



**Kenya Power**

**17.5kV Air Insulated Indoor Switchgear Panels –Part 5: Capitol Switching  
Station Spares- Specification**

**April 2021**


**TITLE:**  
**17.5 KV AIR INSULATED  
INDOOR SWITCHGEAR  
PANELS – PART 5:  
CAPITOL SWITCHING  
STATION SPARES -  
SPECIFICATION**

<b>Doc. No.</b>	<b>KP1/13D/4/1/TSP//11/001-5</b>
<b>Issue No.</b>	<b>1</b>
<b>Revision No.</b>	<b>0</b>
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#### 0.1 Circulation List


COPY NO.	COPY HOLDER
1	Manager, Standards
2	Electronic copy (pdf) on Kenya Power server ( <a href="http://172.16.1.40/dms/browse.php?FolderId=23">http://172.16.1.40/dms/browse.php?FolderId=23</a> )

#### REVISION OF KPLC STANDARDS

To keep abreast of progress in the industry, KPLC Standards shall be regularly reviewed. Suggestions for improvements to approved Standards, addressed to the Manager, Standards Department, are welcome.

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**0.2 Amendment Record**

Rev No.	Date (YYYY-MM-DD)	Description of Change	Prepared by (Name & Signature)	Approved by (Name & Signature)
New	2021-04-01	New issue	N. Wairimu	Dr. Eng. P. Kimemia

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## FOREWORD

This Specification has been prepared by the Standards Department in collaboration with Technical Services Department, all of the Kenya Power and Lighting Company Plc and it lays down requirements for 17.5kV Air insulated indoor Switchgear Panels herein called 17.5kV metal enclosed switchgear control and protection boards and the associated Substation Automation System for Capitol Switching Station.

The specification is intended for use by Kenya Power in procurement of these metal enclosed switchgear boards for use in medium voltage substations.

This specification is in the series of:

*KP1/6C/4/1/TSP/11/001-1: Specification for 11kV Metal Clad protection & Metering Switchgear Panel (Air Insulated with Vacuum Circuit Breaker)*

*KP1/6C/4/1/TSP/11/001-2: 11kV Metal Enclosed Switchgear and Protection/ Control Panels Part 2: Spare Panels — Specification*

*KP1/6C/4/1/TSP/11/001-3: 11kV Air Insulated Indoor Switchgear Panel: Part 3 - Specification*

*KP1/6C/4/1/TSP/13D/001-4: 17.5kV Air Insulated Indoor Switchgear Panel- Part 4: Jeevanjee Substation Spares - Specification*

*KP1/6C/4/1/TSP/11/001-6: 17.5kV Air Insulated Indoor Switchgear Panel- Part 6: University Way Switching Station Spares - Specification*

The specification stipulates the minimum requirements for the 17.5kV Metal Enclosed Switchgear and Protection board and the associated Substation Automation System (SAS) acceptable for use in the company (Kenya Power) and it shall be the responsibility of the manufacturer to ensure adequacy of the design, good workmanship and good engineering practice in the manufacture of the equipment for Kenya Power.

The following are members of the team that developed this specification.

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## 1 SCOPE

- 1.1 This specification covers the design, manufacture, inspection, training and testing at the manufacturer's works and at site and delivery of 17.5kV Metal Enclosed Switchgear and Protection Panels with a Substation Automation System (SAS) for Kenya Power use in Capitol Switching Station.
- 1.2 This specification covers a complete 17.5kV switchgear metal enclosed boards comprising of 2 No. incoming feeders (Incomers) boards, 7 No. outgoing feeders boards, 1 No. Bus Section panel, 1 No. Bus Potential Transformer(PT) cum riser panel, Control devices, Protection Relays, Instrument Transformers, SAS and all other necessary equipment and accessories to make a complete working Medium Voltage Indoor Switchgear Board. The Incomers shall come complete with VTs.

## 2 REFERENCES (NORMATIVE)


The following documents were referred to during the preparation of this specification. In case of conflict, the provisions of this specification shall take precedence. Unless otherwise stated, the latest editions (including amendments) of the following standards shall apply.

IEC 62271-100:	High-voltage switchgear and control gear -Part 100: High-voltage alternating-current circuit breakers.
IEC 62271-200:	High-voltage switchgear and control gear - Part 200: A.C. metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV.
IEC 62271-1	High voltage switchgear and control gear part 1: common specifications
IEC 60071	Insulation Co-ordination
IEC 60051	Direct acting indicating analogue electrical measuring instruments and their accessories.
IEC 61869-1:	Instrument transformers - Part 1: Current transformers.
IEC 61869-3:	Instrument transformers - Part 2: Inductive voltage transformers.
IEC 61869-6:	Instrument Transformers – Part 6: Additional General Requirements for Low Power Instrument Transformers.
IEC 60255:	Electrical Relays.
IEC 60529:	Degrees of protection provided by enclosures (IP Code).
IEC 60815:	Guide for the selection of insulators in respect of polluted conditions.
BS 1363:	13A plugs, sockets outlets, adaptors and connection units. Specification for rewirable and non-rewirable 13A fused plugs.

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BS 381C:	Colours used in identification, coding and other special purpose.
IEC 60870-5-101:	Telecontrol equipment and systems – Part 5-101: Transmission protocols – companion standards for basic Telecontrol tasks.
IEC 60870-5-104:	Telecontrol equipment and systems - Part 5-104: Transmission protocols – Network Access for IEC 60870-5-101 using standard transport
IEC 61870-5-103:	Communication Protocols.
IEC 61850-9-2:	Design of electrical substation automation systems.
IEC 61243-5:	Live working – Voltage Detectors – Part 5: Voltage Detecting System (VDS).
IEEE 1613:	IEEE Standard Environmental and Testing Requirements for Communications Networking Devices in Electric Power Substations
EMC 89/336/EEC:	Directive on Electromagnetic Compatibility.
NEMA TS 2:	Traffic Controller Assemblies with NTCIP Requirements

### 3 TERMS AND ABBREVIATIONS

The Terms given in the reference standards and the following Abbreviations and acronyms shall apply.

AC	Alternating Current
AFLR	Accessibility restricted to Authorized personnel only, F for Front side, L for lateral side, R for Rear side
Amps	Amperes
BDEW	German Association of Energy and Water Industries
CB	Circuit Breaker
CBCT	Core Balance Current Transformer
CT	Current Transformers
DC	Direct Current
FAT	Factory Acceptance Test
GPS	Global Positioning System
HMI	Human Machine Interface
HV	High Voltage
IDMT	Inverse Definite Minimum Time
IEC	International Electrotechnical Commission
IED	Intelligent Electronic Device

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I <sub>n</sub>	Nominal Current
ISF	Instrument Security Factor
kA	Kilo amperes
KPLC	Kenya Power and Lighting Company
kV	Kilo Volts
LAN	Local Area Network
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LI	Lightning Impulse
LV	Low Voltage
MCB	Miniature Circuit Breaker
NERC CIP	North America Electric Reliability Corporation Critical Infrastructure Protection
N/C	Normally Closed
N/O	Normally Open
PME	Protective Multiple Earth
PT	Potential Transformer
RCC	Regional Control Center
RTU	Remote Terminal Unit
SAS	Substation Automation System
SCADA	Supervisory Control and Data Acquisition
SEF	Sensitive Earth Fault
SCMS	Substation Control and Monitoring System
SCS	Substation Control System
TCS	Trip Coil Supervision
TPN	Triple Pole Neutral
VA	Volt Amperes
VT	Voltage Transformer

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XLPE Cross Linked Polyethylene

**ANSI Numbers for protection functions**

50/50N Instantaneous Overcurrent/Instantaneous Earth Fault protection

51/51N Timed Overcurrent/Timed Earth Fault protection

67/67N Directional Overcurrent/Directional Earth Fault protection

86 Lock out Relay

27 Under-voltage Relay

59 Over-Voltage relay

81 Frequency Relay

**4 REQUIREMENTS**

**4.1 SERVICE AND SYSTEM CONDITIONS**

**4.1.1 SERVICE CONDITIONS**

The 17.5kV Air Insulated Switchgear Panels shall be suitable for continuous indoor operation in tropical areas and harsh climatic conditions with following service and system conditions:

- (a) Altitude: up to 2200m above sea level
- (b) Pollution: Heavy saline (Pollution level IV) atmosphere in accordance to IEC 60815
- (c) Humidity: up to 95%
- (d) Ambient temperatures of +30° C average, (-1° C Min and +40° C Max.).
- (e) Isokeraunic level: Up to 180 thunderstorm days per year.

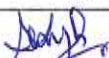
**4.1.2 SYSTEM CONDITIONS**

The Indoor Switchgear panels shall be connected to an overhead system, which is generally unearthed (without aerial earth wire). The equipment shall be suitable for installation in supply systems of the following characteristics.

**Table 1: Equipment Characteristics**

No.	Technical Particulars		Requirements
1.	Frequency		50 Hz
2.	Highest System voltage		17.5kV
3.	Rated Normal current(Ir)	Bus bars	1600A
		Incomer Circuit Breaker	1250A
		Feeder Circuit Breaker	630A

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No.	Technical Particulars	Requirements
4.	Rated Short time current withstand (3sec)(Ik)	31.5 kA rms
5.	Rated peak withstand current (Ip)	78 kA pk
6.	Rated breaking capacity	31.5 kA
7.	Rated making capacity	78 kA
8.	Minimum Lightning Impulse Withstand Voltage 1.2/50µs +ve, dry (peak)	95 kV pk
9.	Minimum Power Frequency Withstand (Dry) Voltage (rms)(1 min)	38 kVrms
10.	Internal Arc Classification (IAC) in accordance to IEC 62271-200	31.5kA, 1 Sec
11.	IAC Class	AFLR
12.	Class IV Site pollution severity (SPS) as per IEC/TS 60815	Very heavy
13.	Specific creepage distance as per IEC/TS 60815- class	31mm/kV

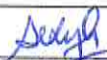
#### 4.2 DESIGN AND CONSTRUCTION

- 4.2.1 The 17.5kV Metal Enclosed Indoor Switchgear and Protection Panels shall be designed and constructed in accordance with IEC 62271-200 and the requirements of this specification.
- 4.2.2 The complete switchgear shall be air insulated fully metal enclosed and shall be such that the complete switchboard is of flush-front design.
- 4.2.3 The panels should have dimensions suitable for installation in limited spaces as defined in this specification; in particular, without compromising the insulation level, the bus-bar current rating and the short circuit withstand performances. The width of the panels for outgoing feeders and bus PTs shall not exceed 630mm. The width of the incomer and bus-section panels shall not exceed 780mm. The maximum height of the board shall not exceed 2500mm.
- 4.2.4 The switchgear shall be built up of individual metal enclosed cubicles or modules with earthed metal partitions. The circuit breakers (CB) shall be mounted on an in-built carriage of the horizontal draw-out type. The panel shall be supplied complete with 2 No. trolleys for feeder panels and 2 No. trolleys for Incomer/Bus-section panels to allow for switching of CB units by a single operator.
- 4.2.5 Each cubicle shall be divided into separate compartments for busbar, MV cable connection, switching device and low voltage (LV) section.
- 4.2.6 The low voltage section shall be separate from the medium voltage section. All the Protection Relays, Auxiliary Relays, Indication Lamps, Instruments, Control and selection switches and any other associated accessories shall be mounted in this compartment.
- 4.2.7 The switchgear shall be designed for erection with the rear side close to a wall as well as for freestanding erection and shall have provisions for bolting to the floor.
- 4.2.8 The top of the cubicle shall be provided with separate over pressure vent directed upwards and towards a common expansion vent. The common expansion vent shall expel pressure sideways outside the control building.

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- 4.2.9 The cable compartment shall have an anti-vermin guard plate giving protection against rats, rodents, snakes etc.
- 4.2.10 Hinged and lockable doors with handles shall be provided at the front of each cubicle for the respective LV compartment, circuit breaker compartment and cable connection compartment. There shall be no need for any additional form of locking/unlocking such as screws, bolts etc.
- 4.2.11 The front cubicle door shall be provided with a window through which the mechanical status of the circuit breaker (ON/OFF & SPRING CHARGED/DISCHARGED) can be checked.
- 4.2.12 Manual close and open push buttons shall be provided on the circuit breaker compartment door for manual closing and opening of the circuit breaker both in service and test positions. The manual close and open push buttons shall be clearly labelled with "close" and "open " labels and with symbols and colour codes as per the IEC standard.
- 4.2.13 There shall be a clear window provision in the cable compartment for visual inspection of the cable termination while in service.
- 4.2.14 The air insulated switchgear panels shall be constructed to IP43 degree of protection as per IEC 60529.
- 4.2.15 All metallic instrument cases, protective relay, switches etc. shall be properly earthed to the switchgear board steelwork frame.
- 4.2.16 Rear cable chamber covers shall be provided with handles and all bolts and nuts shall be stainless steel.
- 4.2.17 Mimic diagram shall be provided on the LV compartment door.
- 4.2.18 The Busbar shall be single, three phase, air insulated and appropriately encapsulated. The primary bus bars and connections shall be of high conductivity and electrolytic Copper materials and be in unit lengths.
- 4.2.19 The Bus bars shall be marked R, Y, B and all the jointing points/ends shall be tin-plated.
- 4.2.20 Bus bars, connections and their support shall be rated 1600Amps continuously under ambient conditions and capable of carrying the short-time current associated with the short circuit ratings of the circuit breakers, for 3 seconds.
- 4.2.21 Bus bars shall be extensible at both ends; such extension shall entail the minimum possible disturbance to the existing bus bar.
- 4.2.22 The Bus bar shutters shall be painted in Red shade (Signal color 537 of BS381C) with "BUSBARS" written in white. The cable shutters shall be painted in lemon color (355 of BS381C). For Bus coupler panel, both the shutters shall be painted Red shade with 'BUSBARS' written in white
- 4.2.23 Provision shall be made for locking bus bar and circuit shutters separately. The Red, Yellow and Blue phase positions shall be clearly marked on respective shutters.
- 4.2.24 Provision shall be made for integral circuit earthing by means of circuit breaker for circuit (cable) and bus- bar earthing. Mechanical interlocks to ensure correct switching operation shall be provided for the two circuits.

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- 4.2.25 All earthing facilities shall be rated for fault making, and padlocking facility provided for the earth switch.
- 4.2.26 The material for Earth bus and cable shall be copper of 99.5% purity, and the earth bus shall be extended outside the switchboard panel
- 4.2.27 Suitable terminal blocks shall be provided for all out going power and control cables. All CT and VT terminal blocks shall have a provision for isolation and banana type sockets for inserting test leads. The terminal blocks for the CTs shall be rated for the maximum possible secondary current of CTs provided.
- 4.2.28 The internal panel wiring for protection, instruments, indications, metering circuits and other control accessories shall be complete with appropriate ferrules and lugs. The panel wiring for protection, instruments, indication, signal/command and metering circuits and other control accessories shall be completely done using flexible copper 2.5mm<sup>2</sup> cables.
- 4.2.29 All circuits for connection to external cables such as DC & AC auxiliary supplies, external tripping, supervisory control and indications shall be wired up to the terminal block at the front of the panel where external cable shall be connected.
- 4.2.30 All projected inter-panel wiring shall be provided in respective cubicles with the wires ferruled, lugged and ready for termination with sufficient spare length.
- 4.2.31 At least 12 spare terminals shall be provided on the terminal board for any future requirements.
- 4.2.32 All primary power cable terminals shall generally be located for rear bottom entry connection.
- 4.2.33 Auxiliary 110V dc, 110Vac and 230Vac supplies for circuit breaker control, alarm circuits, protection relays, metering and motor supply for each panel shall be controlled by miniature circuit breakers rated to carry the full load of the equipment.
- 4.2.34 The cubicle shall be tropical vermin proof. The cover plates shall be of high quality mild steel of at least 2mm thickness thoroughly cleaned by shot blasting or other approved methods.
- 4.2.35 The switchgear panels shall then be given a primary coat and two coats of contrasting colour of durable and weather resisting paint. The final coat shall be painted to RAL 7032 as specified in BS 381C. The final thickness of the paint shall not be less than 80 microns at any point within the switch gear panel.
- 4.2.36 Anti-condensation heaters shall be provided inside each cubicle. They shall be located so as not to cause injury to personal or damage to equipment. A hygrostat control unit with variable temperature and humidity control setting shall be installed to control the heaters. The heaters shall be controlled from a two-position control switch with positions "ON-OFF" in each cubicle.
- 4.2.37 Interior illumination lamps operated by door switches shall be provided for each switchgear control compartment (LV compartment). The lamps shall be of low power LED type and their fittings shall be standard. They shall be readily available in the local market to ease future replacements.
- 4.2.38 The heaters and lighting shall operate from a single-phase supply of 230 Vac.
- 4.2.39 One 230 Vac socket outlet of 3-point square terminals as per BS 1363 shall be provided for each switchgear panel in the LV compartment.

