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Kenya Power

PROTECTIVE RELAYS, CONTROLS DEVICES AND INSTRUMENTS - SPECIFICATION

A Document of the Kenya Power & Lighting PLC

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0.1 Circulation List

COPY NO.	COPY HOLDER
1	Manager, Standards
Electronic copy (pdf) on Kenya Power server (http://172.16.1.40/dms/browse.php?fFolderId=23)	

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)
Issue 1 Rev 1	2018-06-28	Replaces Issue 1 rev 0 of 2013-08-29	S. Nguli	Dr. Eng. P. Kimemia
Issue 1 Rev 2	2020-09-04	Revised to include clause 4.4.19: Low Power Current Transformers Overcurrent and Earth Fault Protective relays	S. Nguli	Dr. Eng. P. Kimemia

FOREWORD

This specification has been prepared by Network Maintenance (Protection section) of the Network Management Division in collaboration with Standards Department and lays down specification for Design, Manufacture and Testing of Protective Relays, Control devices and Accessories, Measuring and Indicating Instruments.

This specification is intended for procurement of materials and does not include provision of contract.

This specification stipulates the minimum requirements for protective relays, control devices and measuring and Indicating Instruments acceptable for use in the company and it shall be the responsibility of the suppliers and manufacturer to ensure that the offered design is of the highest quality and guarantees excellent service to KPLC, good workmanship and good engineering practice in the manufacture of these equipment for KPLC.

There are no other specifications in this series.

Users of these Kenya Power specifications are responsible for their correct interpretation and application.

This specification supersedes all previous specifications for Protective Relay and Control and Measuring and Indicating Instruments.

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

Name	Department
Eng. Paul Mwangi	Network Maintenance
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Rotich Benard	Standards
Vincent Achongo	Technical Services

1. SCOPE

This specification is for Protective Relays, Controls devices and Instruments.

2. NORMATIVE REFERENCES

The following standards contain provision which, through reference in this text, constitute provisions of this specification. For dated editions the cited edition will apply; for undated editions the latest edition of the referenced document shall apply: -

IEC 60255:	Measuring relays and protection equipment –. Part 1: Common requirements
IEC 62271-304:	High-voltage switchgear and controlgear - Part 304: Classification of indoor enclosed switchgear and controlgear for rated voltages above 1 kV up to and including 52 kV related to the use in special service conditions with respect to condensation and pollution
IEC 60051-1:	Direct acting indicating analogue electrical measuring instruments and their accessories - Part 1: Definitions and general requirements common to all parts
IEC 60688:	Electrical measuring transducers for converting a.c. and d.c. electrical quantities to analogue or digital signal.
IEC 61000-4-13:	Electromagnetic compatibility (EMC) - Testing and measurement techniques, harmonics and inter harmonics including mains signalling.
IEC 61850-8-1:2011:	Communication networks and systems for power utility automation
IEC 60870-5-103:	Telecontrol equipment and systems –Part 5-103: Transmission protocols –Companion standard for the informative interface of protection equipment

3. DEFINITIONS AND ABBREVIATIONS

For the purpose of this specification the definitions and abbreviations given in the reference standards shall apply together with the following:

3.1. ABBREVIATIONS

KPLC- Kenya Power and Lighting Company Plc

IEC – International Electro technical Commission

ISO – International Organization for Standardization

4. REQUIREMENTS

4.1. SERVICE CONDITIONS

The equipment shall be tropicalized, designed and constructed for continuous indoor operation in areas with the following atmospheric conditions: -

Altitude:	From sea level up to 2200m above mean sea level.
Humidity:	High at the Coast, up to 90% and lower inland, up to 50%.
Temperatures:	Average ambient temperature of +35°C with a minimum of -1°C and a maximum of +40°C. Maximum Indoor temperature inside the Relay Panels is +50 ° C.
Pollution:	Heavy saline with severe corrosive effects in coastal lands and generally clean air inland.

4.2. GENERAL REQUIREMENTS

4.2.1. All Relays shall be designed for operations in the severe tropic climate conditions and fully comply with climatic aging tests as per IEC TS 62271-304.

4.2.2. In choosing materials and their finishes, due regard shall be given to the humid tropical conditions under which the Relay will be called upon to work.

