports and on demand reports.
- (b) Maintain a graphical display of SAS connectivity and device status. (c) Issue alarms when error conditions occurs
- (d) Provide facility to add and delete addresses and links

5.1.1.4 The contractor shall provide each software in two copies in CD to load into the system in case of any problem related with Hardware/Communication etc.

6.0 TESTS

The substation automation system offered by the ~~1806~~ contractor shall have compliance of following tests to establish compliance with IEC 61850 for EHV sub-station equipment.

Reports of the type tests of any NABL/ equivalent international labs to be provided during detailed engineering. Other acceptance and routine tests shall be executed through TPI at manufacturer's works.

6.1 Type Tests:

6.1.1 Convert IED & Communication Equipment:

- a. **Power Input:**
 - i. Power Input,
 - ii. Current Circuits,
 - ii. Voltage Circuits,
 - iii. iv. Indication Circuits
- b. **Accuracy Test:**
 - i. Operational Measured Values
 - ii. Currents, Voltages

c. Insulation tests:

- i. Dielectric Tests
- ii. Impulse Voltage withstand Test
- d. **Influencing Quantities**
 - i) Limit of operation

[Type text]

- ii) Permissible ripples
- iii) Interruption of input voltage.

e. Electromagnetic Compatibility Test:

- i. 1 MHZ. burst disturbance test
- ii. Electrostatic Discharge Test
- iii. Radiated Electromagnetic Field Disturbance Test
- iv. Electrical Fast transient Disturbance Test
- v. Conducted Disturbances Tests induced by Radio Frequency Field
- vi. Magnetic Field Test
- vii. Emission (Radio interference level) Test.
- viii. Conducted Interference Test

f. Function Tests:

- i. Indication
- ii. Commands
- iii. Measured value Acquisition iv. Display Indications

g. Environmental tests:

- i. Cold Temperature ii. Dry Heat iii. Wet heat
- iv. Humidity (Damp heat Cycle)
- v. Vibration vi. Bump vii. Shock

6.2 Factory Acceptance Tests:

The supplier shall submit a test specification for factory acceptance test (FAT) and commissioning tests of the station automation system for approval. For the individual bay level IED's applicable type test certificates shall be submitted.

The manufacturing phase of the SAS shall be concluded by the factory acceptance test (FAT). The purpose is to ensure that the Contractor has interpreted the specified requirements correctly and that the FAT includes checking to the degree required by the user.

The general philosophy shall be to deliver a system to site only after it has been thoroughly tested and its specified performance has been verified, as far as site conditions can be simulated in a test lab. If the FAT comprises only a certain portion of the system for practical reason, it has to be assured that this test configuration contains at least one unit of each and every type of equipment incorporated in the delivered system.

If the complete system consists of parts from various suppliers or some parts are already installed on site, the FAT shall be limited to sub-system tests. In such a case, the complete system test shall be performed on site together with the site acceptance test (SAT).

6.3 Integrated Testing;

The integrated system tests shall be performed as detailed in subsequent clauses as per following configuration:

- (i) Redundant Station HMI, DR work station, two switches (i.e. for two diameters) along with all IEDs for the Dia and printers.

All other switches for complete sub-station as detailed in section project shall be simulated as needed.

[Type text]

6.3.1 Hardware Integration Tests:

The hardware integration test shall be performed on the specified systems to be used for Factory tests when the hardware has been installed in the factory. The operation of each item shall be verified as an integral part of system. Applicable hardware diagnostics shall be used to verify that each hardware component is completely operational and assembled into a configuration capable of supporting software integration and factory testing of the system. The equipment expansion capability shall also be verified during the hardware integration tests.

6.3.2 Integrated System Tests:

Integrated system tests shall verify the stability of the hardware and the software. During the tests all functions shall run concurrently and all equipment shall operate a continuous 100 Hours period. The integrated system test shall ensure the SAS is free of improper Interactions between software and hardware while the system is operating as a whole.

6.4 Field Tests:

The field tests shall completely verify all the features of SAS hardware and software.

7.0 POWER SUPPLY

Power for the substation automation system shall be derived from substation 220V DC. Inverter of suitable capacity shall be provided for station HMI and its peripheral devices e.g. printer etc. In the event of Power failure, necessary safeguard software shall be built for proper shutdown and restart.

8.0 DOCUMENTATION

The following documents shall be submitted for employer's approval during detailed engineering:

- (a) System Architecture Drawing
- (b) Hardware Specification
- (c) Sizing Calculations of various components
- (d) Response Time Calculation
- (e) Functional Design Document

The following documentation to be provided for the system in the course of the project shall be consistent, CAD supported, and of similar look/feel. All CAD drawings to be provide in "dxf" format.

- List of Drawings
- Substation automation system architecture
- Block Diagram
- Guaranteed technical parameters, Functional Design Specification and Guaranteed availability and reliability
- Calculation for power supply dimensioning
- I/O Signal lists
- Schematic diagrams
- List of Apparatus
- List of Labels
- Logic Diagram (hardware & software)
- Panel Room Layout drawing
- Control Room Lay-out
- Test Specification for Factory Acceptance Test (FAT)
- Product Manuals
- Assembly Drawing

[Type text]

- Operator's Manual
- Complete documentation of implemented protocols between various elements
- Listing of software and loadable in CD ROM
- Other documents as may be required during detailed engineering.