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- 4.2.40 Suitable means shall be provided to monitor the status of HV cables for both the incoming and outgoing cables. The monitoring unit shall be a three-phase device with illumination in red colour for live status visible from the front of the panel without opening any compartment doors. The indication shall be labelled L1 L2 L3. The device shall meet the requirements of IEC 61243-5.
- 4.2.41 Each switchgear panel shall be provided with a tinned copper earth bar of adequate cross section area to be able to withstand the rated short circuit current of 31.5kA for 3 seconds. These earth bars shall be arranged so that the bars of adjacent panels are joined together to form a common earth bus bar for the entire switchgear board. Provisions shall be made at both ends of the assembled switchgear board for connection of the earthing bar to the substation-earthing grid.
- 4.2.42 A changeover scheme for the secondary VT output shall be implemented when the bus section is closed such that all panels are supplied by the VTs on the incomer that is in service. When the bus section is open, each section of the bus shall be supplied by the respective incomer VTs.

### 4.3 CHARACTERISTICS

#### 4.3.1 Low Voltage Equipment

- 4.3.1.1 Low voltage equipment and installation shall be designed in accordance with EMC directives. The rating and design criteria for low voltage equipment shall be as shown in Table 1 below;

**Table 1: Low Voltage Equipment**

No.	Item Description	Requirement
1.	Rated voltage between the phases	400V ac
2.	Connection type	3ph 4 wire
3.	Rated voltage between phase and earth	230V ac
4.	Grounding system	PME
5.	Frequency	50hz
6.	Voltage variation	± 10
7.	Frequency variation	± 2%
8.	Power frequency 1 min test voltage	3kV
9.	Thermal rating of conductors	120%
10.	Maximum short circuit current	31.5 kA, 3s

- 4.3.1.2 The AC supply shall be used for power circuits, panel sockets, panel illuminations and panel heaters.

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#### 4.3.2 DC Auxiliary Supply Rating

- 4.3.2.1 The auxiliary DC supply shall be used for controls, indication, alarm, protection relays, motors, circuit breaker tripping and closing circuits and its characteristic shall be as shown in table 2 below.

**Table 2: DC Auxiliary Supply Characteristics**

No.	Description	Requirement
1.	Equipment/device rated voltage	110V DC
2.	Connection type	2 wire
3.	Voltage variation	77V - 137.5V DC

- 4.3.2.2 All equipment and apparatus including the circuit breakers, protective relays, control devices and accessories, measuring and indicating instruments and other electronic equipment shall be capable of satisfactory operation at 70% to 125% of the rated dc supply voltage.

#### 4.3.3 Medium Voltage Plant Equipment

The Indoor Switchgear panels shall be connected to an overhead system, which is generally unearthed (without aerial earth wire). The equipment shall be suitable for installation in supply systems of the following characteristics. The rating and design criteria for Medium Voltage plant equipment shall be as shown in table 3 below.

**Table 3: Medium Voltage Plant Equipment**

No.	Description	Requirements
1	System description	50Hz, 3 phase, 3 wire
2	Neutral point earthing	Solidly earthed.
3	Highest equipment rated voltage as defined by IEC-60071	17.5kV
4	Maximum rated continuous current of circuit breakers for feeders	630A
5	Maximum rated continuous current of circuit breakers for incomers and Bus -section	1250A
6	Insulation level according to IEC 60071	Minimum Lightning Impulse Withstand Voltage 1.2/50µs +ve, dry (peak)
		Minimum Power Frequency Withstand dry Voltage (rms)(1 min)
7	Bus clearances.	Phase to earth
		phase to phase
8	Rated Short time current withstand (3sec)(Ik)	31.5 kA rms
9	Rated peak withstand current (Ip)	78 kA pk

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No.	Description	Requirements
10.	Rated breaking capacity	31.5 kA
11	Rated Making Capacity	78kA
12.	Specific creepage distance as per IEC/TS 60815:2008 – class	31 mm/kV

#### 4.4 MEDIUM VOLTAGE COMPONENTS CHARACTERISTICS

##### 4.4.1 17.5kV Circuit Breakers

- 4.4.1.1 The circuit breaker shall be three pole operated, indoor withdrawable type, employing Vacuum Interrupter, with air insulation complying with the requirement of IEC 62271-100.
- 4.4.1.2 The moving portion of each circuit breaker shall consist of a three-pole contacts, operating mechanism, primary and secondary disconnecting devices, auxiliary switches, position indication and necessary control wiring.
- 4.4.1.3 The auxiliary switches shall be of the plug-in type, with the male contacts mounted on the breaker carriage and the female contacts on the plug-in cable connected to the panel wiring.
- 4.4.1.4 An extension cable for the plug-in cable shall be provided to allow for testing of a circuit breaker that has been fully extracted from the CB compartment. Other options may be considered where there is adequate proof that the auxiliary contacts will always be making firmly without misalignment. Finger contacts will however not be acceptable.
- 4.4.1.5 The circuit breakers of the same current and voltage ratings shall be interchangeable, both electrically and mechanically.
- 4.4.1.6 The circuit breaker operating mechanism shall be motor wound spring operated, power closing with electrical release and with provision for manual (hand) charge.
- 4.4.1.7 The circuit breaker operation cycle shall be 0 - 0.3 sec – CO- 3min - CO
- 4.4.1.8 The CB shall be provided with two tripping coils and one closing coil all wired to the CB control circuit.
- 4.4.1.9 Mechanical indication shall be provided to indicate the state of the spring. In addition, two pairs of Auxiliary contacts, which are closed when the springs are charged, shall be provided for local and supervisory indication. The motor limit switch assembly shall be made of mechanically sound materials which will not lose their mechanical properties over the service life of the CB.
- 4.4.1.10 The circuit breaker poles between the interrupter units and the primary plug-in contacts shall be fully insulated with durable material.
- 4.4.1.11 A spare set, of at least 8NO and 8NC auxiliary contacts of the circuit breaker shall be provided and shall be wired to a terminal block, for connection to control circuits.

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4.4.1.12 The control circuits for the circuit breaker shall automatically be connected when inserting the breakers into the cubicle by use of a single plug-in cable

#### 4.4.2 Current Transformers

4.4.2.1 The current transformers shall be in accordance with the requirement of IEC 61869-2 and IEC 61869-6.

4.4.2.2 The current transformers shall be single phase, one for each of the three phases and shall be accommodated inside the cubicle. All the cores of respective CTs shall be wired to the LV compartment of the respective cubicle.

4.4.2.3 The current transformers shall have the specified accuracy under load conditions and shall be able to withstand the effect of short-circuit fault current rating of the switchgear for 3 seconds.


4.4.2.4 The current transformers shall have rated burden sufficient for the connected numeric or static type relays, meters and instruments.

4.4.2.5 The current transformer ratings shall be as shown in table 1 below:

**Table 4: Current Transformer Ratings**

NO.	Description	Requirement
1.	Type	Wound epoxy cast resin
2.	Highest System Voltage	17.5kV
3.	Short time Current with stand (STC)	31.5kA for 3 sec
4.	Maximum Continuous Thermal Rating (1.5 In)	For outgoing Feeders 900A For Incomers and Bus section 1875A
5.	Lightning Impulse Withstand Voltage	95kVpeak
6.	One-Minute Power Frequency Withstand Voltage	38kVrms
7.	CT Burden	15VA
8.	<b>Incoming (Incomer) Panels</b>	
	Ratio	600-400/1/1A
	Class	Core 1 5P 20 Core 2 0.5 ISF 10
9.	<b>Outgoing feeders</b>	
	Ratio	600-400/1/1A
	Class	Core 1 5P20 Core 2 0.2 ISF 10
	Core Balance Current Transformer on Outgoing feeder	
	Ratio	50/1A

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NO.	Description	Requirement
	Class	5P10
10.	<b>Bus Section Panel CTS</b>	
	Ratio	600-400/1/1A
	Class	Core 1 5P20
		Core 2 0.5 ISF 10

#### 4.4.3 Voltage Transformers

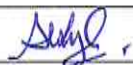
- 4.4.3.1 Voltage transformers shall be suitable for operation of the protection relays, metering and transformer voltage regulation, their design and manufacturing shall meet requirements of IEC 61896-3 and their characteristics shall be as per Table 5.
- 4.4.3.2 The voltage transformer shall be epoxy cast resin type, shall be one for each of the three phases, and, star/star connected complete with removable HV fuses and links.
- 4.4.3.3 The voltage transformers shall be mounted on a common withdrawable truck located in the cable compartment.
- 4.4.3.4 There shall be one bus VT for each section of the board. The bus VT shall be located in the bus PT panel on one section of the board and in the bus riser cum bus PT panel on the other section of the board. The bus VT shall be of the horizontal draw out type.
- 4.4.3.5 The bus voltage transformer secondary shall be connected to a TPN MCB with auxiliary contacts mounted in LV compartment of the panel.

**Table 5: Voltage Transformer Rating**

No.	Description	Requirement
	Ratio	11000/√3/110/√3
2.	Burden	30VA
3.	Impulse Withstand Voltage	95kV peak
4.	One-Minute Power Frequency Withstand Voltage	38kVrms
5.	<b>Incomer Panel Voltage Transformers</b>	
	Ratio	11000/√3:110/√3: 110/√3V
	Class	Core 1 0.5
		Core 2 3P
6.	<b>Bus Voltage Transformer</b>	
	Ratio	11000/√3:110/√3: 110/√3V
	Class	Core 1 0.2
		Core 2 3P

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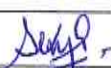


## 4.5 RELAYS

### 4.5.1 General Requirements

- 4.5.1.1 The relays shall be flush mounted in design, and shall be manufactured in accordance to IEC 60255, IEC 61850-2, IEC 61850-9 and shall be EMC 89/336/EEC compliant.
- 4.5.1.2 The relays shall be of Numeric design and supports GOOSE messaging and communication protocols 60870-5-103 and 61850-9-2.
- 4.5.1.3 The LV compartment Terminal Block shall include a test switch (block) which shall enable the CTs circuits to be isolated from the Relay and shorted, to facilitate relay testing in site and to allow isolation of VT circuits, Alarm and Trip Circuits. The test block shall be supplied with the plug-in unit and any other accessories required for secondary injection tests.
- 4.5.1.4 Relay secondary rating shall be 1Amp (three phase) and Power Supply Voltage shall be 110VDC .
- 4.5.1.5 Relay contacts shall be suitable for making and breaking the maximum currents, which they are required to control in normal service. Where contacts of the protective relays are not sufficient for Circuit Breaker Tripping, auxiliary Trip relays shall be provided, to prevent damage to relay output contacts.
- 4.5.1.6 Operating time for auxiliary tripping relays shall not significantly affect the overall fault clearance time, i.e., the auxiliary Trip relays must have short pick up times (<30 ms).
- 4.5.1.7 Relay contacts shall make firmly without bounce and the relay mechanism shall not be affected by panel vibration or external magnetic fields.
- 4.5.1.8 Relays shall be provided with clearly inscribed labels describing their functions and Device Function numbers. The labels shall be put on the outside and in the inside when the doors are open.
- 4.5.1.9 Relays shall be suitable for operation on 110VDC supply without use of dropping resistors or diodes.
- 4.5.1.10 The relay LEDs should be visible from the front of the panel without opening the panel door(s)
- 4.5.1.11 The protection relay shall have a minimum of 5 current inputs (1/1A) and 4No. Voltage transformer inputs 110V ac.
- 4.5.1.12 To reduce the effect of electrolysis, relay coils operating on DC shall be so connected such that they are not continuously connected from the positive pole of the station battery bank.
- 4.5.1.13 The relays thermal rating shall be such that the fault clearance times on any combination of current and time multiplier settings shall not exceed the thermal withstand capability of the relay. (Max. fault current = 31.5kA/3Sec )

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4.5.1.14 Detailed Relay and Device performance specification shall be as per table 6 below.

**Table 6: Detailed Relay and Device Performance requirements**

No.	Item	Requirement
<b>A. Three Phase Overcurrent and Earth Fault Relay</b>		
1.	Type	Numerical design and supports GOOSE messaging and communication protocols 60870-5-103 and 61850-9-2
2.	Current setting range for overcurrent relay	$0.5I_n - 2.4I_n$
3.	Current setting range for earth fault relay	$0.5I_n - 0.8I_n$
4.	I.D.M.T characteristics according to BS 142 or IEC 60255	SI, VI, EL, LTI, including definite time for the high –set elements
5.	Time setting multiplier	0.05 – 1.0
6.	Highest element for both overcurrent and earth fault protection with a setting range	$1 - 30I_n$
7.	Drop off/picking up ratio	>90%
8.	Low transient overreach	<10%
9.	Features	<ul style="list-style-type: none"> <li>i. Broken conductor alarm</li> <li>ii. Thermal overload protection</li> <li>iii. Circuit breaker maintenance</li> <li>iv. Fault records, event records and disturbance records</li> <li>v. Configurable output relays with ability to output starting elements to control</li> <li>vi. Tripping of other upstream protection relays</li> </ul>
<b>B. Three-phase Directional Overcurrent and Earth Fault Relay</b>		
1.	Type	Numerical design and supports GOOSE messaging and communication protocols 60870-5-103 and 61850-9-2
2.	Current setting range for overcurrent relay	$0.5I_n - 2.4I_n$
3.	Current setting range for earth fault relay	$0.5I_n - 0.8I_n$

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No.	Item	Requirement
4.	Quadrature connection for polarizing voltage	$V_n = 110 \text{ V ac}$
5.	High Set Element	$1 - 32I_n$
6.	I.D.M.T characteristics	According to IEC 60255 and Definite time characteristic
7.	Normal operating boundary	$\pm 90$ degrees from relay characteristic angle Relay sensitivity shall be 1% of rated value of current and current polarizing voltage at an angle equal to the relay characteristic angle
8.	Time setting multiplier	0.05 – 1.0
9.	Features	<ul style="list-style-type: none"> <li>i) Applicable on the LV side of a Dyn1 transformers</li> <li>ii) The phase and the directional elements shall be individually selectable.</li> <li>iii) Broken conductor protection feature.</li> <li>iv) Negative sequence protection feature.</li> <li>v) Highest element for both overcurrent and earth fault protection, with a setting range of <math>1 - 30I_n</math>.</li> <li>vi) Thermal protection.</li> <li>vii) Dedicated Breaker Fail Protection.</li> <li>viii) Circuit Breaker Maintenance</li> <li>ix) Incorporate Fault record, Event Records and disturbance records (minimum 1000)</li> <li>x) Configurable output relays with ability to output starting elements to control of other upstream Protection relays.</li> </ul>

**C. Trip Relay**

1.	Instantaneous operation, t	$< 12 \text{ ms}$
2.	Output contacts	At least 8(eight) No. pairs of output contacts 2 (two) No. of which should be NC contacts
3.	Features	<ul style="list-style-type: none"> <li>i. High burden</li> <li>ii. Immune to capacitance discharge currents and leakage currents</li> <li>iii. Provision for manual reset</li> <li>iv. Flag or target should be a red LED or bulb and should be electrically reset</li> </ul>

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No.	Item	Requirement
<b>D. Trip Circuit Supervision Relay</b>		
1.	Feature	i. Continuous supervision of trip circuit breaker in both OPEN & CLOSE position ii. Trip circuit fail – Red LED iii. Trip circuit healthy – Green LED iv. Two normally closed and three normally open output contacts
<b>E. Annunciator Unit</b>		
1.	Features	i. Should have silence, accept and reset buttons. ii. Accommodate 18 signal alarms iii. Relay output for audible alarm and self-supervision iv. Integrated event register to provide analysis of the latest five (5) events.