4.2.3. Iron and Steel shall be painted or galvanized as appropriate. Indoor parts may alternatively have chromium or copper-nickel plated or other approved protective finish.

4.2.4. Small iron and steel parts (other than stainless steel) of all Relays and instruments, the cores of electromagnets and the metal parts of relays and mechanisms shall be treated in an appropriate manner to prevent rusting.

4.2.5. The use of Iron and steels shall be avoided in instruments and electrical relays wherever possible. Steel screws shall be zinc, cadmium or chromium plated or where plating is not possible owing to tolerance limitations; it shall be of corrosion resisting steel.

4.2.6. Instrument screws (except those forming part of a magnetic circuit) shall be of brass or bronze.

4.2.7. Springs shall be of non-rusting material, e.g., phosphor-bronze or nickel silver, as far as possible.

4.2.8. Neoprene and similar synthetic compounds, not subject to deterioration due to the climatic conditions, shall be used for gaskets.

4.2.9. Power supply modules for Relays and Measuring instruments:

a. All equipment and apparatus including protective relays and control and measuring devices shall be capable of satisfactory operation at 80% to 125% of the rated supply voltage.

b. The Rated DC supply voltage shall be inscribed on the device.

4.3. SPECIFIC REQUIREMENTS

4.3.1. Materials

4.3.1.1. All materials supplied shall be new and of the best quality and of the class most suitable for working under the conditions specified.

4.3.1.2. They shall withstand the variations of temperature and atmospheric conditions arising under working conditions without distortion, deterioration or undue stresses in any parts or heating.

4.3.1.3. All the devices shall be suitable for installation in relay panels inside control rooms without air conditioning.

4.3.1.4. The heat generated by the relays and other measuring devices shall therefore be minimal to ensure that the temperature inside the panels does not rise beyond the rating of the relays and other devices.

4.3.2. Instruments

4.3.2.1. All measuring instruments, including the energy meters, shall be of flush-mounted, back-connected, dust-proof and heavy-duty switchboard type and in accordance with the requirement of IEC 60051.

4.3.2.2. For analogue type instruments, scale plates shall be of a permanent white circular or rectangular finish with black pointer and markings. The scale range shall be provided as given in the detailed specifications.

4.3.2.3. All measuring instruments of analogy type shall be approximately 96 X 96 mm enclosures and shall be provided with clearly readable long scale, approximately 240 degrees. The maximum error shall not be more than one and a half (1.5%) percent of full-scale range.

4.3.3. Protective Relays

4.3.3.1. All Measurement relays shall be flush mounted and of Numeric Design, with event recording, disturbance recording, power measurement, and shall be in accordance to IEC 60255.

4.3.3.2. Besides the communication port, the relays shall have a human – machine interface facility (HMI) comprising a keypad and an LCD screen, where one can easily access relay information and manually program the parameter settings.

4.3.3.3. Relay contacts shall be suitable for making and breaking the maximum currents, which they are required to control in normal service.

4.3.3.4. In particular the Relay Trip contacts shall be capable of interrupting without damage the Circuit Breaker Trip Coil Current should the Circuit Breaker Auxiliary Contacts fail to open. Relay trip contacts shall be rated for 130V DC and switching capacity of 1000W/VA make, and 30W/VA break. Permissible current shall be 5A continuous and 15A for 3 seconds.

4.3.3.5. Where contacts of the protective relays are not sufficient for Circuit Breaker Tripping and interrupting the Trip Current, this shall be clearly stated by the manufacturer.

4.3.3.6. Relay contacts shall make firmly without bounce and the relay mechanism shall not be affected by Panel vibration or external magnetic fields.

4.3.3.7. Relays shall be suitable for operation on the rated D.C. Auxiliary supply without use of dropping resistors or diodes.

4.3.3.8. The relay 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).

4.3.3.9. The relays, control devices and instruments shall be supplied complete with all screws, bolts, brackets and all other accessories necessary for mounting/installation in panels and terminating all external wiring connections.