Four sets of hard copy and Four sets of CD ROM containing all the as built documents/drawings shall be provided.

10.0 TRAINING, SUPPORT SERVICES, MAINTENANCE AND SPARES

10.1 Training

The training to be imparted to IOCL persons through OEM of the system at OEM works. The arrangement of the training programs shall be in the ~~IOCL~~ contractor's scope except the travelling, lodging, boarding of the candidates. The training program to be arranged for atleast 20 persons in 3-4 batches. The Contractor shall provide all necessary training material. Each trainee shall receive individual copies of all technical manuals and all other documents used for training. These materials shall be sent to Employer at least two months before the scheduled commencement of the particular training course. Class materials, including the documents sent before the training courses as well as class handouts, shall become the property of Employer. Employee reserves the right to copy such materials, but for in-house training and use only. Hands-on training shall utilize equipment identical to that being supplied to Employer.

The schedule, location, and detailed contents of each course will be finalized during detailed engineering by Engineer Incharge.

The tentative training program is detailed below. However the details shall be finalised before start of the training by Engineer Incharge.

10.2 Computer System Hardware Course

A computer system hardware course shall be offered, but at the system level only. The training course shall be designed to give Employer hardware personnel sufficient knowledge of the overall design and operation of the system so that they can correct obvious problems, configure the hardware, perform preventive maintenance, run diagnostic programs and communicate with contract maintenance personnel. The following subjects shall be covered:

- System Hardware Overview:** Configuration of the system hardware.
- Equipment Maintenance:** Basic theory of operation, maintenance procedures for each element of the computer system, e.g., processors, routers and printers. Configuration of all the hardware equipments.
- System Expansion:** Techniques and procedures to expand and add monitors, and communication channels.
- System Maintenance:** Theory of operation and maintenance of the redundant hardware configuration failover hardware, configuration control panels and failover switches.

10.3 Computer System Software Course:

- System Programming:** Including all applicable programming languages and all stand-alone service and utility packages provided with the system. An introduction parameters (OS software, [Type text])

Network software, database software etc.) on the performance of the system. integrating procedures; scheduling, management, service, and utility functions techniques and procedures.

- (b) **System Initialization and Failover:** Including design, theory of operation, and
- (c) **Diagnostics:** Including the execution of diagnostic procedures and the outputs.
- (d) **Software Documentation:** Orientation in the organization and use of system
- (e) **Hands-on Training:** One week, with allocated computer time for trainee exercises and with the course instructor available for assistance as necessary.

10.4 Application Software Course

The Contractor shall provide a comprehensive application software courses covering all applications

- (a) **Overview:** Block diagrams of the application software and data flows. program interface conventions.
- (b) **Application Functions:** Functional capabilities, design, and major maintenance and expansion techniques.
- (c) **Software Development:** Techniques and conventions to be used for the new software functions.
- (d) **Software Generation:** Generation of application software from source code and configuration control procedures. including the database and display building course. The training shall include
- (e) **Software Documentation:** Orientation in the organization and use of functional and detailed design documentation and of programmer and user manuals.
- (f) **Hands-on Training:** One week, with allocated computer time for trainee performance of unstructured exercises and with the course instructor available for assistance as necessary.
- (g) **Subsystem Maintenance:** Theory of design and operation, maintenance diagnostic procedures, and (where applicable) expansion techniques and include hands-on training for the specific subsystems that are part of similarly designed and configured subsystems. All interfaces to the computing in detail.
- (h) **Operational Training:** Practical training on preventive and corrective including use of special tools and instruments. This training shall be provided on similarly configured systems.

10.5 Requirement of training:

The contractor shall provide training for two batches for two weeks each for following courses.

S. No.	Name of Course
1	Computer System Hardware
2	Computer System Software
3	Application Software

11.0 Maintenance

11.1 Maintenance Responsibility during the Guaranteed Availability Period:

During Guaranteed Availability Period, the Contractor shall take continual actions to ensure the guaranteed availability and shall make available all the necessary resources such as specialist personnel, spare parts, tools, test devices etc. for replacement or repair of all defective parts and shall have prime responsibility for keeping the system operational.

11.2 RELIABILITY AND AVAILABILITY

[Type text]

The SAS shall be designed so that the failure of any single component, processor, or device shall not render the system unavailable. The SAS shall be designed to satisfy the very high demands for reliability and availability concerning:

- Mechanical and electrical design
- Security against electrical interference (EMI)
- High quality components and boards
- Modular, well -tested hardware
- Thoroughly developed and tested modular software
- Easy-to-understand programming language for application programming
- Detailed graphical documentation and application software
- Built-in supervision and diagnostic functions
- Security
 - Experience of security requirements
 - Process know-how
 - Select before execute at operation
 - Process status representation as double indications
- Distributed solution
- Independent units connected to the local area network
- Back-up functions
- Panel design appropriate to the harsh electrical environment and ambient conditions
- Panel grounding immune against transient ground potential rise