#### 4.5.2 Incomer Panel Relay Specific Requirements

- 4.5.2.1 Both incomer panels shall have numerical over current and earth fault relays capable of performing both high set and low set operation. The directional over current and earth fault protection function shall also be available and operational.
- 4.5.2.2 The relay shall include a card for arc flash protection. The arc card shall have three light inputs that is from the cable compartment, from the CB compartment and from the bus bar compartment. Each of the three compartments shall have one light sensor lens linked to the relay inputs through insulated single mode insulated glass fibre optic cable.
- 4.5.2.3 The operation of arc protection shall be programmed to work on two modes; light only and light + current mode.
- 4.5.2.4 Two outputs of the arc protection relay shall be programmed for operation purposes; one output to be used for cable compartment arc sensor operation, the other output to be used for circuit breaker and bus bar compartment arc sensor operation.
- 4.5.2.5 The arc flash protection operating from the cable compartment shall be wired to trip the incomer and the upstream 66kV circuit breaker.
- 4.5.2.6 The arc flash protection operating from the bus bar and circuit breaker compartments shall trip the incomer circuit breaker, the bus section circuit breaker and the upstream 66kV circuit breaker.
- 4.5.2.7 The relay front face LED indications shall be programmed to indicate the following

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- i. 50+50N operated
- ii. 67+67N operated
- iii. TCS1-unhealthy
- iv. TCS2-unhealthy
- v. Trip relay 86 operated
- vi. Cable compartment arc sensor operated.
- vii. Breaker/Busbar compartment arc sensor operated.
- viii. Arc sensor operated in outgoing/bus PT panel.
- ix. Incomer PT fuse failure.

#### 4.5.3 Bus Section Panel Relay Specific Requirements

- 4.5.3.1 Bus section panel shall have numerical over current and earth fault relay capable of performing both high set and low set operation.
- 4.5.3.2 The relay shall include a card for arc flash protection. The arc card shall have two light inputs i.e. from CB compartment and from the bus bar compartment. Each of the two compartments shall have one light sensor lens linked to the relay inputs through single mode insulated glass fibre optic cable.
- 4.5.3.3 The operation of arc protection shall be programmed to work on two modes; light only and light + current mode.
- 4.5.3.4 The arc flash protection operating from the bus bar and circuit breaker compartments shall trip the two incomer circuit breakers and the bus section circuit breaker.
- 4.5.3.5 The relay front face LED indications shall be programmed to indicate the following;
  - i. 50+50N operated
  - ii. 51+51N operated
  - iii. TCS1-unhealthy
  - iv. TCS2-unhealthy
  - v. Trip relay 86 operated
  - vi. Breaker/bus bar compartment arc sensor operated.
  - vii. Arc sensor operated in outgoing/bus PT panel/Incomer.

#### 4.5.4 Outgoing Feeder Panel Relay Specific Requirements

- 4.5.4.1 The outgoing feeder panels shall have numerical over current and earth fault relay capable of performing both high set and low set operation. The relay shall have additional current input port for sensitive earth fault function.
- 4.5.4.2 The relay shall have binary inputs for activation of auto reclose and sensitive earth fault protection functions via external selector switches.

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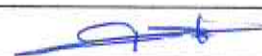
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- 4.5.4.3 The relay shall include a card for arc flash protection. The arc card shall have three light inputs i.e. from cable compartment, from CB compartment and from the bus bar compartment. Each of the three compartments shall have one light sensor lens linked to the relay inputs through a single mode insulated glass fibre optic cable.
- 4.5.4.4 The operation of arc protection shall be programmed to work on two modes; light only and light + current mode.
- 4.5.4.5 Two outputs of the arc protection relay shall be programmed for operation purposes; one output to be used for cable compartment arc sensor operation, the other output to be used for circuit breaker and bus bar compartment arc sensor operation.
- 4.5.4.6 The arc flash protection operating from the cable compartment shall be wired to trip the feeder circuit breaker only.
- 4.5.4.7 The arc flash protection operating from the bus bar and circuit breaker compartments shall trip the incomer circuit breaker, the bus section circuit breaker and the feeder circuit breaker.
- 4.5.4.8 The relay front face LED indications shall be programmed to indicate the following
- 50+50N operated
  - 51+51N operated
  - TCS1/2-unhealthy
  - Load shedding trip
  - SEF operated.
  - Trip relay 86 operated
  - Cable compartment arc sensor operated.
  - Breaker/Busbar compartment arc sensor operated.
  - Auto-reclose in progress
  - Auto-reclose unsuccessful

#### 4.5.5 Bus PT Panel Relay Specific Requirements

- 4.5.5.1 The bus PT panel shall have numerical voltage relay capable of performing both high set and low set operation. The relay shall be capable of performing under-voltage, over-voltage, under-frequency and over frequency protection.
- 4.5.5.2 There shall be four stages of under frequency programmed and wired to a 5-position selector switch in all the outgoing feeders and incomers trip circuits. The selector switch shall have the off, stage 1, stage 2, stage 3 and stage 4 positions. These shall be used for under frequency load shedding.
- 4.5.5.3 The relay shall include a card for arc flash protection. The arc card shall have two light inputs i.e. from PT compartment and from the bus bar compartment. Each of the two compartments shall

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**TITLE:**  
**17.5 KV AIR INSULATED**  
**INDOOR SWITCHGEAR**  
**PANELS – PART 5:**  
**CAPITOL SWITCHING**  
**STATION SPARES -**  
**SPECIFICATION**

<b>Doc. No.</b>	<b>KP1/13D/4/1/TSP//11/001-5</b>
<b>Issue No.</b>	<b>1</b>
<b>Revision No.</b>	<b>0</b>
<b>Date of Issue</b>	<b>2021-04-01</b>
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- i. Circuit breaker ON - Red in colour.
- ii. Circuit breaker OFF - Green in colour
- iii. Auto Trip - Orange in colour
- iv. Trip circuit Healthy - White in colour
- v. Spring Charged - Blue in colour
- vi. Circuit breaker in Service - Red in colour
- vii. Circuit breaker in Test - Green in colour
- viii. Earth switch ON - Red in colour
- ix. Earth switch OFF - Green in colour

**4.6.4 Bus section cubicle LV compartment electrical indications:**

- i. Circuit breaker ON - Red in colour.
- ii. Circuit breaker OFF - Green in colour
- iii. Auto trip - Orange in colour
- iv. Trip circuit Healthy - White in colour
- v. Spring Charged-Blue in colour
- vi. Circuit breaker in service - Red in colour
- vii. Circuit breaker in test - Green in colour

**4.6.5 Bus PT cubicle LV compartment electrical indication**

- i. Earth switch ON - Red in colour
- ii. Earth switch OFF - Green in colour
- iii. 11kV Voltmeter
- iv. Voltage selector switch (L1-L2, L2-L3, L3-L1, L1-N, L2-N, L3-N)


**4.6.6 Circuit breaker mechanical indications**

- i. One mechanical ON/OFF indicator, with inscription "ON" in white letters on red background and inscription "OFF" in white letters on green background. This should be an integral part of the circuit breaker.
- ii. One mechanical indication of the state of the spring inscription, "SPRING CHARGED" (white letters on red background). This should be an integral part of the Circuit Breaker.

**4.6.7 Earth Switch mechanical indications**

- i. One mechanical ON/OFF indicator, with inscription "ON" white letters on red background and inscription "OFF" white letters on green background. This should be an integral part of the earth switch.

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have one light sensor lens linked to the relay inputs through a single mode insulated glass fibre optic cable.

- 4.5.5.4 The operation of arc protection shall be programmed to work on two modes; light only or binary + light mode.
- 4.5.5.5 The arc flash protection operating from the bus bar and PT compartments shall trip the incomer circuit breaker and the bus section circuit breaker.
- 4.5.5.6 The binary input shall be active preferably when there is a current at the incomer circuit or any other method to show presence of primary supply.
- 4.5.5.7 The relay front face LED indications shall be programmed to indicate the following;
- 27 operated
  - 59 operated
  - 81 operated
  - PT secondary MCB trip.
  - PT compartment arc sensor operated
  - Bus bar compartment arc sensor operated.
  - Load shedding stage 1.
  - Load shedding stage 2.
  - Load shedding stage 3
  - Load shedding stage 4

#### 4.6 INDICATING INSTRUMENTS

- 4.6.1 All indicating instruments shall be flush mounted and shall be in accordance to requirement of IEC 60051.
- 4.6.2 Incomer Cubicle LV compartment electrical indications:
- Circuit breaker ON - Red in colour.
  - Circuit breaker OFF - Green in colour
  - Auto Trip-Orange in colour
  - Trip circuit Healthy - White in colour
  - Spring Charged - Blue in colour
  - Circuit breaker in Service - Red in colour
  - Circuit breaker in Test - Green in colour
  - Earth switch ON - Red in colour
  - Earth switch OFF - Green in colour
- 4.6.3 Outgoing feeder cubicle LV compartment electrical indications:

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#### 4.7 POWER CABLE TERMINATION

- 4.7.1 HT cable compartment design shall be suitable either for shrinkable (or equivalent) jointing application termination.
- 4.7.2 The following provisions shall be made:
- Nine gland fabricated sheet steel cable compartment, complete with gland and armour clamp, suitable for receiving nine single core (3 per phase) 11kV cables each of size up to 630mm<sup>2</sup> (for Incomer type panels).
  - Single gland fabricated sheet cable compartment complete with gland and armour clamp suitable for receiving three core cable up to 400mm<sup>2</sup> 11kV XLPE cable (for feeder type panels).
  - The cable compartment design shall facilitate easy modification in future, to receive three single core (1 per phase) 11kV cables of size up to 630mm<sup>2</sup>.

#### 4.8 OTHER FEATURES REQUIRED IN THE SWITCHGEAR PANELS

- 4.8.1 Trip circuit supervision for both CB ON and CB OFF.
- 4.8.2 Detailed nameplate for the Circuit Breaker with all VCB rating details.
- 4.8.3 Name plate for Current and Voltage Transformers with rating details.
- 4.8.4 Two sets of NO + NC auxiliary contact of circuit breaker wired to the control cable termination block for status indication.
- 4.8.5 High voltage presence indicator.
- 4.8.6 Alarm and Annunciator scheme for entire 17.5kV indoor switchboard, with audible Urgent and Non-Urgent Alarm.
- 4.8.7 All indoor switchboard panels shall be provided with Bus-wires for all signal, commands, indications, metering etc. ready for looping to the next switchboard panel.
- 4.8.8 All relays shall be software based incorporating features for fault records, event records and diagnostic data downloaded via RS232 serial port, USB-2 and higher versions.
- 4.8.9 Auxiliary supplies for panel heating and lighting shall be 230VAC, 50Hz, single-phase 3-wire, while protection, spring charging motor, Control and Circuit Breaker Trip/Close auxiliary supply shall be 110VDC.
- 4.8.10 All panels shall have names at the front and at the rear as per feeder or incomer name. The names shall be engraved on a high quality long life PVC or metal material. List of circuits for Jeevanjee 17.5kV Board:

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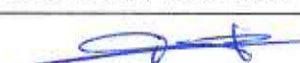
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1. Union Towers : Outgoing Feeder 1
2. Hilton: Outgoing Feeder 2
3. RMU(Local TX): Outgoing Feeder 3
4. Muthurwa Market: Outgoing Feeder 4
5. Bus Section
6. Bus Riser cum Bus PT
7. Parklands: Incoming Feeder 1
8. Jeevanjee 2: Incoming Feeder 2
9. Kimathi House: Outgoing Feeder 5
10. Kirinyaga Road: Outgoing Feeder 6
11. Rupsons House: Outgoing Feeder 7

4.8.11 The circuit breaker carriage shall have the nameplate of the circuits as per the scope of supply.

#### 4.9 CONTROL ACCESSORIES REQUIREMENTS

##### 4.9.1 Outgoing Feeder Panels

All the outgoing feeders shall be equipped with but not limited to the following IEDs:


- i. Three phase over current and earth fault relay IEC 61850 compliant
- ii. Current test block.
- iii. Multifunctional meter.
- iv. Local/ remote switch.
- v. Energy meter provision
- vi. SEF selection switch ON/OFF
- vii. Circuit Breaker Control (Close & Open) push buttons
- viii. Auto-reclose selector switch

##### 4.9.2 Bus Section Panel

4.9.2.1 The bus coupler shall be equipped with but not limited to the following IEDs;

- i. Three phase over current and earth fault Relay IEC 61850 compliant.
- ii. Multifunctional meter.
- iii. Local/Remote switch for CB operation
- iv. Circuit breaker control (Close, Open) push buttons.
- v. Hooter with ON/OFF switch

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vi. Urgent and Non-Urgent Alarm Relays (annunciator) with silence, accept and reset push buttons.

4.9.2.2 The following alarms shall be connected to annunciator;

- a) 110 DC supply fail
- b) 240 AC supply fail
- c) Incomer I fault trip
- d) Incomer II fault trip
- e) Bus section fault trip
- f) Feeder fault trip
- g) Relay internal fault (relay fail)
- h) Trip circuit fail.

NB: In each of the 17.5kV panels, the alarm circuits will be wired and also provided with Bus-wires ready for looping to the next panel.

#### 4.9.3 Bus PT Panel

- i. Under and over voltage protection relay IEC 61850 compliant.
- ii. Voltage selector switch
- iii. Voltage meter.

#### 4.10 INTERLOCKS

The Switchboard shall be equipped but not limited to the following electrical and mechanical interlocks for safe functioning and operation.


##### 4.10.1 Outgoing Feeder Panels interlocks

- i. The circuit breaker shall not be racked in or out in closed position.
- ii. Circuit breaker shall not be racked in with earth switch closed.
- iii. The circuit breaker shall not be operated in the intermediate position.
- iv. The cable compartment door shall only be opened with the earth switch closed.
- v. The racking in of the circuit breaker shall be done with the CB compartment door closed.
- vi. The CB compartment door shall not be opened with the CB in service position.
- vii. The earth switch shall only be closed with the CB in test position.
- viii. It shall not be possible to insert the earth switch operating handle into position except when the circuit breaker is in test position.

##### 4.10.2 Incoming Panels interlocks

- i. The circuit breaker shall not be racked in or out in closed position.
- ii. Circuit breaker shall not be racked in with earth switch closed.
- iii. The circuit breaker shall not be operated in the intermediate position.

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- iv. The cable compartment door shall only be opened with the earth switch closed.
- v. The racking in of the circuit breaker shall be done with the CB compartment door closed.
- vi. The CB compartment door shall not be opened with the CB in service position.
- vii. The earth switch shall only be closed with the incomer CB in test position and the upstream CB open.
- viii. It shall not be possible to insert the earth switch operating handle into position except when the circuit breaker is in test position and the upstream circuit breaker is open.