4.3.3.10. Plug –in auxiliary relays for DIN rail mounting shall be supplied complete with the bases.

4.4. DETAILED SPECIFICATIONS FOR RELAYS, INSTRUMENTS AND CONTROL DEVICES

These specifications indicate the required performance characteristics for each of the Protection Relays.

4.4.1. Ratings for Protection Relays and Control Devices:

Unless otherwise stated, all protection relays and control devices shall have the following rated values:

(a) The power system where the relays are to be installed has nominal frequency of 50HZ
(b) The rated CT secondary current is 1A

(c) The rated VT secondary voltage is 110V AC, phase to phase (63.5V AC phase to ground)

(d) DC auxiliary rating is 110V DC.

(e) Relay trip operation shall be indicated by a red LED, for measurement relays. Red mechanical flags are acceptable for transformer mechanical protection – auxiliary

4.4.2. **Distance Protection Relay Type I:**

4.4.2.1. The Distance relay is for use on Transmission Lines, to provide fast and highly dependable selective fault clearance on both overhead and underground feeders.

4.4.2.2. The Relay shall be for application in a substation with 1&1/2 circuit breaker configuration, hence shall be suitable for tripping of two circuit breakers, monitoring the status of two circuit breakers and automatic reclosure of two circuit breakers. The relay shall be used for re-trofit to replace existing old static & electromechanical relays.

4.4.2.3. **This relay shall have the following functions and features: -**

i. The relay shall have four(4) analogue current input channels and five(5) voltage input channels for connection of CT & VT secondary analogue signals as a minimum.

ii. The relay shall be suitable for Flush mounting on the protection panel

iii. The relay shall be of Numeric/Digital Design and employ complete digital signal processing of measured values.

iv. Full Scheme Distance Protection, with parallel calculation and monitoring of all the fault loops shall be provided.

v. The relay shall have selective single phase and/or three phase Tripping Logic

vi. The relay shall have Under Impedance Starting criteria. Other starting criteria in addition to the under impedance starting are acceptable.

vii. Five zones of phase distance protection (for Phase-phase faults) with selectable Mho and quadrilateral characteristics. Parameters (i.e. resistive reach, reactive reach and time delay) for each zone shall be independently set.

viii. As a minimum, five(5) zones of ground distance protection (for Phase-Ground/Phase-Earth Faults) with selectable Mho and Quadrilateral characteristics with residual current compensation. Parameters (resistive reach, reactive reach and time delay) for each Zone shall be independently set.

ix. The Distance Protection Zones direction shall be independently set as forward or reverse or non-directional.

x. Operating time for Distance Zone 1 set at 0 seconds delay shall not exceed 30ms

xi. Communication channel Aided Scheme logic for phase and ground distance protection shall have the following schemes as a minimum

(a) Permissive Under Reach Transfer scheme (PUTT)

(b) Permissive Overreach Transfer scheme(POTT) and

(c) Blocking Schemes.

(d) Direct Transfer Tripping Scheme

Note: The Tele-protection scheme shall be suitable for hardwiring connection between the relay and the telecommunication multiplexer cabinet.

xii. Load encroachment Discrimination Feature, shall guarantee reliable discrimination between load operation and short circuits for long highly loaded lines, to prevent inadvertent trips.

xiii. Parallel line compensation to cancel the effect of mutual inductance.

xiv. Measuring voltage monitoring/ Fuse failure supervision Logic.

xv. The Distance Relay shall be blocked from operating in the event of failure of the measuring voltage or when the auxiliary switch of the Voltage Transformer secondary MCB trips.

xvi. Weak in-feed Protection: Echo and/or Trip, to allow effective operation of permissive schemes when there is no in-feed on one end of the line.

xvii. Current Reversal Guard Feature – for use on parallel lines

xviii. Power Swing detection feature for blocking Distance operation for moderate power swings and to trip for out of step conditions

xix. Voltage Memory Feature for use by the distance comparators

xx. Automatic Switch On to Fault Feature(SOTF), to be enabled when the line is de-energised and only active for a set time delay after the line circuit breaker is closed

xxi. Directional Earth Fault Protection, with communication channel aided scheme with the following schemes: -

(a) Directional Comparison Scheme(POTT)