12.0 Basic Monitoring requirements minimum but not limited to:

- Switchgear status indication
- Measurements (U, I, P, Q, f, pf)
- Event
- Alarm
- Winding temperature of Transformers.
- Ambient temperature.
- Status and display of 415V LT system, 220V DC, ~~110V~~ UPS system.
- Acquisition of all counters in PLCC panels through potential free contacts from PLCC or independently by counting the receive/send commands.
- Acquisition of alarm and fault record from protection relays Disturbance.
- Monitoring the state of batteries by displaying DC voltage, charging current and load current etc.
- Tap-position of Transformer
- GIS gas pressure
- Transformer auxiliaries status i.e. humidifier etc.
- Spares

List of Inputs

The exact number and description of digital inputs shall be as per detailed engineering requirement. Apart from the above mentioned digital inputs, minimum of 500 inputs shall be kept as spare for use in future.

List of Inputs/outputs is attached as Annexure-S-3/C-9/2

[Type text]

However detailed input/output shall be decided at the time of detailed engineering.

~~The supply, Erection and commissioning of various Transducers required at 220KV, 33KV feeders and I.T system are in scope of LSTK contractor.~~

~~The detailed hard wired cabling, LAN, FO cabling, laying and termination is also in scope of LSTK contractor.~~

The connectivity of remote HMI at SIX KM distance at PNC shall be from Fibre Optical cable. The supply, ~~laying~~ and termination of optical fiber cable is in scope of ~~LSTK~~ contractor.

Annexure-S-3/C-9/2

S No.	Type of I/O	Signal Description	Remarks
A	220 kV Line Breaker		
1	DI	CB in service & Closed	Hardwired
2	DI	CB in service & Open	Hardwired
3	DO	Trip from ECS	Hardwired
4	AI	R phase current	These signals are required over numerical relaying metering LAN and Transducers output having redundant signal
5	AI	Y phase current	
6	AI	B phase current	
7	AI	3-phase real power	
8	AI	3-phase reactive power	
9	AI	R phase Voltage	
10	AI	Y phase Voltage	
11	AI	B phase Voltage	
12	AI	Power factor	
13	AI	Frequency	
14	AI	Oil temperature (4-20 mA)	From Transformer, Hardwired
15	AI	Winding temperature (4-20 mA)	From Transformer, Hardwired
17	DI	CB in service & Open	Hardwired
18	DI	Relay 86 operated	These signals are required over numerical relaying metering LAN and Transducers output having redundant signal
19	DI	Relay 95 operated	
20	DI	Transformer trouble	
21	DI	Trip on under voltage	
22	DI	Numerical relay Unhealthy	
23	DO	Trip from ECS	Hardwired
24	DO	Breaker inhibited from closing due to load shedding	Hardwired
25	DI	Status of each pole of CB, Isolator, Earth switch	Hardwired
26	DI	CB trouble	These signals are required over numerical relaying metering LAN.
27	DI	CB operation/closing lockout	
28	DI	Pole discrepancy optd	
29	DI	Trip coil faulty	
30	DI	LBB optd	
31	DI	Bus bar protn trip relay optd	
32	DI	Main bkr auto recloser operated	
33	DI	Tie/transfer auto recloser operated	

[Type text]

34	DI	A/r lockout	
35	DI	Tie/transfer bkr a/r lockout	
36	DI	Direct trip-I/II sent	
37	DI	Direct trip-I/II received	
38	DI	Main I/II blocking	
39	DI	Main I/II-Inter trip send	
40	DI	Main I/II-Inter trip received	
41	DI	O/V STAGE – I operated	
42	DI	O/V STAGE – II operated	
43	DI	FAULT LOCATOR FAULTY	
44	DI	MAIN-I/II CVT FUSE FAIL	
45	DI	MAIN-I PROTN TRIP	
46	DI	MAIN-II PROTN TRIP	
47	DI	MAIN-I PSB ALARM	
48	DI	MAIN-I SOTF TRIP	
49	DI	MAIN-I R-PH TRIP	
50	DI	MAIN-I Y-PH TRIP	
51	DI	MAIN-I B-PH TRIP	
52	DI	MAIN-I START	
53	DI	MAIN-I/II Carrier aided trip	
54	DI	MAIN-I/II fault in reverse direction	
55	DI	MAIN-I/II ZONE-2 TRIP	
56	DI	MAIN-I/II ZONE-3 TRIP	
57	DI	MAIN-I/II weak end infeed optd	
58	DI	MAIN-II PSB alarm	
59	DI	MAIN-II SOTF TRIP	
60	DI	MAIN-II R-PH TRIP	
61	DI	MAIN-II Y-PH TRIP	
62	DI	MAIN-II B-PH TRIP	
63	DI	MAIN-II start	
64	DI	MAIN-II aided trip	
65	DI	MAIN-I/II fault in reverse direction	
66	DI	Back-up o/c optd	
67	DI	Back-up e/f optd	
68	DI	220V DC-I/II source fail	
69	DI	SPEECH CHANNEL FAIL	
70	DI	PLCC Protection Channel-I FAIL	
71	DI	PLCC Protection Channel-II FAIL	
B 220 kV Transformer Breaker			
1	DI	CB in service & Closed	Hardwired
2	DI	CB in service & Open	Hardwired
3	DO	Trip from ECS	Hardwired
4	AI	R phase current	These signals are required over numerical relaying metering LAN and Transducers output having redundant signal
5	AI	Y phase current	
6	AI	B phase current	
7	AI	3-phase real power	
8	AI	3-phase reactive power	
9	AI	R phase Voltage	
10	AI	Y phase Voltage	
11	AI	B phase Voltage	
12	AI	Power factor	
13	AI	Frequency	
14	AI	Oil temperature (4-20 mA)	From Transformer, Hardwired
15	AI	Winding temperature (4-20 mA)	From Transformer, Hardwired
16	DI	CB in service & Closed	Hardwired