#### 4.11 WIRING

- 4.11.1 All wiring inside the switchgear panel shall be done with PVC insulated wires not less than 2.5 mm<sup>2</sup>, stranded flexible cables for control, voltage transformers and ac auxiliary supply wiring.
- 4.11.2 The current transformer wiring shall be done with PVC insulated wires of 4.0 mm<sup>2</sup> stranded flexible cables.
- 4.11.3 A suitable wiring duct system firmly fixed on the panel and having covers shall be installed for all inter-panel and front to rear panel wiring as well as for wiring within the panels. This shall provide easy access for inspection and replacement of the wires.
- 4.11.4 Wiring between terminals of various devices shall be point to point. Splices or tee connections will not be acceptable. Wire runs from the duct to the devices shall be neatly trunked or clamped.
- 4.11.5 Exposed wiring shall be kept to a minimum but where used, shall be formed into compact groups suitably bound together and properly supported.
- 4.11.6 Instrument transformers secondary circuits shall be grounded only on the terminal block in the control compartment. Facilities for short circuiting the current transformers secondary windings while the switch gear panel is in service shall be provided. The current transformers shall be mounted in such a way that their secondary winding terminals are easily accessible and visible.
- 4.11.7 Cable supports and clamp type terminal lugs shall be provided for all incoming and outgoing wires terminated at each panel. All wires shall be marked at each point of termination on to the terminal block or device. These wire markers shall be of approved type and permanently attached to the wire. The wire marker or ferrule shall correspond to the device number or terminal block number of origin and the number of terminal where it is connected.

#### 4.12 PHASE ARRANGEMENT

- 4.12.1 The standard phase arrangement when facing the front of the panel shall be R-Y-B-N and L-N from left to right, from top to bottom and front to back for AC 3 phase and single Phase circuits.
- 4.12.2 For DC circuits it shall be P-N from left to right, top to bottom and front to Back

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#### 4.13 WIRING COLOUR CODE

All wires shall have ferrules at all terminations to distinguish each wire and terminal. The wires shall have the following colours as shown in table 7 below;

**Table 7: Wiring Colour code**

No	Circuit	Colour
1	Voltage transformers/Current transformers	Red, Yellow, Blue ,Black
2	Auxiliary AC supply connection cable/bus wire	Red and black
3	DC control wiring within panel	Grey
4	Grounding/earthing cable /wire	Green with yellow stripes.

#### 4.14 PHASE AND POLARITY COLOUR CODE

Coloured ferrules shall be provided on each wire in order to identify phase and polarity as shown in table 8 below.

**Table 8: Phase and polarity colour code**

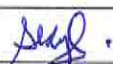
No	Polarity	Colour
1	AC three phase for CT and VT secondary wiring	First Phase-Red Second Phase-Yellow Third Phase-Blue Neutral-Black
2	AC Single phase	First Phase-Red Neutral-Black Ground-Green with yellow stripes.
3	DC auxiliary supply connection	Positive-Red Negative-Black

#### 4.15 ADDITIONAL SPECIFIC REQUIREMENTS FOR THE SWITCHGEAR PANELS

##### 4.15.1 Testing Facilities

- 4.15.1.1 Separate Test facilities for each AC current and voltage transformer secondary circuit so as to give access for testing of each protective relay and its associated circuits. This may consist of either test terminal blocks for the front of the panel mounting with automatic short circuiting of the secondary current by means of movement of links from their normal operating position, or a relay test block mounted adjacent to each or any other suitable testing arrangement.

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4.15.1.2 Each current transformer circuit shall be earthed through a removable link at one point only. The common Protection Trip and Alarm circuit for each Panel shall be provided with an isolation link to facilitate testing and breakdown maintenance.

#### 4.15.2 Relay/device programming software and connection cables

4.15.2.1 All software must be provided for programming and downloading of data for all IEDs supplied. The software User's Guide shall also be supplied.

4.15.2.2 The Numerical Relays shall be equipped with an Ethernet Communication port to facilitate connection to a PC laptop. The relevant communication cable, between the relay and the laptop shall also be provided (3 cables). Communication facilities shall be provided on each Numerical Relay for Remote Interrogation and Programming of the Numerical Relays.

4.15.2.3 All relevant software and firmware upgrades shall attract no additional cost and shall be readily available from manufacturer websites/support centres. The software and firmware upgrades shall not degrade the fundamental protection and control functionality of the relays.

4.15.2.4 Besides the communication port, the relays shall have Human –Machine Interface facility (HMI) with LCD screen where one can easily access the relay information. The HMI on the relay shall be fully functional over the service life of the switchgear without degradation in screen and LEDs visibility and sensitivity of navigation keys/buttons.

#### 4.16 SPARES

The following spares shall be supplied for each board in a station in addition to bidding document spares requirements

- i. Portable set testing plugs- One set
- ii. Spring charging handle- Two sets
- iii. Circuit breaker draw out handle- Two sets
- iv. Two numbers of Circuit breaker TRIP and CLOSE coils


### 5 SUBSTATION AUTOMATION SYSTEM

#### 5.1 GENERAL REQUIREMENTS

5.1.1 The main components of the Substation Automation System (SAS) are communication gateway, inter-bay bus, Intelligent Electronic Devices (IED) for bay control and protection.

5.1.2 A communication gateway/Remote terminal unit shall secure the information flow with Regional Control Centres. The inter-bay bus shall provide independent station-to-bay and bay-to-bay data exchange. The bay level IED for protection and control shall provide the direct connection to the

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switchgear without the need of interposing components and perform control, protection, and monitoring functions.

5.1.3 In order to meet the requirements of this specification the detailed design of the SAS is within the manufacturer's responsibility, but subject to approval by KPLC.

5.1.4 The SAS shall typically include:

- i. 1(one) No. independent Gateway/Remote terminal unit for communications to the SCADA system.
- ii. Satellite clock, complete with GPS Receiver, Antenna and necessary time synchronization ports.
- iii. Laptop Computer for maintenance, information transfer and emergency HMI
- iv. Communication network equipment [station (system) LAN, Field Communication Network, Various optical couplers, etc.].
- v. Interface for control and monitoring of the circuit/bay
- vi. Interface with metering units
- vii. Interface for protection devices that cannot directly interface with the substation LAN


## 5.2 SAS FUNCTIONALITIES

- 5.2.1 It shall have a full operational control, reporting, alarm and indication facilities for the substation from the RCC's (Supervisory level).
- 5.2.2 It shall have an operational control of each new circuit/bay from the protection relay panel using the bay control unit LCD display (Bay level).
- 5.2.3 It shall have the control of each item of plant from the Local Control Cubicle (LCC) (Local Level).
- 5.2.4 The control facilities from each control point shall be interlocked (hardwired) to prevent operation of any device simultaneously from more than one control point.
- 5.2.5 At least one fully operational control point shall remain available in the event of a single equipment or communications failure.
- 5.2.6 Complete facilities shall exist for the proper lockout and maintenance tagging of circuits and plant items to ensure the safety of personnel and the security of the system
- 5.2.7 The SAS shall use open communication protocols and be readily interfaced with third party devices operating on open protocols. The Tenderer shall describe such interfaces and provide an experience list of devices with which the offered control system has previously been interfaced.

## 5.3 GENERAL SYSTEM DESIGN

- 5.3.1 The SAS shall be suitable for operation and maintenance of the complete substation including future extensions. The offered products shall be suitable for efficient and reliable operation of outdoor or indoor substations for distribution and transmission.
- 5.3.2 The systems shall be of the state-of-the art based on IEC61850, IEC60870-5-101,103,104 for operation under electrical conditions present in high-voltage substations, follow the latest

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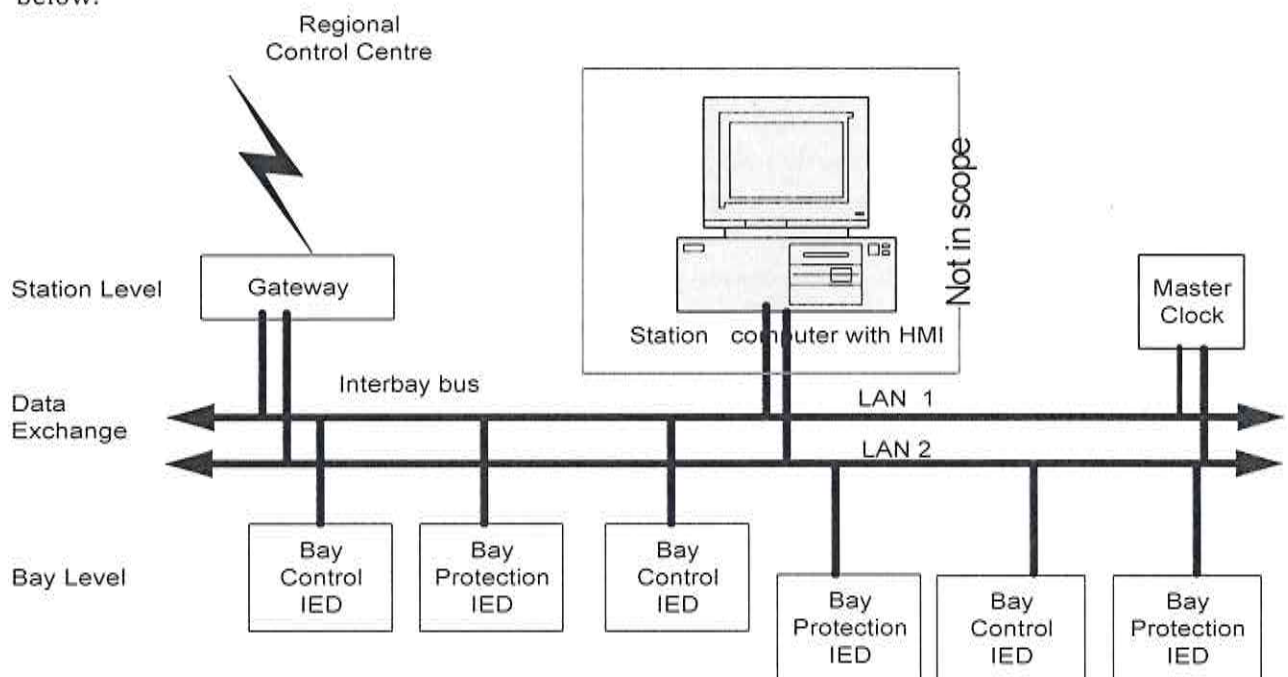
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engineering practice, ensure long-term compatibility requirements and continuity of equipment supply and the safety of the operating staff. Other serial protocols for connection of legacy equipment i.e RS232/485, Modbus&/Modbus TCP shall also be supported.

- 5.3.3 The offered SAS, shall support remote control and monitoring from Regional Control Centre via a gateway/remote terminal unit.
- 5.3.4 The system shall be designed such that personnel without any background knowledge in microprocessor-based technology are able to operate the system easily after having received some basic training.
- 5.3.5 Cubicles shall incorporate the control, monitoring and protection functions specified, self-monitoring, signalling and testing facilities, measuring as well as memory functions, event recording, Sequential Event Recording (SER) with time stamping of events at the RTU and disturbance recording. The basic control functions are to be derived from a modular standardized and type-tested software library.
- 5.3.6 For safety and availability reasons the Substation Automation System shall be based on a decentralized architecture and on a concept of bay-oriented, distributed intelligence.
- 5.3.7 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.
- 5.3.8 The typical SAS layout shall be structured in two levels, i.e. in a station and a bay level as shown below.



**System Architecture of Substation Automation**

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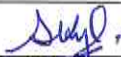
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**Figure 1: Architecture of Substation Automation System**

- 5.3.9 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 shall be directly connected to the switchgear without any need for additional interposition or transducers.
- 5.3.10 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.
- 5.3.11 The data exchange between the electronic devices on bay and station level shall take place via the inter-bay bus. The bus shall be realized using fibre-optic cables or Ethernet.
- 5.3.12 The entire station shall have the capability to be controlled and supervised from a station HMI in future. This shall however not be implemented in this scope.
- 5.3.13 To provide highest reliability the gateway/RTU shall work completely independent meaning retrieving the process data directly from the bay level devices.
- 5.3.14 Clear control priorities shall prevent that operation of a single switch can be initiated at the same time from more than one of the various control levels, i.e. SCADA, station, bay level or apparatus level. The priority shall always be on the lowest enabled control level.
- 5.3.15 The supervisory level contains gateway for the communication with remote control centres.
- 5.3.16 A dedicated master clock for the synchronization of the entire system shall be provided. This master clock should be independent of the station computer and of the gateway, and should synchronize all devices via the inter-bay bus.
- 5.3.17 The SA shall contain the following main functional parts:
- Gateway/RTU for remote supervisory control via SCADA.
  - Master clock (e.g. GPS receiver).
  - Collection of the relevant data concerning the substation and distribution of the data where needed.
  - Bay and supervisory level devices for control, monitoring and protection.
  - Bay-oriented local control panels.
- 5.3.18 The signal list shall comprise the following:
- Commands
  - Status Indications
  - Alarms
  - Set Point Regulation
  - Measured Values
  - Energy measurement
- 5.3.19 The design shall include mapping of the Signal list from the supplier to the requirements of the Regional Control Centre (supervisory level) signal requirements.
- 5.3.20 The design of the supervisory control system shall include the following:
- Control mode selection
  - Select-before-execute principle

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- iii. Command supervision:
  - a. Interlocking and blocking
  - b. Double command
- iv. Auto reclosing
- v. Monitoring pole discrepancy and trip function
- vi. Transformer tap changer control
- vii. Display of interlocking and blocking
- viii. Breaker position indication
- ix. Alarm annunciation
- x. Sequential Event Recording (SER) with time stamping of events
- xi. Measurement display
- xii. Data storage for at least 200 events

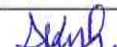
**5.3.21 Select-before-execute:**

- 5.3.21.1 For safety reasons the command is always given in two stages: selection of the object and command for operation.
- 5.3.21.2 These two commands are realized with one contact each; only when both contacts are closed, is the final command (open or close) executed.

**5.3.22 Gateway/RTU:**

- 5.3.22.1 It shall collect, store and map signals of relays, measurement units, control units and IEDs in the substation to regional control centre
- 5.3.22.2 The standard protocols which shall be supported by the RTU/gateway are:
  - i. IEC 60870-5-101/-103/-104
  - ii. IEC 61850
  - iii. DNP3, serial and TCP/IP
  - iv. Modbus serial and TCP/IP
  - v. Meter interfaces
- 5.3.22.3 Parameter setting, diagnostics and testing by means of a configuration tool shall be provided in this scope both locally and remotely.
- 5.3.22.4 Database and parameter setting shall be by menu-controlled dialogues from a local PC and remotely from the corresponding control centre with downloading function.
- 5.3.22.5 Equipment used shall comply with IEC 61850-3, IEEE 1613 and NEMA TS 2 for ruggedness and reliable communications performance
- 5.3.22.6 Extended temperature ranges shall be -40°C to +75°C for rough ambient conditions.
- 5.3.22.7 It shall have high EMC stability for direct use in substations, complying with IEC 60255.
- 5.3.22.8 The substation master control shall be capable of automatic restart in the event of power failure without loss of functionality or local database.
- 5.3.22.9 It shall be possible to interface with 3rd party IEDs

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**TITLE:**  
**17.5 KV AIR INSULATED**  
**INDOOR SWITCHGEAR**  
**PANELS – PART 5:**  
**CAPITOL SWITCHING**  
**STATION SPARES -**  
**SPECIFICATION**

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- 5.3.22.10 It shall have cybersecurity features that comply with NERC\_CIP and BDEW whitepaper for requirements for secure control and telecommunications system
- 5.3.22.11 It shall be readily possible to update the substation computer software/gateway software to alter or extend the SCS functionality. The Tenderer shall state how this is achieved.
- 5.3.23 Substation Local Area Network
- 5.3.23.1 Local substation communications shall use Ethernet LAN to connect the components of the SCS using open international protocols like IEC 61850. The LAN may be of star-coupler configuration. No single point of failure of the substation LAN shall result in any loss of substation control functionality.
- 5.3.23.2 Equipment used shall comply with IEC 61850-3, IEEE 1613 and NEMA TS 2 for ruggedness and reliable communications performance.
- 5.3.24 Satellite Clock:  
Time synchronization and event time tagging with resolution of 1ms shall be provided by a satellite GPS clock signal as the Master clock. The secondary clock shall be provided via the SCADA system.
- 5.3.25 Audible Alarm
- 5.3.26 One common sounder shall be provided to give at least two distinct audible alarms in case of alarms/faults or events.
- 5.3.26.1 The sounder shall be configurable according to the event type and to the control status of the SCS (Local/Remote). An auto-silencing scheme shall be provided for the alarm and the sounder shall be controlled by distinctly labelled "Audible alarm ON/OFF" control switch.
- 5.3.26.2 The complete unit may be mounted in suitable relay/control panel.
- 5.3.27 Common Bay Unit  
The Common Bay Unit (CBU) shall be provided for monitoring of common services. The CBU shall be located in Control/Relay Room.
- 5.3.28 Data Transmission:
- 5.3.28.1 The SAS shall be able to communicate with the existing KPLC SCADA central system using a variety of open protocols. The RCC shall be capable of remote access to the SAS via the SCADA system. The protocols currently supported are IEC 60870-5-101 & IEC 60870-5-104.
- 5.3.28.2 This communication link must be via an approved communication mode complete with the terminal equipment all supplied, installed & commissioned in this scope.
- 5.3.29 Spare Parts:  
The Contractor shall furnish a list of recommended spare parts and test equipment for the purchased SA system to maintain reliable SCMS operation. The spare parts list shall be subdivided into:
- short-term spare parts that are necessary for two (2) years of operation. These spare parts shall be included in the contract.
  - long-term spare parts that are necessary for ten (10) years of operation.