(b) Blocking Scheme

(c) Selectable final time tripping for use when the communication channel is not in use, or for use on radial feeder. It shall be possible enable/disable the final time trip feature.

xxii. Back up three phase overcurrent & Earth fault protection, with the following protection functions:

a) High set element for Phase and Earth fault overcurrent with selectable definite time delay

b) Low set element for Phase and Earth fault overcurrent with inverse current-time characteristics as per IEC 60255.

xxiii. Stub Bus overcurrent protection enabled via binary input when the bay disconnector is open

xxiv. Under frequency and rate of change of frequency Protection

xxv. Overvoltage protection

xxvi. Circuit Breaker Failure Protection

xxvii. Circuit Breaker Contact wear feature

xxviii. Broken Conductor detection for Alarm purposes.

xxix. Auto-reclose function for One Phase and/or three phases, suitable for use with the following selections made via external switch:

(a) **Auto reclose Block**: No Auto-reclose: Trip to Lockout

(b) **Single Pole Autoreclose** :(Single pole Trip and Auto-reclose for Distance Zone 1-phase to ground faults only). Other faults types shall lead to three phase trip and lock out.

(c) **Single Pole + Three Phase Auto-reclose (SPAR + DAR):** Single pole trip and auto-reclose for Distance Zone 1 phase to ground faults only, followed by three pole trip and auto-reclose for the next phase to ground fault or phase to phase fault within the reclaim time). If the first fault is phase to phase, then the scheme will perform three phase trip and auto-reclose only and lock out if a second fault of any type occurs during the reclaim time. Three phase faults shall lead to Trip and Lockout.

(d) **Three Phase Autoreclose (DAR):** three phase Trip and auto-reclose only for phase to ground faults or Phase to Phase faults. Lock out for three phase faults.

(e) It shall be possible to initiate autoreclose in the distance relay from the line current differential relay in the neighbouring panel protecting the same transmission line.

xxx. Synchro-check Function for use with three phase auto-reclose

xxxi. Fault Locator; with automatic display on the Relay LCD Screen of the distance to fault in terms of Line percentage or distance in km. This information is for use by other operational staff to guide the maintenance/repair teams. The last distance to fault will always be displayed on the screen, for ease on access by the Operational Personnel.

Note 1: In the bid submission the bidder shall demonstrate that the requirement of this clause is fully met. Requirement to use the keypad to access this information is **not acceptable**

Note 2: Distance Relays which do not meet this requirement shall **not be accepted**

The accuracy of Distance to fault location shall have tolerable error of not more than ±2%.

The following information shall be provided with fault location:

(a) The short-circuit loop which was used to determine the fault reactance

(b) The reactance X per phase in Ohms Primary and secondary

(c) The Resistance R per phase in Ohms Primary and secondary

(d) The distance to fault in percentage and km of line length

xxxii. The relay shall be able to display Fault details on the LCD such as Fault- Loop or Faulty phases, the Zone, and the Relay Operate time.

xxxiii. Disturbance recorder with capacity to record ten(10) analogues and twelve(12) digital signals. The relay shall have capacity to store the latest, twenty (20) disturbance records.

xxxiv. Storage of at least one hundred (100) event records

xxxv. Storage of at least Twenty (20) Trip records. The following fault data shall be available:

a) Magnitude and phase angle of phase currents and voltages before the fault

b) Magnitude and phase angle of phase currents and voltages during the fault

c) The sequence of events of digital signals, start and operate (Trip) signals involved in fault detection and clearance. The events shall be time tagged to 10ms level.

xxxvi. Events and fault records shall not be erased even when the auxiliary DC supply is switched off.

xxxvii. Metering and display on the LCD screen of the following Power system instantaneous parameters including;

a) Voltage

b) Load current

c) Active Power

d) Reactive Power

e) Apparent Power

f) Power Factor and

g) Frequency

NB: Simultaneous Maximum demand values of Active Power, Reactive Power and Apparent Power shall be available in the relay.

xxxviii. At least Twenty-Four (24) Binary inputs.

xxxix. At least Thirty-two (32) Binary outputs

Note: *Two pairs of the binary output relays shall be rated to directly energise the circuit breaker trip coil. These output relays shall provide phase segregated outputs for each phase. This is to allow single phase tripping and auto-reclose. This trip output relays shall have fast operating times of less than 5 ms*

xl. Stability against switching inrush currents and reverse faults.