[Type text]

17	DI	CB in service & Open	Hardwired
18	DI	Relay 86 operated	These signals are required over numerical relaying metering LAN and Transducers output having redundant signal
19	DI	Relay 95 operated	
20	DI	Transformer trouble	
21	DI	Trip on under voltage	
22	DI	Numerical relay Unhealthy	
23	DO	Trip from ECS	Hardwired
24	DO	Breaker inhibited from closing due to load shedding	Hardwired
25	DI	Status of each pole of CB, Isolator, Earth switch	Hardwired
26	DI	CB trouble	These signals are required over numerical relaying metering LAN.
27	DI	CB operation/closing lockout	
28	DI	Pole discrepancy optd	
29	DI	Trip coil faulty	
30	DI	LBB optd	
31	DI	Bus bar protn trip relay optd	
32	DI	REF OPTD	
33	DI	DIF OPTD	
34	DI	OVERFLUX ALARM (MV)	
35	DI	OVERFLUX TRIP (MV)	
36	DI	OVERFLUX ALARM (HV)	
37	DI	OVERFLUX TRIP (HV)	
38	DI	HV BUS CVT ½ FUSE FAIL	
39	DI	MV BUS CVT ½ FUSE FAIL	
40	DI	OTI ALARM/TRIP	
41	DI	PRD OPTD	
42	DI	OVERLOAD ALARM	
43	DI	BUCHOLZ TRIP	
44	DI	BUCHOLZ ALARM	
45	DI	OLTC BUCHOLZ ALARM	
46	DI	OLTC BUCHOLZ TRIP	
47	DI	OIL LOW ALARM	
48	DI	back-up o/c (HV) optd	
49	DI	back-up e/f (HV)optd	
50	DI	220v DC-I/II source fail	
51	DI	TAP MISMATCH	
52	DI	GR-A PROTN OPTD	
53	DI	GR-B PROTN OPTD	
54	DI	back-up o/c (MV) optd	
55	DI	back-up e/f (MV)optd	
C Bus Coupler Breaker			
1	AI	R phase current	These signals are required over numerical relaying metering LAN and Transducers output having redundant signal
2	AI	Y phase current	
3	AI	B phase current	
4	AI	3-phase Real power	
5	AI	3-phase Reactive power	
6	DI	CB in service & closed	Hardwired
7	DI	CB in service & open	Hardwired

[Type text]