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### 5.3.30 Documentation

5.3.30.1 The Contractor shall provide all necessary drawings, design specifications, design details, operation and maintenance manuals. All manuals and As-Built-Drawings documents shall be supplied in three hard copies and a softcopy in PDF.

5.3.30.2 The following documentation should be provided for the system in the course of the project. It shall be consistent, CAD supported and of similar look/feel:

- i. Control Room Layout
- ii. Single-Line Diagram
- iii. Block Diagram
- iv. Circuit Diagram
- v. List of Apparatus/ Equipment
- vi. List of Labels
- vii. Functional Design Specification (FDS)
- viii. Test Specification for Factory Acceptance Test (FAT)
- ix. Logic Diagram
- x. List of Signals
- xi. Operator's Manual
- xii. Product Manuals
- xiii. Calculation for uninterrupted power supply (UPS) dimensioning
- xiv. Concept and contract for maintenance
- xv. It is necessary to present the technical description and the technical data for the whole system and for any equipment and function
- xvi. Time plan for the project realization.

### 5.3.31 SCMS System Maintenance:

5.3.31.1 A laptop computer as a service unit shall be foreseen for on-site modifications of the control and protection devices. This service unit shall be used for documentation, testing, commissioning & future maintenance work on the SCMS.

5.3.31.2 It shall be equipped with the necessary configuration software for all the SCMS equipment supplied, particularly the RTU/gateway configuration tool.

### 5.3.32 System Acceptance

The System will be accepted by KPLC if both:

- i. The System and all items of equipment have successfully completed all the specified tests
- ii. All failures, problems and reservations noted during the tests have been corrected to the satisfaction of KPLC.
- iii. If either of these conditions has not been complied with, then the necessary corrective action shall be agreed between the Contractor and KPLC.

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## 6 TEST REQUIREMENTS

- 6.1 The switchgear and protection/control panels shall be inspected and tested in accordance with the requirement of IEC 62271-200 and this specification.
- 6.2 Circuit breakers shall be inspected and tested in accordance with the requirement of IEC 62271-100 and this specification.
- 6.3 Relays shall be inspected and tested in accordance with the requirement of IEC 60255 and this specification.
- 6.4 Current transformers and voltage transformers shall be inspected and tested in accordance with the requirement of IEC 61869-2, IEC 61869-3 and IEC 61869-6 respectively and this specification.

## 7 MARKING AND PACKING

- 7.1 The switchgear panels and associated components shall be packed in a manner as to protect them from any damage in transportation, storage and repeated handling.
- 7.2 Each assembly and package of items associated with the switchgear shall be suitably marked. A packing and parts list shall be provided.
- 7.3 In addition to markings required elsewhere in the specification, each panel and component shall be marked in accordance with the relevant IEC standard and shall include the following:
  - i. Name of manufacturer and country
  - ii. Type/Model reference number
  - iii. Ratings (voltage, current, insulation, frequency etc.)
  - iv. Serial number
  - v. Month and year of manufacture
  - vi. Property of KPLC

## 8 SAMPLE

- 8.1 Following the Approval of the drawings, the manufacturer shall initially manufacture one sample panel. Upon manufacture of the panel, the manufacturer shall invite the Employer to inspect and conduct factory acceptance tests (FATs) on the panel.
- 8.2 The manufacturer shall then rectify any minor defects noted during this initial FATs. Upon successful initial FATs, the Employer shall authorize the manufacturer to proceed with manufacture of all the other switchgear panels.
- 8.3 Where the manufactured sample panel is unsatisfactory and the manufacturer fails to rectify the switchgear panel to satisfactory standard within four weeks after attendance of the initial FATs, the Employer shall have the option to cancel the tender.

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## APPENDICES

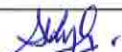
### APPENDIX A: TESTS AND INSPECTION (NORMATIVE)

- A.1. It shall be the responsibility of the manufacturer to perform or to have performed all the tests specified.
- A.2. Certified true copies of previous Type Test and Routine Test Reports issued by the National Testing/ Standards Authority of the country of manufacture (or ISO/IEC 17025 accredited laboratory) shall be submitted with the offer for evaluation (all in English Language). A copy of the accreditation certificate for the laboratory shall also be submitted. Any translations of certificates and test reports into English shall be signed and stamped by the Testing Authority
- A.3. The equipment shall be subject to Factory Acceptance Tests (FATs) at the manufactures' works before dispatch. The routine tests shall be as per relevant manufacturing standards. Acceptance tests will be witnessed by two Engineers appointed by Kenya Power and Lighting Company Limited (KPLC).
- A.4. Triplicate copies of test reports shall be completed for all the circuit breakers, voltage transformers, current transformers and Protection and Control schemes and submitted to Kenya Power and Lighting Company for approval before shipment.
- A.5. On receipt of the equipment, Kenya Power shall inspect and may perform or have performed any of the relevant tests to verify compliance with the specification. The manufacturer shall replace without charge to Kenya Power, equipment which upon examination, test or use fail to meet any or all the requirements in the specification.

### APPENDIX B: QUALITY MANAGEMENT SYSTEM (NORMATIVE)

- B.1. The Supplier shall submit a Quality Assurance Plan (QAP) that will be used to ensure that the design, material, workmanship, tests, service capability, maintenance and documentation, will fulfil the requirements stated in the contract documents, standards, specifications and regulations. The QAP shall be based on and include relevant parts to fulfil the requirements of ISO 9001: 2015.
- B.2. The Manufacturer's Declaration of Conformity to reference standards and copies of Quality Management Certifications including copy of valid and relevant ISO 9001:2015 Certificate shall be submitted with the tender for evaluation.
- B.3. The bidder shall indicate the delivery time of the switchgear and control panel, manufacturer's monthly and annual production capacity and experience in the production of the equipment for Kenya Power.

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## APPENDIX C: TECHNICAL DOCUMENTATION (NORMATIVE)

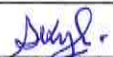
C.1. The bidder shall submit its tender complete with technical documents for tender evaluation. The technical documents to be submitted (all in English language) for tender evaluation shall include the following:

- Fully-filled clause by clause Guaranteed Technical Particulars (GTPs — Appendix D) stamped and signed by the manufacturer;
- Copies of the Manufacturer's catalogues, brochures, drawings and technical data;
- Hard copy design drawings of the equipment done on AutoCAD detailing dimensions, panel layout, wiring and schematic. The drawings shall include 3-D views.
- Sales records for previous five years outside the country of origin and reference letters from at least four of the customers;
- Details of manufacturing capacity and the manufacturer's experience as per bidding document;
- Copies of type test reports and certificates by a third-party testing laboratory accredited to ISO/IEC 17025;
- Copy of accreditation certificate to ISO/IEC 17025 for the testing laboratory;
- Manufacturer's warranty and guarantee as per bidding document;
- Manufacturer's letter of authorization, copy of the manufacturer's ISO 9001:2008 certificate and other technical documents required in the tender.

C.2. The successful bidder (supplier) shall submit the following documents/details (from the manufacturer as per tender) to The Kenya Power & Lighting Company Plc for approval before manufacture:

- Fully-filled clause by clause Guaranteed Technical Particulars (GTPs) signed by the manufacturer;
- Hard copy drawings of the equipment done on AutoCAD detailing dimensions, panel layout, wiring and schematic. The drawings shall include 3-D views. The drawings shall be in standard format clearly indicating drawing number, parts list with material details & quantities, standard of manufacture, ratings, approval details and identify of the manufacturer (as per manufacturer's authorization submitted during tendering). The drawings shall be stamped and signed by the manufacturer.

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- c) Three sets of operational manuals and drawings detailing dimensions, panel layout, wiring and schematic.
  - d) Quality Assurance Plan (QAP) that will be used to ensure that the design, material, workmanship, tests, service capability, maintenance and documentation will fulfil the requirements stated in the contract documents, standards, specifications and regulations. The QAP shall be based on and include relevant parts to fulfil the requirements of ISO 9001:2008;
  - e) Detailed Test Program to be used during factory testing;
  - f) Marking details and method to be used in marking the equipment;
  - g) Packaging details (including packaging materials and marking and identification of component packages).
- C.3. Three copies of as built drawing on A3 or A4 paper to be supplied prior to shipment of the switchgear. A soft copy of the drawings done on AutoCAD and editable on AutoCAD release 2000 and later versions to be supplied for commissioning and storage as a backup.
- C.4. All manuals necessary for Operations & Maintenance, Commissioning, Installation, Testing Configuration and Programming, of the relays and all other equipment shall be provided with the switchgear.
- C.5. Foundation /mounting details shall be provided to guide in Civil works.
- C.5. All necessary software for configuration, setting and programming and for downloading and analysis of Relay data shall be provided. The software and updates shall be provided at no extra costs.

#### **APPENDIX D: MANUFACTURER'S QUALIFICATION**

- D.1. The 17.5kV Switchgear panel manufacturer shall have a minimum of 25 years' experience in the manufacture of 17.5kV Switchgear panel.
- D.2. The 17.5kV Switchgear panel on offer shall have been in service and given reliable service for a minimum period of 8 years in at least two (2) power utilities in at least three (3) of the following continents/regions:
- a) Europe
  - b) North America
  - c) Africa
  - d) Asia or South America

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- D.3. The 17.5kV Switchgear panel manufacturer shall provide references to support these requirements including export records with copy of contractual letters, switchgear panel's details and date of sale/export, letter of satisfaction from power utilities shall also be provided with the bid.
- D.4. 17.5kV Switchgear panel that have failed in service or mal-operated while in service on the Kenyan power system shall not be accepted.
- D.5. The warranty for the offered 17.5kV Switchgear panel shall be 5 years from the date of delivery to KPLC store.

## **APPENDIX E: TRAINING**

### **E.1 TRAINING AT THE MANUFACTURER'S PREMISES**

- During the factory acceptance testing (FAT), the manufacturer shall conduct complete training for the 17.5kV Switchgear and SAS for the two KPLC Engineers/Technicians attending FATs.
- This shall include theory followed by practical demonstrations. All the operational and installation procedures shall be exhaustively explained and demonstrated.
- The manufacturer shall plan adequate time for the training separate from the FATs. The duration of the training shall however not be less than one (1) eight-hour working day. The employer may send a separate team from the team witnessing the FATs to attend the training. The duration and the cost of the training shall be indicated in the bid.
- The full cost of the visit, including air tickets and accommodation shall be borne by KPLC. The manufacturer/bidder shall however take care of the local transport.
- The manufacturer shall conduct an assessment to ensure that the KPLC Engineers/technicians have acquired the necessary knowledge and skills to be able to successfully install the switchgear panels and SAS on the power system.
- On completion of the training for the SAS, KPLC staff shall be able to modify and make changes to the configuration of the SCMS including the gateway and signal list mapping to accommodate any future changes as well as interfacing & data transmission to the RCC.

### **E.2 LOCAL TRAINING (IN KENYA)**

- Following the delivery of the switchgear panels and SAS, the manufacturer shall conduct complete training for the complete set of terminations/joints for a total of (20) KPLC Engineers/Technicians, in Nairobi Kenya.
- The Training shall include theory on how the equipment works followed by practical demonstrations on safety, installation procedures and instructions and parameter settings. All steps in installation shall be exhaustively explained and demonstrated, including normalizing the system and documenting the site events

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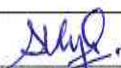
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- (c) The manufacturer shall meet the total cost of the factory as well as Local Training in Nairobi Kenya.
- (d) The supplier shall also meet all the other costs for conducting the local training, including local accommodation and transport for the training staff. The supplier shall provide all the training materials including notes.
- (e) The manufacturer shall conduct an assessment to ensure that the KPLC Engineers/technicians have acquired the necessary knowledge and skills to be able to successfully install the switchgear panels and SAS on the power system.
- (f) On completion of the training for the SAS, KPLC staff shall be able to modify and make changes to the configuration of the SCMS including the gateway and signal list mapping to accommodate any future changes as well as interfacing & data transmission to the RCC.

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**APPENDIX F: GUARANTEED TECHNICAL PARTICULARS (GTPS) — NORMATIVE**

*(to be filled and signed by the Supplier/manufacturer and submitted together with relevant copies of the Manufacturer's catalogues, brochures, drawings, technical data, sales records for previous five years, four customer reference letters, details of suppliers' capacity and experience; and copies of complete type test certificates and test reports for tender evaluation, all in English Language)*

**Tender No.** .....

**Bidder's name and Address**.....

Clause	Description	KPLC Requirement	Bidders offer*
	Manufacturer's Name		State
	Country of Manufacture		State
	Type Reference/Model Number of item	Complete Panel	State
		Circuit breaker	State
		Voltage Transformer	State
		Current Transformer	State
		Relays	State
		SAS	State
<b>1.</b>	<b>Scope</b>		
1.1	Scope	17.5kV Metal Enclosed Switchgear and Protection Panels with a Substation Automation System	Specify
1.2	List of complete Switchgear panels	2 No. incoming feeders (Incomers) boards, 7 No. outgoing feeders boards, 1 No. Bus Section panel, 1 No. Bus PT cum riser panel	Specify
	The incomers shall come complete with VTs		Specify
<b>2.</b>	<b>References (Normative)</b>		
	Applicable Standards	Complete Panel	List
		Circuit breaker	List
		Voltage Transformer	List
		Current Transformer	List
		Relays	List
		SAS	List
<b>3.</b>	<b>Terms and Definitions</b>		State
<b>4.</b>	<b>Requirements</b>		

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Clause	Description	KPLC Requirement	Bidders offer*
<b>4.1.1</b>	<b>Service Conditions</b>		
	Altitude	Up to 2200m above sea level	Specify
	Pollution	Heavy saline (Pollution level IV) atmosphere in accordance to IEC 60815	Specify
	Humidity	95%	Specify
	Ambient Temperatures	+30° C average, (-1° C Min and +40° C Max.).	Specify
	Isokeraunic Level	Up to 180 thunderstorm days per year	Specify
<b>4.1.2</b>	<b>System Conditions</b>		
Table 1	Frequency	50 Hz	Specify
	Highest System voltage	17.5kV	Specify
	Rated Normal current(Ir)	Bus bars 1600A	Specify
		Incomer Circuit Breaker 1250A	Specify
		Feeder Circuit Breaker 630A	Specify
	Rated Short time current withstand (3sec)(Ik)	31.5 kA rms	Specify
	Rated peak withstand current (Ip)	78 kA pk	Specify
	Rated breaking capacity	31.5 kA	Specify
	Rated making capacity	78 kA	Specify
	Minimum Lightning Impulse Withstand Voltage 1.2/50µs +ve, dry (peak)	95 kV pk	Specify
	Minimum Power Frequency Withstand (Dry) Voltage (rms)(1 min)	38 kVrms	Specify
	Internal Arc Classification (IAC) in accordance to IEC 62271-200	31.5kA, 1 Sec	Specify
	IAC Class	AFLR	Specify