xli. Clear faulted phase indication.

xlii. Clear fault identification even for boundary conditions.

xliii. At Least twelve (12) LEDs for indication of the following; - Relay trip, Phase L1, Phase L2, Phase L3, Zone 1, Zone 2, Zone 3, DEF, Channel aided trip, SOTF, etc.

xliv. Relay healthy LED

xlv. Relay self-supervision, with LED for healthy status indication(green) and Error indication (red) and watchdog contact

xlvi. Protocol applicable: Full IEC 61850-8-1 compliant & IEC 60870-5- 103. Appropriate communication ports to be provided for local and remote communication.

xlvii. Relay Terminals-shall be screw type terminals large enough to accommodate at least 2 x 2.5 mm2 cable and shall be located at the back of the relay

xlviii. Front Serial RS232 or USB or Optical or Ethernet Port shall be provided for relay configuration and parameter setting and download of Data using a Laptop Computer.

xlix. Software for Programming the configuration and Relay Settings and also downloading and analysing the Relay Data shall be provided.

l. Relay to Laptop connection cable shall be provided.

li. **Relay configuration:** The Manufacturer shall carry out relay configuration at the Factory to suit installation in existing transmission substations in KPLC Network. Existing Protection and control drawings for the substations shall be handed over to the manufacturer/supplier for relay configuration. The FATs shall be carried out once the relays have been configured. Correct functionality of all relay Protection and Control Functions shall checked during the FATS, including correct operation of the single pole auto reclose scheme where applicable.

4.4.3. **Distance Protection Relay Type II**

4.4.3.1. The Distance relay shall be used for protection of Sub transmission and Distribution Lines, both overhead lines and underground cables of different characteristic impedances and lengths. The relay shall be used for fault location on the protected feeders.

4.4.3.2. To achieve this, the relay shall automatically display the distance to fault in km on the LCD screen upon fault interruption. ***This requirement is critical and the offered relays that are not able to meet this requirement will not be considered.***

4.4.3.3. The ability to Access the distance to fault details using the Keypad or a laptop is of secondary value and shall not be considered as a solution for the above requirement.

4.4.3.4. **The relay shall have the following functions and features: -**

i. The relay shall have four analogue current input channels and four voltage input channels for connection of CT & VT secondary analogue signals

ii. Shall be suitable for Flush mounting on the protection panel

iii. The relay shall be of Numeric/Digital Design and employ complete digital processing of measured values

iv. The Relay offered must have been in Service in Kenya Power System and operated successfully for the last Six years. Improved designs of previous relays are acceptable. Relays offers from Manufacturers who have not supplied relays before are not acceptable for this tender.

v. Relays that have failed in service or mal-operated shall not be acceptable

vi. Full distance Protection Scheme, i.e., non-switched

vii. Under Impedance Starting criteria. Other starting criteria in addition to the under impedance starting are acceptable.

viii. The relay shall employ three phase tripping Criteria, since it shall be used on sub-transmission and distribution lines

ix. Four zones of Phase distance protection (for Phase-phase faults) with selectable Mho and Quadrilateral characteristics. Parameters (resistive reach, reactive reach and time delay) for each Zone independently set.

x. Four zones of Ground distance protection, (for phase- Ground/Phase-Earth Faults) with selectable Mho and Quadrilateral characteristics with residual current compensation. Parameters (resistive reach, reactive reach and time delay) for each zone shall be independently set.

xi. The distance Zones direction shall be independently set as forward or reverse or non-direction. Minimum operating time shall not exceed 40ms.

xii. Communication channel Aided Scheme logic for the distance protection with the following schemes:

a. Permissive Under-reach Transfer scheme

b. Permissive Overreach Transfer scheme and

c. Direct Transfer Tripping Scheme

Note: The tele-protection shall be achieved by hard wiring between the relay and the telecommunication equipment

xiii. Load encroachment Discrimination Feature, to increase the possibility to detect high resistive faults on heavily loaded lines.