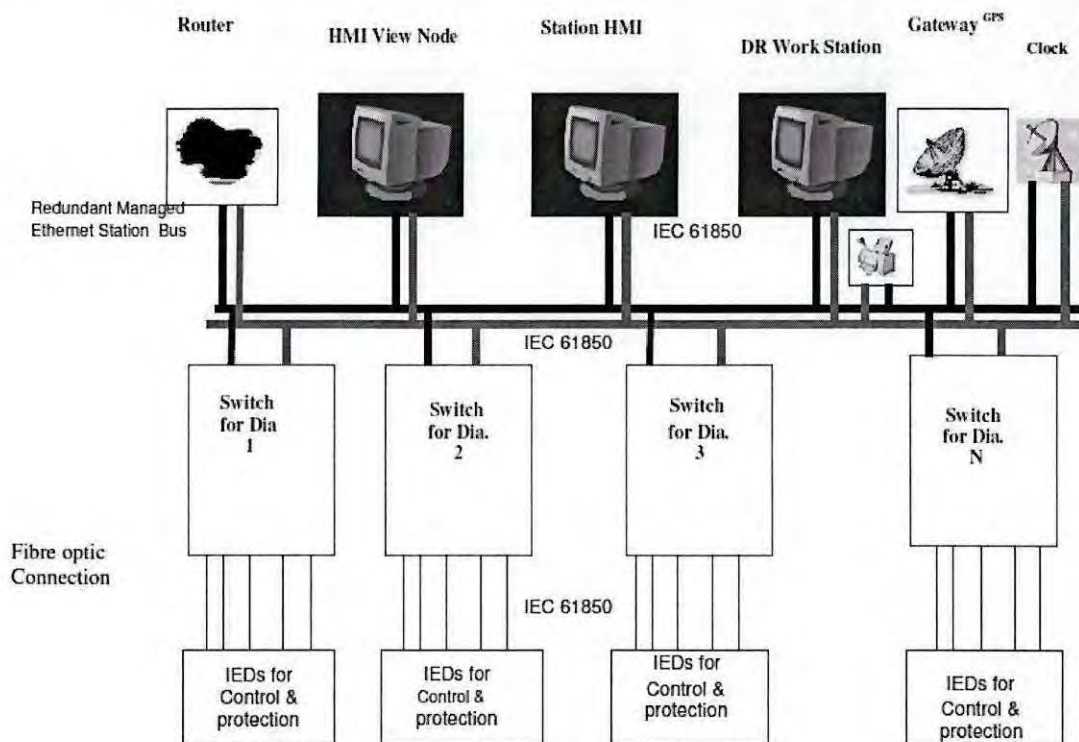
8	DI	Relay 86 operated	These signals are required over numerical relaying metering LAN.
9	DI	Relay 95 operated	
10	DI	Auto-changeover blocked	
11	DI	Numerical relay Unhealthy	
12	DI	Switchboard (A-I-M Selector Switch) — Auto mode	Hardwired
13	DI	Switchboard (A-I-M Selector Switch) — Indep. mode	Hardwired
14	DI	Switchboard (A-I-M Selector Switch) — Manual mode	Hardwired
15	DI	AC Control Supply #1 Failure	Hardwired
16	DI	AC Control Supply #2 Failure	Hardwired
17	DI	DC Control Supply #1 Failure	Hardwired
18	DI	DC Control Supply #2 Failure	Hardwired
19	DI	AC Space heater supply #1 Failure	Hardwired
20	DI	AC Space heater supply #2 Failure	Hardwired
21	DO	Trip from ECS	Hardwired
22	DO	Breaker inhibited from closing due to load shedding	Hardwired
23	DO	Trip from ECS	Hardwired
24	DO	Bus bar main-I trip	These signals are required over numerical relaying metering LAN.
25	DI	Bus bar main-II trip	
26	DI	Bus bar zone-I CT open	
27	DI	Bus bar zone-II CT open	
28	DI	Bus transfer CT sup. Optd	
29	DI	Bus transfer bus bar protn optd	
30	DI	Bus protection relay fail	
31	DI	Bus bar protn trip relay optd	
D	BUS PT PANEL		
1	AI	Voltage for Bus-I, Bus-II and Transfer bus wherever applicable	These signals are required over numerical relaying metering LAN and Transducers output having redundant signal
2	AI	Voltage R-Y phase Y-B phase B-R phase	
3	AI	Frequency for Bus-I and Bus-II	
4	AI	Ambient temperature (switchyard).	
E	LT System		
1	DI	Incomer-I On/Off	These signals are required over numerical relaying metering LAN and Transducers output having redundant signal
2	DI	Incomer-II On/Off	
3	DI	415V Bus-I/II U/V	
4	DI	415v bus coupler breaker on/off	
5	DI	DG set bkr on/off	
6	DI	Alarm/trip signals as listed in Section: DG set	
7	DI	LT transformer-I Bucholz Alarm & trip	
8	DI	LT transformer-II Bucholz Alarm & trip	
9	DI	LT transformer-I WTI Alarm & trip	
10	DI	LT transformer-II WTI Alarm & trip	
11	DI	LT transformer-I OTI Alarm & trip	
12	DI	LT transformer-II OTI Alarm & trip	
13	DI	PLCC exchange fail	
14	DI	Time sync. Signal absent	
15	DI	Alarm/trip signals : Battery charger & UPS (all)	
16	DI	220v dc-I earth fault	

[Type text]

17	DI	220v dc-II earth fault
18	AI	Voltage R-Y, Y-B, B-R of Main Switch Board section-I
19	AI	Voltage R-Y, Y-B, B-R of Main Switch Board section-II
20	AI	Voltage R-Y, Y-B, B-R of Diesel Generator
21	AI	Current from LT transformer-I
22	AI	Current from LT transformer-II
23	AI	Current from Diesel Generator
24	AI	Voltage of 220V DCDB-I
25	AI	Voltage of 220V DCDB-II
26	AI	Current from 220V Battery set-I
27	AI	Current from 220V Battery set-II
28	AI	Current from 220V Battery charger-I
29	AI	Current from 220V Battery charger-I
30	AI	Current from UPS-1
31	AI	Voltage from UPS-
32	AI	Current from UPS-2
33	AI	Voltage from UPS-2
34	AI	back-up o/c (MV) optd
35	AI	back-up e/f (MV)optd

[Type text]

TYPICAL ARCHITECTURAL DRAWING OF SUBSTATION AUTOMATION SYSTEM



1. The redundant managed bus shall be realized by high speed optical bus using industrial grade components and shall be as per IEC 61850.
- ~~2. For 220kV, for two adjacent bays can be housed in one Kiosk along with its switch. For 220/33kV T/F, bays can be housed in one Kiosk along with its switches.~~
3. Inside the sub-station, all connections shall be realized as per IEC 61850 protocol.
4. For gateway, it shall communicate with Remote Supervisory Control Centre (RSCC) on IEC 60870- 5-101 protocol.
5. The router to Remote Control Centre (RCC) shall communicate on IEC 60870-5-101 protocol.
6. The printer as required shall be connected to station bus directly and can be managed either from [Type text]

station HMI, HMI view node or disturbance recorder work station.