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


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Clause	Description	KPLC Requirement	Bidders offer*
	Class IV Site pollution severity (SPS) as per IEC/TS 60815	Very heavy	Specify
	Specific creepage distance as per IEC/TS 60815:2008 – class	31mm/kV	Specify
4.2	<b>Design and Construction</b>		
4.2.1	Standard of manufacture	IEC 62271-200	Specify
4.2.2	Type of design	Flush-front design	Specify
4.2.3	The width of the panels for outgoing feeders and bus PTs	630mm	Specify
	The width of the incomer and bus-section panels	780mm	Specify
	The maximum height of the board	2500mm	Specify
4.2.4	The switchgear shall be built up of individual metal enclosed cubicles or modules with earthed metal partitions		Specify
	The circuit breakers (CB) shall be mounted on an in-built carriage of the horizontal draw-out type		Specify
	Trolleys	2 No. trolleys for feeder panels	Specify
		2 No. trolleys for Incomer/Bus-section panels	Specify
4.2.5	Number of compartments	Busbar, MV cable connection, switching device and low voltage (LV) section.	Specify
4.2.6	Low voltage section shall be	separate from the medium voltage section	State
4.2.7	Erection requirements	shall be designed for erection with the rear side close to a wall as well as for freestanding erection and shall have provisions for bolting to the floor	State
4.2.8	Over pressure vent	Provide	State
4.2.9	An anti-vermin guard plate	Provide in the cable compartment	State
4.2.10	Hinged and lockable doors	provide at the front of each cubicle for the respective LV compartment, circuit breaker compartment and cable connection compartment	State
4.2.11	Front cubicle door provided with a window		State

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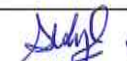
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Clause	Description	KPLC Requirement	Bidders offer*
4.2.12	Manual close and open push buttons provided on the circuit breaker compartment door		State
	Labelling of close and open push buttons	Clearly labelled with "close" and "open " labels and with symbols and colour codes as per the IEC standard	Specify
4.2.13	Clear window provision in the cable compartment		State
4.2.14	Degree of protection	IP 43	Specify
4.2.15	Earthing	All metallic instrument cases, protective relay, switches etc. shall be properly earthed to the switchgear board steelwork frame	Specify
4.2.16	Rear cable chamber covers	provide with handles and all bolts and nuts shall be stainless steel	Specify
4.2.17	Mimic diagram	Provide on the LV compartment door.	State
4.2.18	Busbar shall be single, three phase, air insulated and appropriately encapsulated		State
	Busbar material	high conductivity and electrolytic Copper	State
4.2.19	Busbar Marking	R,Y,B	State
	All the jointing points/ends are tin-plated		State
4.2.20	Bus bars, connections and support current ratings	1600A	State
4.2.21	Bus bars extensible at both ends with minimum disturbance to existing busbar		Specify
4.2.22	Busbar shutters marking		Specify
4.2.23	Provision for locking busbar and circuit shatters separately		Provide
4.2.24	Provision for integral circuit earthing with mechanical interlock		Specify
4.2.25	Earthing facilities rated for fault making		Specify
	Padlocking facility for the earth switch.		Specify
4.2.26	Material for earth bus and cable	Copper of 99.5% purity	Specify
4.2.27	Terminal blocks shall be provided for all out going power and control cables		Specify
	CT and VT terminal blocks	Provision for isolation and banana type sockets for inserting test leads	Specify
	CTs terminal block rating	Maximum possible secondary current of CTs provided	Specify

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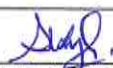
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Clause	Description	KPLC Requirement	Bidders offer*
4.2.28	The internal panel wiring for protection, instruments, indications, metering circuits and other control accessories shall be complete with appropriate ferrules and lugs		Specify
4.2.29	All circuits for connection to external cables shall be wired up to the terminal block at the front of the panel where external cable shall be connected.		Specify
4.2.30	All projected inter-panel wiring shall be provided in respective cubicles with the wires ferruled, lugged and ready for termination with sufficient spare length.		Specify
4.2.31	No. of spare terminals on the terminal block	12	Specify
4.2.32	Primary power cable terminals location	For rear bottom entry connection.	Specify
4.2.33	Auxiliary supplies control	Miniature circuit breakers rated to carry the full load of the equipment	Specify
4.2.34.	The cubicle shall be tropical vermin proof		Specify
	Material of cubicle	High quality mild steel	Specify
	Thickness	2mm	Specify
4.2.35	Final coat colour	RAL 7032 as specified in BS 381C	Specify
	Thickness of paint	80 microns	Specify
4.2.36	Anti-condensation heaters are provided inside each cubicle		Specify
	A hygrostat control unit with variable temperature and humidity control setting is installed to control the heaters		Specify
	The heaters is controlled from a two-position control switch with positions "ON-OFF" in each cubicle		Specify
4.2.37	Interior illumination lamps operated by door switches shall be provided for each switchgear control compartment (LV compartment)		Specify
	Types of lamps	Low power LED	Specify
4.2.38	Operating voltage for heaters and lighting	230V ac	Specify
4.2.39	Socket type	230V ac socket outlet of 3-point square terminals	Specify
4.2.40	Monitoring unit for HV cable	A three-phase device with illumination in red colour for live status visible from the front of the panel without opening any compartment doors	Specify
4.2.41	Material of earth bar	Copper	Specify

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Clause	Description	KPLC Requirement	Bidders offer*
	Arrangement of the bars of adjacent panels are joined together to form a common earth bus bar for the entire switchgear board		Specify
	Provisions at both ends of the assembled switchgear board for connection of the earthing bar to the substation-earthing grid.		Specify
4.2.42	Changeover scheme for the secondary VT output		Specify
4.3	Characteristics		
4.3.1	Low Voltage Equipment		
4.3.1.1	Rated voltage between the phases	400V ac	State
	Connection type	3ph 4 wire	State
	Rated voltage between phase and earth	230V ac	State
	Grounding system	PME	State
	Frequency	50hz	State
	Voltage variation	± 10	State
	Frequency variation	± 2%	State
	Power frequency 1 min test voltage	3kV	State
	Thermal rating of conductors	120%	State
	Maximum short circuit current	31.5kA	State
4.3.1.2	AC supply application	Power circuits, panel sockets, panel illuminations and panel heaters.	State
4.3.2	DC Auxiliary supply rating		
	Equipment/device rated voltage	110V DC	State
	Connection type	2 wire	State
	Voltage variation	77V - 137.5V DC	State
4.3.3	Medium Voltage Plant Equipment		
	System description	50Hz, 3 phase, 3 wire	State
	Neutral point earthing	Solidly earthed.	State
	Highest equipment rated voltage as defined by IEC-60071	17.5kV	State

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Clause	Description	KPLC Requirement	Bidders offer*
	Maximum rated continuous current of circuit breakers for feeders	630A	State
	Maximum rated continuous current of circuit breakers for for incomers and Bus -section	1250A	State
Insulation level according to IEC 60071	Minimum Lightning Impulse Withstand Voltage 1.2/50µs +ve, dry (peak)	95kVpk	State
	Minimum Power Frequency Withstand dry Voltage (rms)(1 min)	38kVrms	State
Bus clearances.	Phase to earth	300mm	State
	phase to phase	250mm	State
	Rated Short time current withstand (3sec)(Ik)	31.5 kA rms	State
	Rated peak withstand current (Ip)	78 kA pk	State
	Rated breaking capacity	31.5 kA	State
	Rated making capacity	78 kA	State
	Specific creepage distance as per IEC/TS60815:2008 - class	31 mm/kV	State

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Clause	Description	KPLC Requirement	Bidders offer*
4.4	Medium Voltage Component Characteristics		
4.4.1	17.5 kV Circuit Breaker		
4.4.1.1	Standard of manufacture	IEC 62271-100	State
	Type of circuit Breaker	Three pole operated, indoor withdrawable type, employing Vacuum Interrupter, with air insulation	State
4.4.1.2	Moving portion components	A three-pole contacts, operating mechanism, primary and secondary disconnecting devices, auxiliary switches, position indication and necessary control wiring	State
4.4.1.3	Auxiliary switches type	Plug-in type	State
	Type and position of contacts	The male contacts mounted on the breaker carriage and the female contacts on the plug-in cable connected to the panel wiring.	State
4.4.1.4	Provision of extension cable to allow for testing		State
4.4.1.5	Interchangeability of circuit breakers		State
4.4.1.6	CB operating mechanism characteristics	Motor wound spring operated, power closing with electrical release and with provision for manual (hand) charge	State
4.4.1.7	Operation cycle	0 - 0.3 sec - CO- 3min - CO	State
4.4.1.8	Coils	Two tripping coils and one closing coil	State
4.4.1.9	Mechanical indication to indicate the state of the spring		Specify
4.4.1.10	Insulation between the interrupter units and the primary plug-in contacts		Specify
4.4.1.11	No of spare auxiliary contacts	At least 8NO and 8NC auxiliary contacts	Specify
4.4.1.12	Provision of anti-pumping facility		Specify
4.4.1.13	Control circuit design	Automatically be connects when inserting the breakers into the cubicle by use of a single plug-in cable	Specify
4.4.2	<b>Current Transformers</b>		
4.4.2.1	Standard of manufacture	IEC 61869-2 and IEC 61869-6	Specify
4.4.2.2	Type	Single phase	Specify
4.4.2.3	The current transformers shall have the specified accuracy under load conditions		Specify

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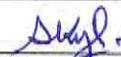
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Clause	Description	KPLC Requirement	Bidders offer*
	Shall be able to withstand the effect of short-circuit fault current rating of the switchgear for 3 seconds		Specify
4.4.2.4	Current transformers have rated burden sufficient		Specify
4.4.2.5	Ratings		
	Type	Wound epoxy cast resin	Specify
	Highest System Voltage	17.5kV	Specify
	Short time Current with stand (STC)	31.5kA for 3 sec	Specify
	Maximum Continuous Thermal Rating (1.5 In)	For outgoing Feeders 900A	Specify
		For Incomers and Bus section 1875A	Specify
	Lightning Impulse Withstand Voltage	95kVpeak	Specify
	One-Minute Power Frequency Withstand Voltage	38kVrms	Specify
	CT Burden	15VA	Specify
	Incoming (Incomer)		
	Ratio	600-400/1/1A	Specify
	Class	Core 1 5P 20	Specify
		Core 2 0.5 ISF 10	Specify
	Outgoing Feeders		
	Ratio	600-400/1/1A	Specify
	Class	Core 1 5P20	Specify
		Core 2 0.2 ISF 10	Specify
	Core Balance Current Transformer on Outgoing feeder		
	Ratio	50/1A	Specify
	Class	5P10	Specify
	Bus Section Panel CTs		
	Ratio	600-400/1/1A	Specify
	Class	Core 1 5P20	Specify

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Clause	Description	KPLC Requirement	Bidders offer*
	Core 2	0.5 ISF 10	Specify
4.4.3	Voltage Transformer		
4.4.3.1	Standard of manufacture	IEC 61896-3	Specify
4.4.3.2	VT type	Epoxy cast resin type, shall be one for each of the three phases, and, star/star connected complete with removable HV fuses and links	Specify
4.4.3.3	VT mounting	A common withdrawable truck located in the cable compartment	Specify
4.4.3.4	Location of Bus VT	The bus VT shall be located in the bus PT panel on one section of the board and in the bus riser cum bus PT panel on the other section of the board	Specify
	Bus VT type	Horizontal draw out type	Specify
4.4.3.5	VT protection	A TPN MCB	Specify
Table 5	Ratio	11000/√3/110/√3	Specify
	Burden	30VA	Specify
	Impulse Withstand Voltage	95kV peak	Specify
	One-Minute Power Frequency Withstand Voltage	38kVrms	Specify
	Incomer Panel Voltage Transformers		
	Ratio	11000/√3:110/√3: 110/√3V	Specify
	Class	Core 1 0.5	Specify
		Core 2 3P	Specify
	Bus PT Voltage Transformer		
	Ratio	11000/√3:110/√3: 110/√3V	Specify
	Class	Core 1 0.2	Specify
		Core 2 3P	Specify
4.5	Relay		
4.5.1	General Requirements		
4.5.1.1	Standard of manufacture	IEC 60255 and EMC 89/336/EEC compliant	Specify
4.5.1.2	Relay type	Numeric design and supports GOOSE messaging and communication protocols 60870-5-103 and 61850-9-2.	Specify
4.5.1.3	Provision of Test switch (block)		Specify

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Clause	Description	KPLC Requirement	Bidders offer*
4.5.1.4	Relay current rating	1A	Specify
	Relay voltage rating	110V DC	Specify
4.5.1.5	Relay contacts are suitable for making and breaking the maximum currents, which they are required to control in normal service		Specify
4.5.1.6	Auxiliary Trip relay short pick up times	<30 ms	Specify
4.5.1.7	Relay contacts make firmly without bounce		Specify
	the relay mechanism is not affected by panel vibration or external magnetic fields		Specify
4.5.1.8	Relay labelling		Specify
4.5.1.9	Suitable for operation on 110VDC supply without use of dropping resistors or diodes.		Specify
4.5.1.10	Relay LEDs are visible from the front of the panel without opening the panel door(s)		Specify
4.5.1.11	Number of current inputs	5 (1/1A)	Specify
	Number of voltage transformer inputs	4	Specify
4.5.1.12	Reduction of effects of electrolysis	Relay coils operating on DC shall be so connected such that they are not continuously connected from the positive pole of the station battery bank	Specify
4.5.1.13	Thermal withstand capability of the relay		Specify
4.5.1.14	Detailed Relay and Device performance requirements		
	<b>A. Three Phase Overcurrent and Earth Fault relay</b>		
	Type	Numerical design and supports GOOSE messaging and communication protocols 60870-5-103 and 61850-9-2	Specify
	Current setting range for overcurrent relay	$0.5I_n - 2.4I_n$	Specify
	Current setting range for earth fault relay	$0.5I_n - 0.8I_n$	Specify
	I.D.M.T characteristics according to BS 142 or IEC 60255	SI, VI, EL, LTI, including definite time for the high-set elements	Specify
	Time setting multiplier	0.05 – 1.0	Specify

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**17.5 KV AIR INSULATED**  
**INDOOR SWITCHGEAR**  
**PANELS – PART 5:**  
**CAPITOL SWITCHING**  
**STATION SPARES -**  
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Clause	Description	KPLC Requirement	Bidders offer*
	Highest element for both overcurrent and earth fault protection with a setting range	$1 - 30I_n$	Specify
	Drop off/picking up ratio	$>90\%$	Specify
	Low transient overreach	$<10\%$	Specify
	Features	i. Broken conductor alarm ii. Thermal overload protection iii. Circuit breaker maintenance iv. Fault records, event records and disturbance records v. Configurable output relays with ability to output starting elements to control vi. Tripping of other upstream protection relays	Specify
<b>B. Three-phase Directional Overcurrent and Earth Fault Relay</b>			
	Type	Numerical design and supports GOOSE messaging and communication protocols 60870-5-103 and 61850-9-2	Specify
	Current setting range for overcurrent relay	$0.5I_n - 2.4I_n$	Specify
	Current setting range for earth fault relay	$0.5I_n - 0.8I_n$	Specify
	Quadrature connection for polarizing voltage	$V_n = 110\text{ V}$	Specify
	High Set Element	$1 - 32I_n$	Specify
	I.D.M.T characteristics	According to IEC 60255 and Definite time characteristic	Specify
	Normal operating boundary	$\pm 90$ degrees from relay characteristic angle Relay sensitivity shall be 1% of rated value of current and current polarizing voltage at an angle equal to the relay characteristic angle	Specify
	Time setting multiplier	$0.05 - 1.0$	Specify