xiv. Fuse failure supervision Logic

xv. Voltage Memory Feature for use by the distance comparators

xvi. Automatic Switch on to Fault Feature(SOTF), enabled when the line is de-energised and only active for a set time delay after the line circuit breaker is closed

xvii. Directional Earth Fault Protection, with communication channel aided scheme as follows

a. Directional Comparison Scheme

b. Blocking Scheme

***Note**: Selectable final time tripping for use when the communication channel is not in use, or for use on radial feeder.*

xviii. Back up three phase overcurrent & Earth fault protection, with the following protection functions:

(a) High set element for Phase and Earth fault overcurrent with selectable definite time delay

(b) Low set element for Phase and Earth fault overcurrent with inverse current-time characteristics as per IEC 60255.

Other Functions, include:

xix. Sensitive Earth Fault Protection

xx. Stub Bus overcurrent protection

xxi. Circuit Breaker Failure Protection

xxii. Under-frequency and rate of change of frequency protection

xxiii. Overvoltage protection

xxiv. Broken conductor detection for Alarm purposes.

xxv. Auto-reclose function for three phases, suitable for high speed and delayed auto-reclose.

xxvi. The Auto-reclose scheme will be selectable as enabled or disabled preferably on the relay LCD screen:

xxvii. Only the selected functions in the distance relay shall initiate auto-reclose

xxviii. The auto-reclose function shall be capable of two auto-reclose shots, with separately set dead times.

Note: It shall be possible to initiate auto-reclose in the distance relay from an external backup overcurrent and earth fault relay on the same Panel.

xxix. Fault Locator; with automatic display on the Relay LCD Screen of the distance to fault in terms of Line percentage or distance in km. This information is for use by other operational staff to guide the maintenance teams. The last distance to fault shall always be displayed on the screen.

Note: In the bid submission the bidder shall demonstrate that the requirement of this clause is fully met. Requirement to use the keypad or laptop to access this information is OK, as a secondary option, but will not be considered on its own to fulfil the requirements above.

Distance Relays Offered which do not meet the above requirement shall not be accepted

xxx. The accuracy of Distance to fault location shall have tolerable error of not more than ±2%

xxxi. The following additional information shall be provided with fault location:

a) The short-circuit loop which was used to determine the fault reactance

b) The reactance X per phase in Ohms Primary and secondary

c) The resistance R per phase in Ohms Primary and secondary

d) The distance to fault in percentage and km of line length:

xxxii. The relay shall be able to display Fault details on the LCD Screen such as Fault- Loop or Faulty phases, the Zone, and the Relay Operate time.

xxxiii. Internal Disturbance recorder with capacity to record eight analogue and twelve digital signals. The relay shall have capacity to store the latest, twenty (20), disturbance records.

xxxiv. Storage of at least Fifty (50) event records

xxxv. Storage of at least twenty (20) trip records. The following fault data will be available:

(a) Magnitude and phase angle of phase currents and voltages before the fault

(b) Magnitude and phase angle of phase currents and voltages during the fault

(c) The sequence of events of digital signals, start and operate (Trip) signals involved in fault detection and clearance. The events shall me time tagged to 10ms level.

xxxvi. Events and fault records shall not be erased even when the auxiliary DC supply is switched off.

xxxvii. The relay shall have Metering and display on the LCD screen of the following Power system instantaneous parameters including;

(a) Voltage

(b) Load current

(c) Active Power

(d) Reactive Power

(e) Apparent Power

(f) Power Factor and

(g) Frequency

Note: Simultaneous Maximum demand values of Active Power, Reactive Power and Apparent Power shall be available in the relay.

xxxviii. As a minimum, the relay shall have ten (10) Binary inputs and twelve (12) Binary outputs.