For software interlocking the ~~DBT~~ contractor shall describe the scenario while an IED of another bay is switched off or fails.

A software interlock override function shall be provided which can be enabled to bypass the interlocking function.

PART-B

LOAD MANAGEMENT SYSTEM (LMS):

1.0 GENERAL

1.1. Scope

1.1.1. The scope of work under this tender includes design, engineering, manufacturing, supply, erection, testing and commissioning of Power Management System (PMS) for the main purpose of load management for the electrical power generation and distribution at the PR and PNCP complex including grid. The offered system can be configured such that the data acquisition as detailed in this tender document can be suitably integrated with the existing network.

1.1.2. The system shall include micro-processor based RTU systems, hardware, software and peripherals for monitoring and controlling the electrical power system and provide effective load control during any power generation loss & provide effective control of internal generation system when running in Grid Synchronized System. The described system shall improve the operation of the electrical supply system of the plant in terms of cost, safety, and availability.

1.1.3. The PMS will be implemented for 220 KV substation, PR Generation system and PNCP generation system. PNCP power plant is around 5 KMs from the 220 KV grid sub-station. The offered PMS system will be installed in the new 220 KV sub-station. This system will acquire all required inputs from PR generation system and PNCP generation system. The tentative system architecture is attached as Annexure- S-3/C9/3. Main purpose of the PMS is to maintain stability of electrical grids, generators in plant, especially in critical situations like a generator outage. The LMS system shall be divided into three major segments:

- a) PR loads management
- b) PNCP loads management
- c) Grid System.

1.1.4. PNCP Load management:

1.1.4.1. One no. of redundant RTU unit shall be provided at the PNCP power plant which will acquire all running generator MW, MVAR, voltage, current, ON/OFF status. This RTU will also extend the control commands of central LMS system upto running generators of PNCP power plant for active and reactive power controls as per defined

[Type text]

logic. For active control, signal to be extended upto the existing turbine governor system and for reactive control signal to be extended up to the existing DAVR panels.

- 1.1.4.2. The required analog and digital input connectivity from the existing generator to the RTUs shall be in the scope of ~~ESK~~ contractor. Any modification or additions of hardware required in the existing system like transducers etc for required inputs shall also be in the ~~ESK~~ contractor. This includes all signal and control cablings from existing system to new RTU panels. *(Internal wiring of Panels only is in Bidder's Scope)*
- 1.1.4.3. New RTU panel will comprise of minimum but not limited to
- 1.1.4.3.1. Redundant processor unit
 - 1.1.4.3.2. Redundant remote communication units.
 - 1.1.4.3.3. Redudant power supply units.
 - 1.1.4.3.4. Required IO interface hardwares (both analog and digital)
 - 1.1.4.3.5. Redudant media convertors and redundant networks as required.
- 1.1.4.4. The new remote RTU unit shall communicate with the central LMS processing unit through redundant OFC links. The supply of all materials for OFC connectivity including the OFC cable, LIU and splicing etc is in the scope of ~~ESK~~ contractor including its ~~laying and~~ termination.

1.1.5. PR Load management:

- 1.1.5.1. One no. of redundant RTU unit shall be provided at the PR power plant which will acquire all running generator MW, MVAR, voltage, current, ON/OFF status. This RTU will also extend the control commands of central LMS system upto running generators of PR power plant for active and reactive power controls as per defined logic. For active control, signal to be extended upto the existng turbine governor system and for reactive control signal to be extended upto the existing DAVR panels.
- 1.1.5.2. The required analog and digital input connectivity from the existing generator to the RTUs shall be in the scope of ~~ESK~~ contractor. Any modification or additions of hardware required in the existing system like transducers etc for required inputs shall also be in the ~~ESK~~ contractor. This includes all signal and control cablings from existing system to new RTU panels. *(Internal wiring of Panels only is in Bidder's Scope)*
- 1.1.5.3. New RTU panel will comprise of minimum but not limited to
- 1.1.5.3.1. Redundant processor unit
 - 1.1.5.3.2. Redundant remote communication units.
 - 1.1.5.3.3. Redudant power supply units.
 - 1.1.5.3.4. Required IO interface hardware's (both analog and digital)
 - 1.1.5.3.5. Redudant media convertors and redundant networks as required.
- 1.1.5.4. The new remote RTU unit shall communicate with the central LMS processing unit through redundant OFC links. The supply of all materials for OFC connectivity including the OFC cable, LIU and splicing etc is in the scope of ~~ESK~~ contractor including its ~~laying and~~ termination.

1.1.6. Grid management:

- 1.1.6.1. One no. of redundant RTU unit shall be provided at the new 220 KV grid sub-station which will acquire all 220 KV feeders' MW, MVAR, voltage, current, ON/OFF status. This RTU will also extend the control commands of central LMS system upto the grid feeders and OLTC panels for reactive power controls as per defined logic. For reactive control signal to be extended upto the OLTC control panels.