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


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Clause	Description	KPLC Requirement	Bidders offer*
	Features	i) Applicable on the LV side of a Dyn1 transformers ii) The phase and the directional elements shall be individually selectable. iii) Broken conductor protection feature. iv) Negative sequence protection feature. v) Highest element for both overcurrent and earth fault protection, with a setting range of 1-30In. vi) Thermal protection. vii) Dedicated Breaker Fail Protection. viii) Circuit Breaker Maintenance ix) Incorporate Fault record, Event Records and disturbance records (minimum 1000) x) Configurable output relays with ability to output starting elements to control of other upstream Protection relays.	Specify
<b>C. Trip Relay</b>			
	Instantaneous operation, t	< 12ms	Specify
	Output contacts	At least 8(eight) No. pairs of output contacts 2 (two) No. of which should be NC contacts	Specify
	Features	i. High burden ii. Immune to capacitance discharge currents and leakage currents iii. Provision for manual reset iv. Flag or target should be a red LED or bulb and should be electrically reset	Specify
<b>D. Trip Circuit Supervision Relay</b>			
	Feature	i. Continuous supervision of trip circuit breaker in both OPEN & CLOSE position ii. Trip circuit fail – Red LED iii. Trip circuit healthy – Green LED iv. Two normally closed and three normally open output contacts	Specify
<b>E. Annunciator Unit</b>			

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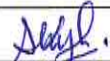
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Clause	Description	KPLC Requirement	Bidders offer*
	Features	i. Should have silence, accept and reset buttons. ii. Accommodate 18 signal alarms iii. Relay output for audible alarm and self-supervision iv. Integrated event register to provide analysis of the latest five (5) events.	Specify
4.5.2	Incomer Panel Relay Specific Requirement		
4.5.2.1	Type of relays	Numerical over current and earth fault relays capable of performing both high set and low set operation	Specify
		The directional over current and earth fault protection function	Specify
4.5.2.2	The relay has a card for arc flash protection		Specify
	Arc card 3 light inputs	from the cable compartment, CB compartment and bus bar compartment	Specify
	Each of the three compartments has one light sensor lens linked to the relay inputs through insulated single mode insulated glass fibre optic cable		Specify
4.5.2.3	Arc protection modes	light only and light + current mode	Specify
4.5.2.4	Outputs of the arc protection	one output to be used for cable compartment arc sensor operation	Specify
		the other output to be used for circuit breaker and bus bar compartment arc sensor operation	Specify
4.5.2.5	The arc flash protection operating from the cable compartment	Wired to trip the incomer and the upstream 66kV circuit breaker.	Specify
4.5.2.6	The arc flash protection operating from the bus bar and circuit breaker compartments	Wired to trip the incomer circuit breaker, the bus section circuit breaker and the upstream 66kV circuit breaker	Specify

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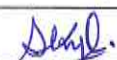


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Clause	Description	KPLC Requirement	Bidders offer*
4.5.2.7	LED indications	i. 50+50N operated ii. 67+67N operated iii. TCS1-unhealthy iv. TCS2-unhealthy v. Trip relay 86 operated vi. Cable compartment arc sensor operated. vii. Breaker/Busbar compartment arc sensor operated. viii. Arc sensor operated in outgoing/bus PT panel. ix. Incomer PT fuse failure.	Specify
4.5.3	Bus section Panel Relay Specific requirements		
4.5.3.1	Type of relays	Numerical over current and earth fault relays capable of performing both high set and low set operation	Specify
4.5.3.2	The relay has a card for arc flash protection		Specify
	Arc card 2 light inputs	from CB compartment and bus bar compartment	Specify
	Each of the two compartments has one light sensor lens linked to the relay inputs through insulated single mode insulated glass fibre optic cable		Specify
4.5.3.3	Arc protection modes	light only and light + current mode	Specify
4.5.3.4	The arc flash protection operating from the bus bar and circuit breaker compartments	Wired to trip the two incomer circuit breakers and the bus section circuit breaker	Specify
4.5.3.5	LED indications	i. 50+50N operated ii. 51+51N operated iii. TCS1-unhealthy iv. TCS2-unhealthy v. Trip relay 86 operated vi. Breaker/bus bar compartment arc sensor operated. vii. Arc sensor operated in outgoing/bus PT panel/Incomer.	Specify
4.5.4	Outgoing Feeder Panel relay Specific Requirements		

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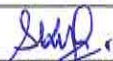
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Clause	Description	KPLC Requirement	Bidders offer*
4.5.4.1	Type of relay	Numerical over current and earth fault relays capable of performing both high set and low set operation	Specify
	The relay has an additional current input port for sensitive earth fault function		Specify
4.5.4.2	Binary inputs application	For activation of auto reclose and sensitive earth fault protection functions via external selector switches	Specify
4.5.4.3	The relay has a card for arc flash protection		Specify
	Arc card 3 light inputs	from the cable compartment, CB compartment and bus bar compartment	Specify
	Each of the three compartments has one light sensor lens linked to the relay inputs through insulated single mode insulated glass fibre optic cable		Specify
4.5.4.4	Arc protection modes	light only and light + current mode	Specify
4.5.4.5	Outputs of the arc protection	one output to be used for cable compartment arc sensor operation	Specify
		the other output to be used for circuit breaker and bus bar compartment arc sensor operation	Specify
4.5.4.6	The arc flash protection operating from the cable compartment	Wired to trip the feeder circuit breaker only	Specify
4.5.4.7	The arc flash protection operating from the bus bar and circuit breaker compartments	Wired to trip the incomer circuit breaker, the bus section circuit breaker and the feeder circuit breaker	Specify
4.5.4.8	LED indications	i. 50+50N operated ii. 51+51N operated iii. TCS1/2-unhealthy iv. Load shedding trip v. SEF operated. vi. Trip relay 86 operated vii. Cable compartment arc sensor operated. viii. Breaker/Busbar compartment arc sensor operated. ix. Auto-reclose in progress x. Auto-reclose unsuccessful	Specify

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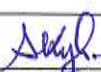
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Clause	Description	KPLC Requirement	Bidders offer*
4.5.5	BUS PT Panel Relay Specific Requirements		
4.5.5.1	Type of relay	Numerical voltage relay capable of performing both high set and low set operation	Specify
	Relay capabilities	Performing under-voltage, over-voltage, under-frequency and over frequency protection	Specify
4.5.5.2	Has four stages of under frequency programmed and wired to a 5-position selector switch in all the outgoing feeders and incomers trip circuits		Specify
	The selector switch positions	The off, stage 1, stage 2, stage 3 and stage 4 positions	Specify
4.5.5.3	The relay has a card for arc flash protection		Specify
	Arc card 2 light inputs	from PT compartment and bus bar compartment	Specify
	Each of the two compartments has one light sensor lens linked to the relay inputs through insulated single mode insulated glass fibre optic cable		Specify
4.5.5.4	Arc protection modes	light only and light + current mode	Specify
4.5.5.5	The arc flash protection operating from the bus bar and PT compartments	Wired to trip the incomer circuit breaker and the bus section circuit breaker	Specify
4.5.5.6	Method to show presence of primary supply	The binary input shall be active when there is a current at the incomer circuit	Specify
4.5.5.7	LED Indications	i. 27 operated ii. 59 operated iii. 81 operated iv. PT secondary MCB trip. v. PT compartment arc sensor operated vi. Bus bar compartment arc sensor operated. vii. Load shedding stage 1. viii. Load shedding stage 2. ix. Load shedding stage 3 x. Load shedding stage 4	Specify
4.6	Indicating instruments		
4.6.1	All indicating instruments are flush mounted		Specify
	Standard of manufacture	IEC 60051	Specify

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Clause	Description	KPLC Requirement	Bidders offer*
4.6.2	Incomer Cubicle LV Compartment electrical indications	i. Circuit breaker ON - Red in colour. ii. Circuit breaker OFF - Green in colour iii. Auto Trip-Orange in colour iv. Trip circuit Healthy - White in colour v. Spring Charged - Blue in colour vi. Circuit breaker in Service - Red in colour vii. Circuit breaker in Test - Green in colour viii. Earth switch ON - Red in colour ix. Earth switch OFF - Green in colour	Specify
4.6.3	Outgoing feeder Cubicle LV compartment electrical indications	i. Circuit breaker ON - Red in colour. ii. Circuit breaker OFF - Green in colour iii. Auto Trip - Orange in colour iv. Trip circuit Healthy - White in colour v. Spring Charged - Blue in colour vi. Circuit breaker in Service - Red in colour vii. Circuit breaker in Test - Green in colour viii. Earth switch ON - Red in colour ix. Earth switch OFF - Green in colour	Specify
4.6.4	Bus section Cubicle LV compartment electrical indications	i. Circuit breaker ON - Red in colour. ii. Circuit breaker OFF - Green in colour iii. Auto trip - Orange in colour iv. Trip circuit Healthy - White in colour v. Spring Charged-Blue in colour vi. Circuit breaker in service - Red in colour vii. Circuit breaker in test - Green in colour	Specify
4.6.5	Bus PT Cubicle LV compartment electrical indications	i. Earth switch ON - Red in colour ii. Earth switch OFF - Green in colour iii. 11kV Voltmeter iv. Voltage selector switch (L1-L2, L2-L3, L3-L1, L1-N, L2-N, L3-N)	Specify

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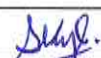


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Clause	Description	KPLC Requirement	Bidders offer*
4.6.6	Circuit Breaker mechanical indications	i. One mechanical ON/OFF indicator, with inscription "ON" in white letters on red background and inscription "OFF" in white letters on green background. This should be an integral part of the circuit breaker.  ii. One mechanical indication of the state of the spring inscription, "SPRING CHARGED" (white letters on red background). This should be an integral part of the Circuit Breaker.	Specify
4.6.7	Earth Switch mechanical indications	One mechanical ON/OFF indicator, with inscription "ON" white letters on red background and inscription "OFF" white letters on green background. This should be an integral part of the earth switch.	Specify
4.7	Power Cable termination		
4.7.1	HT cable compartment design is suitable either for shrinkable (or equivalent) jointing application termination		Specify
4.7.2	Provisions	i. Nine gland fabricated sheet steel cable compartment, complete with gland and armour clamp, suitable for receiving nine single core (3 per phase) 11kV cables each of size up to 630mm <sup>2</sup> (for Incomer type panels).  ii. Single gland fabricated sheet cable compartment complete with gland and armour clamp suitable for receiving three core cable up to 400mm <sup>2</sup> 11kV XLPE cable (for feeder type panels).  iii. The cable compartment design shall facilitate easy modification in future, to receive three single core (1 per phase) 11kV cables of size up to 630mm <sup>2</sup> .	Specify
4.8	Other features required in the switchgear panels		

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Clause	Description	KPLC Requirement	Bidders offer*
4.8.1	Trip circuit supervision for both CB ON and CB OFF		Specify
4.8.2	Detailed nameplate for the Circuit Breaker with all VCB rating details		Specify
4.8.3	Name plate for Current and Voltage Transformers with rating details		Specify
4.8.4	Two sets of NO + NC auxiliary contact of circuit breaker wired to the control cable termination block for status indication		Specify
4.8.5	High voltage presence indicator		Specify
4.8.6	Alarm and Annunciator scheme for entire 17.5kV indoor switchboard, with audible Urgent and Non-Urgent Alarm		Specify
4.8.7	All indoor switchboard panels shall be provided with Bus-wires for all signal, commands, indications, metering etc. ready for looping to the next switchboard panel		Specify
4.8.8	All relays shall be software based incorporating features for fault records, event records and diagnostic data downloaded via RS232 serial port, USB-2 and higher versions.		Specify
4.8.9	Auxiliary supplies for panel heating and lighting	230VAC, 50Hz, single-phase 3-wire	Specify
	Auxiliary supplies for protection, spring charging motor, Control and Circuit Breaker Trip/Close	110VDC	Specify
4.8.10	All panels shall have names at the front and at the rear as per feeder or incomer name		Specify
	The names shall be engraved on a high quality long life PVC or metal material		Specify
4.8.11	Nameplate of the circuits on the circuit breaker carriage		Specify
4.9	Protection Relays, Indicating and control IEDS requirement		

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Clause	Description	KPLC Requirement	Bidders offer*
4.9.1	Outgoing Feeder panels	i. Three phase over current and earth fault relay IEC 61850 compliant ii. Current test block. iii. Multifunctional meter. iv. Local/ remote switch. v. Energy meter provision vi. SEF selection switch ON/OFF vii. Circuit Breaker Control (Close & Open) push buttons viii. Auto-reclose selector switch	Specify
4.9.2	Bus section panel	i. Three phase over current and earth fault Relay IEC 61850 compliant. ii. Multifunctional meter. iii. Local/Remote switch for CB operation iv. Circuit breaker control (Close, Open) push buttons. v. Hooter with ON/OFF switch vi. Urgent and Non-Urgent Alarm Relays (annunciator) with silence, accept and reset push buttons.	Specify
	Alarms connected to annunciator	a) 110 DC supply fail b) 240 AC supply fail c) Incomer I fault trip d) Incomer II fault trip e) Bus section fault trip f) Feeder fault trip g) Relay internal fault (relay fail) h) Trip circuit fail.	Specify
4.9.3	Bus PT Panel	i. Under and over voltage protection relay IEC 61850 compliant. ii. Voltage selector switch iii. Voltage meter.	Specify
4.10	Interlocks		

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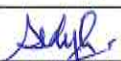
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Clause	Description	KPLC Requirement	Bidders offer*
4.10.1	Outgoing Panel interlocks	<ul style="list-style-type: none"> <li>i. The circuit breaker shall not be racked in or out in closed position.</li> <li>ii. Circuit breaker shall not be racked in with earth switch closed.</li> <li>iii. The circuit breaker shall not be operated in the intermediate position.</li> <li>iv. The cable compartment door shall only be opened with the earth switch closed.</li> <li>v. The racking in of the circuit breaker shall be done with the CB compartment door closed.</li> <li>vi. The CB compartment door shall not be opened with the CB in service position.</li> <li>vii. The earth switch shall only be closed with the CB in test position.</li> <li>viii. It shall not be possible to insert the earth switch operating handle into position except when the circuit breaker is in test position.</li> </ul>	Specify

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Clause	Description	KPLC Requirement	Bidders offer*
4.10.2	Incoming Panel Interlocks	<ul style="list-style-type: none"> <li>i. The circuit breaker shall not be racked in or out in closed position.</li> <li>ii. Circuit breaker shall not be racked in with earth switch closed.</li> <li>iii. The circuit breaker shall not be operated in the intermediate position.</li> <li>iv. The cable compartment door shall only be opened with the earth switch closed.</li> <li>v. The racking in of the circuit breaker shall be done with the CB compartment door closed.</li> <li>vi. The CB compartment door shall not be opened with the CB in service position.</li> <li>vii. The earth switch shall only be closed with the incomer CB in test position and the upstream CB open.</li> <li>viii. It shall not be possible to insert the earth switch operating handle into position except when the circuit breaker is in test position and the upstream circuit breaker is open.</li> </ul>	Specify
4.11	Wiring		
4.11.1	Control, voltage transformers and ac auxiliary supply wiring	PVC insulated wires not less than 2.5 mm <sup>2</sup> , stranded flexible cable	Specify
4.11.2	Current transformer wiring	PVC insulated wires of 4.0 mm <sup>2</sup> stranded flexible cables	Specify
4.11.3	Installation of a suitable wiring duct system firmly fixed on the panel and having covers		Specify
4.11.4	Wiring between terminals	Point to point	Specify
4.11.5	Exposed wiring is minimal		Specify
4.11.6	Instrument transformer grounding	On the terminal block in the control compartment	Specify
	Provision of facility for short circuiting the current transformers secondary windings		Specify