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1.1.6.2. The required analog and digital input connectivity from all 220 KV feeders to the RTUs shall be in the scope of ~~the~~ contractor. Any modification or additions of hardware required in the existing system like transducers etc for required inputs shall also be in the ~~the~~ contractor. ~~This includes all signal and control cabling from existing system to new RTU panels.~~

1.1.6.3. New RTU panel will comprise of minimum but not limited to

- 1.1.6.3.1. Redundant processor unit
- 1.1.6.3.2. Redundant remote communication units.
- 1.1.6.3.3. Redundant power supply units.
- 1.1.6.3.4. Required IO interface hardwares (both analog and digital)
- 1.1.6.3.5. Redundant media convertors and redundant networks as required.

1.1.6.4. The new remote RTU unit shall communicate with the central LMS processing unit through redundant OFC links. The supply of all materials for OFC connectivity including the OFC cable, LIU and splicing etc is in the scope of ~~the~~ contractor including its ~~laying and~~ termination.

The proposed System shall integrated with new GPS system as included in this project. Unless otherwise specified, the following shall be, but not limited to, the brief scope:

- Design & Engineering of the system including System Integration with existing network
- Supply of all hardware, software & programming required to achieve the specified functionality.
- Supply of interfacing equipment (RTU/Ethernet Switches, etc) as applicable
- Supply of standard software, application software to achieve DAS & Load management requirement.
- 2 nos. Operator Work Station in PR Control Room, 2 Nos. of Operator work station in PNCP control and 1 No. of Engineering cum operator work station Engineering room shall be provided.
- Site Acceptance testing
- Supply of all types of cables and terminations along with inter-panel wiring as per the requirement
- Necessary report formatting & generation as per the requirements.
- Commissioning & hand-over
- Drawings & Documentation.

Following functional requirement shall be met by the application software at minimum:

- Acquire information from the generators and 220 KV grid systems for complete project as specified in the tender document over fast data network.
- Monitor the actual generation data and available spinning reserve of both PR and PNCP.
- Monitoring the actual grid import for both the lines.
- Monitor the actual load of individual grid transformers.
- Load control to maintain grid import within the limit.
- Load control to maintain internal generators within their capabilities
- Load control to maintain grid transformer operation within their capacities including its OLTC remote operation
- Load control to maintain system voltages and frequencies as per applicable logic.

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- Optimisation of spinning reserves and grid margins for tripping of any internal generators at both PR and PNCP end.
- Ensuring system stability based on the various optimisation control loops.
- Priority based load control based on the guiding parameters as per the system requirements.
- Data logging of time tagged events and alarms.
- Time Synchronization of the system.
- Display of system SLD with live parameters including spinning reserves and margin.
- Option of manual control of internal generation parameters and OLTCs.
- Generation of audio visual alarms for any abnormality and violation of any operating limits.
- Option of pre-select mode of operations for one or all internal generators.
- Fast Optimisation of internal generation spinning reserves in case of loss of grid to minimize the load shedding.

All the required transducer for signal input to LMS system shall be redundant in nature. Highest of the two to be selected for calculation and alarm & system shall generate alarm for mismatch/ error. Separate Transducer panel may be provided as per project requirement which is working on redundant UPS supply. Supply, installation of required transducer, its wiring in new or existing switchgears shall also be in the scope of ~~LOE~~ contractor.

All the digital inputs taken for the system shall be hard contact as much as possible. If any multiplication is required, same shall be done through use of latching relays. All the generator, grid system and critical status signal shall also be redundant. Supply, installation of required multiplier (if any), its wiring in new or existing switchgears shall also be in the scope of ~~LOE~~ contractor.

LMS system to operator HMI data link at both PR and PNCP power plant shall be redundant OFC link with redundancy at all level.

LMS system DO & AO shall be suitable for control as per existing Turbine controllers, DAVR system of both GT & STG at PR and PNCP. All required information for proper integration/ data inputs of existing system from OEM (if required) shall be collected by ~~LOE~~ contractor and same also be submitted to IOCL for information/ comments.

LMS system complete architecture, operating philosophy, redundancy. Control logic ect shall be submitted to IOCL for approval prior to start of manufacturing.

Site commissioning, parameterization, tuning etc shall be done under the supervision of OEM of the system & in the scope of ~~LOE~~ contractor with all associated liasoning, ~~and~~.

LMS system main processor, power supply system, IO communication cards, IO cards, communication port & cables, etc shall be design with redundancy to ensure failure of any single component shall not lead to outage/ reduction in any functionality of the offered system.

1.2. CODES & STANDARDS

The System Design, manufacturing and testing shall be in compliance with the requirements of IEC and other applicable standards. Bidders shall provide necessary compliance for the same.

1.3. UNITS

[Type text]

Unless and otherwise specified, international system of units (SI) shall be used for all drawings and documents.

2. SERVICE CONDITIONS

2.1. AMBIENT CONDITIONS

The offered system shall be designed as per metrological data as specified in any other part of tender document.

2.2. POWER SUPPLY

- ~~110V~~ AC Supply from UPS to be provided with new 220 KV GIS sytem.
- 230V AC Raw Power Supply from station auxiliary supply system of GIS

Any other voltage level as desired by the supplied equipment shall be suitably drawn from the above supplies by using reliable interfaces.