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	Current transformer mounting in a way that their secondary winding terminals are easily accessible and visible		Specify
4.11.7	Provision of cable supports and clamp type terminal lugs		Specify
	Marking of the wires	At each point of termination on to the terminal block or device	Specify
	The wire marker or ferrule corresponds to the device number or terminal block number of origin and the number of terminal where it is connected.		Specify
<b>4.12</b>	<b>Phase Arrangement</b>		
4.12.1	For AC 3 phase and single Phase circuits	When facing the front of the panel shall be R-Y-B-N and L-N from left to right, from top to bottom and front to back	Specify
4.12.2	For DC circuits	P-N from left to right, top to bottom and front to Back	Specify
<b>4.13</b>	<b>Wiring colour code</b>		
	Voltage transformers/Current transformers	Red, Yellow, Blue ,Black	Specify
	Auxiliary AC supply connection cable/bus wire	Red and black	Specify
	DC control wiring within panel	Grey	Specify
	Grounding/earthing cable /wire	Green with yellow stripes.	Specify
<b>4.14</b>	<b>Phase and polarity colour code</b>		
	AC three phase for CT and VT secondary wiring	First Phase-Red Second Phase-Yellow Third Phase-Blue Neutral-Black	Specify
	AC Single phase	First Phase-Red Neutral-Black Ground-Green with yellow stripes.	Specify
	DC auxiliary supply connection	Positive-Red Negative-Black	Specify
4.15	Additional Specific Requirements for the switchgear panels		

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Clause	Description	KPLC Requirement	Bidders offer*
4.15.1	Testing Facilities		
4.15.1.1	Separate Test facilities for each AC current and voltage transformer secondary circuit		Specify
4.15.1.2	Earthing each current transformer circuit	removable link at one point only	Specify
	The common Protection Trip and Alarm circuit for each Panel provided with an isolation link		Specify
4.15.2	Relay/device programming software and connection cables		
4.15.2.1	Provision of all software's for all IEDs supplied		Specify
	Provision of software User's Guide		Specify
4.15.2.2	The Numerical Relays equipped with an Ethernet Communication port to facilitate connection to a PC laptop		Specify
	Provision of 3 communication cables between the relay and the laptop		Specify
	Communication facilities provided on each Numerical Relay for Remote Interrogation and Programming of the Numerical Relays		Specify
4.15.3	Provision of Human –Machine Interface facility (HMI) with LCD screen where one can easily access the relay information		Specify
	The HMI on the relay is fully functional over the service life of the switchgear without degradation in screen and LEDs visibility and sensitivity of navigation keys/buttons.		Specify
4.16	Spares	i. Portable set testing plugs- One set ii. Spring charging handle- Two sets iii. Circuit breaker draw out handle- Two se iv. Two numbers of Circuit breaker TRIP and CLOSE coils	Specify
5.0	<b>Substation Automation System</b>		
5.1	<b>General requirements</b>		
5.1.1	Main components of SAS	communication gateway, inter-bay bus, intelligent electronic devices (IED) for bay control and protection	Specify
5.1.2	Application of main components		
	Communication gateway/Remote terminal unit	Secure the information flow with Regional Control Centres	Specify

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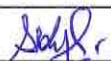
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Clause	Description	KPLC Requirement	Bidders offer*
	Inter-bay bus	Provide independent station-to-bay and bay-to-bay data exchange	Specify
	The bay Level IEDs for protection and control	Provide the direct connection to the switchgear without the need of interposing components and perform control, protection, and monitoring functions	Specify
5.1.3	The detailed design of the SAS is within the manufacturer's responsibility, but subject to approval by KPLC		Specify
5.1.4	Components of the SAS	<ul style="list-style-type: none"> <li>i. 1 No. independent Gateway/Remote terminal unit for communications to the SCADA system.</li> <li>ii. Satellite clock, complete with GPS Receiver, Antenna and necessary time synchronization ports.</li> <li>iii. Laptop Computer for maintenance, information transfer and emergency HMI</li> <li>iv. Communication network equipment [station (system) LAN, Field Communication Network, Various optical couplers, etc.].</li> <li>v. interface for control and monitoring of the circuit/bay</li> <li>vi. Interface with metering units</li> <li>vii. Interface for protection devices that cannot directly interface with the substation LAN</li> </ul>	Specify
<b>5.2</b>	<b>SAS functionalities</b>		
5.2.1	Supervisory level	It shall have a full operational control, reporting, alarm and indication facilities for the substation from the RCC's	Specify
5.2.2	Bay level	It shall have an operational control of each new circuit/bay from the protection relay panel using the bay control unit LCD display	Specify
5.2.3	Local level	It shall have the control of each item of plant from the Local Control Cubicle (LCC)	Specify
5.2.4	Control facilities	Each control point shall be interlocked (hardwired) to prevent operation of any device simultaneously from more than one control point	Specify

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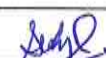


**TITLE:**  
**17.5 KV AIR INSULATED**  
**INDOOR SWITCHGEAR**  
**PANELS – PART 5:**  
**CAPITOL SWITCHING**  
**STATION SPARES -**  
**SPECIFICATION**

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Clause	Description	KPLC Requirement	Bidders offer*
5.2.5	At least one fully operational control point shall remain available in the event of a single equipment or communications failure.		Specify
5.2.6	Complete facilities shall exist for the proper lockout and maintenance tagging of circuits and plant items		Specify
5.2.7	The SAS shall use open communication protocols		Specify
	Experience list of devices with which the offered control system has previously been interfaced		Provide
<b>5.3</b>	<b>General System Design</b>		
5.3.1	Suitability	operation and maintenance of the complete substation including future extensions	Specify
		efficient and reliable operation of outdoor or indoor substations for distribution and transmission	Specify
5.3.2	Applicable standards	IEC61850, IEC60870-5-101,103,104	Specify
5.3.3	Offered SAS support remote control and monitoring from Regional Control Centre via a gateway/remote terminal unit		Specify
5.3.4	Offered SAS can be operated by personnel with basic training		Specify
5.3.5	Cubicle functions	The control, monitoring and protection functions specified, self-monitoring, signalling and testing facilities, measuring as well as memory functions, event recording, Sequential Event Recording (SER) with time stamping of events at the RTU and disturbance recording.	Specify
	The basic control functions are to be derived from a modular standardized and type-tested software library		Specify
5.3.6	SAS is based on a decentralized architecture and on a concept of bay-oriented, distributed intelligence		Specify
5.3.7	Functions shall be decentralized, object-oriented and located as close as possible to the process.		Specify
	The main process information of the station shall be stored in distributed databases.		Specify
5.3.8	Architecture of SAS		Provide

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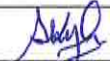
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Clause	Description	KPLC Requirement	Bidders offer*
5.3.9	Bay level	IEDs shall provide all bay level functions regarding control, monitoring and protection, inputs for status indication and outputs for commands	Specify
	The IEDs are directly connected to the switchgear without any need for additional interposition or transducers.		Specify
5.3.10	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		Specify
5.3.11	The data exchange between the electronic devices on bay and station level shall take place via the inter-bay bus.		Specify
	The inter-bay bus shall be realized using fibre-optic cables or Ethernet		Specify
5.3.12	The entire station shall have the capability to be controlled and supervised from a station HMI in future		Specify
5.3.13	The gateway/RTU shall work completely independent		Specify
5.3.14	Clear control priorities provided		Specify
5.3.15	The supervisory level contains gateway for the communication with remote control centres		Specify
5.3.16	Provision of a dedicated master clock for the synchronization of the entire system		Specify
5.3.17	SAS functional parts	i. Gateway/RTU for remote supervisory control via SCADA. ii. Master clock (e.g. GPS receiver). iii. Collection of the relevant data concerning the substation and distribution of the data where needed. iv. Bay and supervisory level devices for control, monitoring and protection. v. Bay-oriented local control panels.	Specify
5.3.18	Signal list	i. Commands ii. Status Indications iii. Alarms iv. Set Point Regulation v. Measured Values vi. Energy measurement	Specify

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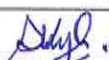


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Clause	Description	KPLC Requirement	Bidders offer*
5.3.19	The design shall include mapping of the Signal list from the supplier to the requirements of the Regional Control Centre (supervisory level) signal requirements		Specify
5.3.20	Design of supervisory control system	i. Control mode selection ii. Select-before-execute principle iii. Command supervision: a. Interlocking and blocking b. Double command iv. Auto reclosing v. Monitoring pole discrepancy and trip function vi. Transformer tap changer control vii. Display of interlocking and blocking viii. Breaker position indication ix. Alarm annunciation x. Sequential Event Recording (SER) with time stamping of events xi. Measurement display xii. Data storage for at least 200 events	Specify
5.3.21	Select before execute		
5.3.21.1	Stages of command	Selection of the object and command for operation.	Specify
5.3.21.2	When is the final command (open or close) executed?		Specify
5.3.22	Gateway/RTU		
5.3.22.1	The gateway/RTU shall collect, store and map signals of relays, measurement units, control units and IEDs in the substation to regional control centre		
5.3.22.2	Standard protocols supported by RTU/gateway	i. IEC 60870-5-101/-103/-104 ii. IEC 61850 iii. DNP3, serial and TCP/IP iv. Modbus serial and TCP/IP v. Meter interfaces	Specify
5.3.22.3	Provision of a configuration tool for parameter setting, diagnostics and testing		Specify
5.3.22.4	Database and parameter setting shall be by menu-controlled dialogues from a local PC and remotely from the corresponding control centre with downloading function		Specify

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Clause	Description	KPLC Requirement	Bidders offer*
5.3.22.5	Standards complied with for ruggedness and reliable communications performance	IEC 61850-3, IEEE 1613 and NEMA TS 2	Specify
5.3.22.6	Extended temperature range	40°C to +75°C	Specify
5.3.22.7	SAS has high EMC stability		Specify
5.3.22.8	The substation master control shall be capable of automatic restart in the event of power failure without loss of functionality or local database		Specify
5.3.22.9	It shall be possible to interface with 3rd party IEDs		Specify
5.3.22.10	Cyber security features		Specify
5.3.22.11	It shall be readily possible to update the substation computer software/gateway software to alter or extend the SCS functionality		Specify
5.3.23	Substation Local Area Network		
5.3.23.1	Local substation shall use Ethernet LAN		Specify
5.3.23.2	Standards complied with for ruggedness and reliable communications performance	IEC 61850-3, IEEE 1613 and NEMA TS 2	Specify
5.3.24	Satellite Clock		
	Master clock	Time synchronization and event time tagging with resolution of 1ms shall be provided by a satellite GPS clock signal	Specify
	Resolution	1ms	Specify
	Secondary clock	Provided via SCADA	Specify
5.3.25	Audible alarm		Specify
5.3.26	Common Bay Unit		Specify
5.3.27	Data Transmission		Specify
5.3.28	Spare parts		Provide
5.3.29	<b>Documentation</b>		
5.3.29.1	Drawings, design specifications, design details, operation and maintenance manuals		Provide

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Clause	Description	KPLC Requirement	Bidders offer*
5.3.29.2	Documentation to be provided	i. Control Room Layout ii. Single-Line Diagram iii. Block Diagram iv. Circuit Diagram v. List of Apparatus/ Equipment vi. List of Labels vii. Functional Design Specification (FDS) viii. Test Specification for Factory Acceptance Test (FAT) ix. Logic Diagram x. List of Signals xi. Operator's Manual xii. Product Manuals xiii. Calculation for uninterrupted power supply (UPS) dimensioning xiv. Concept and contract for maintenance xv. It is necessary to present the technical description and the technical data for the whole system and for any equipment and function xvi. Time plan for the project realization.	Provided
5.3.30	SCMS system Maintenance		
5.3.30.1	Provision of laptop computer		Specify
5.3.30.2	Laptop with necessary configuration tool		Specify
5.3.31	System Acceptance		Specify
6.	Test Requirements		
6.1	Switchgear and protection/control panels testing standards	IEC 62271-200	Specify
6.2	Circuit Breaker testing standards	IEC 62271-200	Specify
6.3	Relays testing standards	IEC 60255	Specify
6.4	Current transformer and voltage transformer testing standards	IEC 61869-2, IEC 61869-3 and IEC 61869-6	Specify

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
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Clause	Description	KPLC Requirement	Bidders offer*
7.	Marking and Packing		
7.1	Packing to protect from damage during transport, handling and storage		Specify
7.2	Packing and part list		Specify
7.3	Other marking details	i. Name of manufacturer and country ii. Type/Model reference number iii. Ratings (voltage, current, insulation, frequency etc.) iv. Serial number v. Month and year of manufacture vi. Property of KPLC	Specify
<b>8.</b>	<b>Sample</b>		
8.1	Manufacture of sample panel and initial FATs		State compliance
8.2	Manufacturer shall then rectify any minor defects noted during this initial FATs		State compliance
8.3	Cancellation of tender where the manufactured sample panel is unsatisfactory and the manufacturer fails to rectify the switchgear panel to satisfactory standard within four weeks after attendance of the initial FATs		State compliance
<b>A</b>	<b>Test and Inspection</b>		
A1	Responsibility of the manufacturer		State
A2	Certified true copies of previous type test reports		State
A3	List of Factory Acceptance Tests to be witnessed by Kenya Power Engineers at the factory		List
A4	Copies of test reports all the circuit breakers, voltage transformers, current transformers and Protection and Control schemes to be submitted to Kenya Power for approval before shipment		State
A5	Upon inspection and testing, defective equipment shall be replaced by the manufacturer with no charge to Kenya Power		Specify
<b>B</b>	<b>Quality Management System</b>		
B1	QAP		Provide
B2	Copy of ISO 9001: 2015		Provide
B3	Delivery time, Production capacity and experience of the manufacturer		State
<b>C</b>	<b>Technical Documentation</b>		
C1	Documents submitted with tender documents for evaluation		

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Clause	Description	KPLC Requirement	Bidders offer*
	a. Fully filled GTPs		State
	b. Copies of manufacturer's catalogues, manufacturing drawings, technical data		State
	c. Hard copy design drawings of the equipment done on AutoCAD		State
	d. Sales records for previous five years and reference letters		State
	e. Manufacturing capacity and manufacturer's experience		State
	f. Copies of type test certificates and type test reports by a third-party testing laboratory accredited to ISO/IEC 17025		State
	g. Copy of accreditation certificate to ISO/IEC 17025 for the testing laboratory		State
	h. Manufacturer's warranty and guarantee		State
	i. Manufacturer's letter of authorization, copy of the manufacturer's ISO 9001:2008/2015 certificate		State
C2	To be submitted for approval before manufacture		
	a. Fully Filled Clause by clause GTPs		state
	b. Hard copy design drawings of the equipment done on AutoCAD		Specify
	c. Three sets of operational manuals and drawings detailing dimensions, panel layout, wiring and schematic.		State
	d. QAP Plan		State
	e. Test Program to be used after manufacture;		State
	f. Marking details and method to be used in marking the equipment;		State
	g. Packaging and marking details		State
C3	Documents to be submitted before shipment		State
C4	Manuals to be provided with the switchgear and control panels		List
C5	Foundation /mounting details		Provide
C6	Software to be provided		List
D.	Manufacturer Qualification		
D.1	Minimum manufacturing experience	25 years	Specify

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

Clause	Description	KPLC Requirement	Bidders offer*
D.2	Minimum number of years in at least 2 power utilities in at least three of the following regions: Europe, North America, Africa, Asia or South America	8 years	Specify
D.3	References	Export records with copy of contractual letters, switchgear panels details and date of sale/export, letter of satisfaction from power utilities	Specify
D.4	Has the switchgear panel failed in service or mal-operated while in service on the Kenyan power system?		State
D.5	Minimum Warranty	5 years	Specify
E.	Training		
E.1	Training at manufacturer's premises		Specify
E.2	Local Training		Specify

**NOTE:**

- 1) Bidders shall give full details of the items on offer as per the specification and applicable standards. The details provided shall conform to the test reports and their certificates, as well as labelled drawings complete with dimensions, catalogues and/or brochures for the purpose of tender evaluation.
- 2) Bidders should note that the above Guaranteed Technical Particulars Schedules must be fully completed and submitted with the bid. Wherever there is conflict between the GTPs and the clauses in the specification, the clauses in the specification take precedence. Failure to complete the schedules shall lead to rejection of the bid.
- 3) Guaranteed values shall be specified. \* Words like 'agreed', 'confirmed', 'As per KPLC specifications', etc. shall not be accepted and shall be considered non-responsive.

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**Manufacturer's Name, Signature, Stamp and Date**

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Signed: 	Signed: 
Date: 2021-04-01	Date: 2021-04-01