All equipment (except for devices like monitor, printer) shall have redundant power source.

3. SYSTEM DESCRIPTION

- 3.1. The load control function shall be based on a distributed system architecture using a backbone LAN (local area network) with the standard communication according to IEC 61850 for fast data transfer.
- 3.2. The central PMS Controller on plant level should be RTU based.
- 3.3. In order to reach the desired short reaction time It must be noted, that the entire Ethernet network must be designed and parameterized in that way to achieve a very fast reaction time typically below 100 ms excluding the field devices operation time. Same needs to be demonstrated during SAT.
- 3.4. The HMI shall display the information from the whole grid including the existing generation system.
- 3.5. The HMI is required to supervise, monitor and operate the LMS system along with monitoring the whole electrical network connected with the system. All images and indications on the HMI should be based on a preconfigured design, which should incorporate the long-term experience of Bidder in many delivered substation automation systems / PMS projects worldwide.
- 3.6. The primary load shedding or automatic load shedding system shall carry out the following main functions at minimum:
 - Continuously checks changes in the electrical network parameters /configuration.
 - Continuously checks the energy balance in every network configuration.
 - Calculates the dynamic load limits/ equipment capability limits / Grid limits .

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- Generates load control commands when necessary.
 - Changes loads status, nominal load selection values as per system operating limits.
 - Informs and guides operators.
 - Generates reports.
 - Supervise computer system
- 3.7. The Controller (RTU) must present an open, expandable and future-proof system, by taking into account latest standards, such as e.g. modular system concept, etc.
- 3.8. RTU should be having redundant power supply, redundant communication processor and redundant central processor. These cards shall be accommodated within same rack and panel due to space constraint. No separate rack / RIOs shall be provided.
- 3.9. A common Engineering & Operator Work Station shall be provided in CPP (SS-01) Control Room connected to the station LAN. The provided server shall have capability to talk to the existing DCS Server on OPC connectivity. Necessary OPC Licence with latest version shall be provided & loaded on the Server.
- 3.10. PC for Workstation shall be of industrial/server grade loaded with minimum required utility/communication software to avoid system overload.
- 3.11. Sizing & Scalability: The system shall be scalable and shall be able to add more RTU / Field devices in future.
- 3.12. LMS Generation control feature shall ensure a stable system under all electrical power system modes of operation:
- Normal operation (connected- and island modes).
 - In the event of loss of a transmission line or transformer: independent control of each Island.
 - Load step changes (up and down)
 - Outage or failure of generation facilities.
- 3.13. The automatic generation control system shall be secondary to the proprietary generator control systems supplied by the generator vendor.
- 3.14. Control of any machine through LMS shall be operator selectable. If Control from LMS is kept disable, Existing normal machine control loops will kept working.
- 3.15. ~~15.14~~ The contractor to elaborate the behaviour and functionality of LMS system in case of electrical faults, voltage dips/ sags in addition of normal load control. The LMS system shall be of second priority in comparison of original OEM control system so that machine safety and security shall remain prime.
- 3.16. AGC (Automatic Generation Control) functions:-
- Load Frequency Control (LFC) based on minimization of the Area Control Error (ACE) to maintain nominal frequency
 - Automatic Voltage Control (AVC) to maintain nominal voltage at defined busbar of the grid
 - Control of operation mode of turbine governors (e.g. isochronous / droop / manual) depending on grid mode (connected / island)

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- 3.17. Sharing of active and reactive power to all involved generators according to predefined participation factors. These factors have to be monitored and adapted online on the HMI by the operator.
- 3.18. Necessary furniture requirement along with printer for the system for mounting the Work Station shall be provided at site by ~~the~~ contractor including tables, chairs along with necessary chairs, drawers, printers etc.
- 3.19. System shall be synchronized with the existing GPS for CPP Control Room.
- 3.20. All data transfer shall be on fast data transfer protocol to achieve data resolution of as low as 1ms
- 3.21. System shall be provided with the latest software.
- 3.22. Following values shall be displayed at minimum on the PC at Operator Station located at various location:
- Instantaneous kW, kVAr and kVA
 - Total kWh, kVAh and kVAh
 - Line Voltages, Bus Voltages at each level
 - 3 phase currents at each level & feeders
 - Power Factor at each level & feeders
 - Frequency
 - Breaker Status
 - All required displays for load sharing
 - Mode selections, spinning reserve data.
 - Generator running load and capacity. Capacity shall be editable by operator as and when required.
- 3.23. Minimum 20% wired spares shall be provided for future expansion requirement. This shall include licence for required software, I/Os etc
- 3.24. The controller provided shall not be loaded more than 50% at any point of time and shall be redundant in nature.
- 3.25. System provided shall not hang due to overload at any point of time & provide high reliability for the Load Shedding function for the plant.
- 3.26. IEC61850 Ethernet switch shall have redundant fibre optic port for the onward connection to the data concentrator/RTUs/Load shedding controller.
- 3.27. It shall be noted that at any point of time, the whole system or part of it should not fail due to any single point failure.

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