Note: Two pairs of the binary output relays shall be rated to directly energise the circuit breaker trip coil. These contacts shall be able to safely interrupt the Circuit Breaker trip Coil current.

xxxix. Stability against switching inrush currents and reverse faults.

xl. Clear faulted phase indication.

xli. Clear fault identification even for boundary conditions.

xlii. At least twelve (12) LEDs for indication of the following; - Relay trip, Phase L1, Phase L2, Phase L3, Zone 1, Zone 2, Zone 3, DEF, Channel aided trip, SOTF, etc.

xliii. Relay healthy LED

xliv. Relay self-supervision, with LED for healthy status indication(green) and Error indication (red) and watchdog contact

xlv. Protocol applicable: IEC 61850-8-1. Appropriate communication ports to be provided on the relay.

xlvi. Relay Terminals-shall be screw type terminals large enough to accommodate at least 2 x2.5mm^2 cable and shall be located at the back of the relay.

xlvii. Front Serial RS232 or USB or Optical or Ethernet Port shall be provided for relay configuration and parameter setting and download of Data using a Laptop Computer.

xlviii. Software for Programming the configuration and Relay Settings and also downloading and analysing the Relay Data shall be provided.

xlix. Relay to Laptop connection cable

l. **Relay configuration:** The Manufacturer shall carry out relay configuration at the Factory to suit installation in existing transmission substations in KPLC Network. Existing Protection and control drawings for the substations shall be handed over to the manufacturer/supplier for relay configuration. The FATs shall be carried out once the relays have been configured. Correct functionality of all relay Protection and Control Functions shall checked during the FATS.

4.4.4. **Line Current Differential Relay Type I:**

The differential relay shall be used to protect an overhead transmission line. The actual line length will be indicated in the technical schedules. The lines to be protected will be of varying lengths.

The specific requirements in terms of length of line to be protected will be stated in the scope of supply or Price schedule.

4.4.4.1. Each relay is expected to interface directly with a single mode optical fibre.

4.4.4.2. Each Relay shall come with 20 metre fibre patch cords with ST connectors to connect with optical fibre cable at the ODF.

4.4.4.3. In addition to performing the differential function the relay shall incorporate back up distance protection and three phase overcurrent and earth fault back-up protection functions.

4.4.4.4. The Differential relay shall be for use on Transmission Lines, to provide fast and highly dependable selective fault clearance on overhead lines.

4.4.4.5. The Relay shall be for application in a substation with 1&1/3 circuit breaker configuration, hence shall be suitable for tripping of two circuit breakers, monitoring the status of two circuit breakers and automatic reclosure of two circuit breakers.

4.4.4.6. The relay shall be used for retrofit purposes to replace existing old static & electromechanical relays.

4.4.4.7. The relays shall also incorporate the following protection features:

i. Full numerical design with at least two groups of settings.

ii. The relay shall be suitable for Flush mounting on the panel.

iii. Shall have Single pole and three pole tripping logic

iv. The relays at the two ends shall operate under directly connected fiber optical cable

v. Simultaneous tripping of relays at both ends even if there is little or no in-feed from one end.

vi. Phase segregated current differential measurement of both magnitude and phase angle.

vii. High speed discriminative Protection for all fault types.

viii. High sensitivity for detection of high resistive phase to earth faults

ix. Integrated Distance protection with at least three Zones of selectable Quadrilateral/mho comparator characteristics, with load encroachment discrimination, SOTF, Power Swing Block. Fuse Failure Protection and Directional earth fault Protection.

x. The distance protection and the Directional Earth Protection shall have unit protection schemes such as those covered in the specifications for Distance Protection Type I.

xi. In case of Loss of communication for the differential protection, the distance protection shall automatically be enabled.

xii. Back up Overcurrent and earth fault protection with Definite Time and Inverse IEC Time-current Characteristics

xiii. Selective Single phase and three phase tripping suitable for single pole trip and auto-reclose for phase to ground faults and three phase trip and lock out for other faults.

xiv. The relay shall be capable of initiation of auto-reclose on an external autoreclose relay. The relay shall achieve the following functionality via an external selector switch:

a. **Autoreclose Block**; No Autoreclose/Trip to Lockout
b. **Single Pole Autoreclose** (Single pole Trip and Autoreclose for phase to ground faults only)
c. **Single pole + Three Phase Autoreclose (SPAR + DAR):** Single pole trip and autoreclose for Phase to ground faults followed by three pole trip and auto-reclose for the next phase to ground or phase to phase fault within the reclaim time). Where the initial fault is a phase to phase fault, then only one shot of three phase trip and auto-reclose will be performed.
d. **Three Phase Autoreclose (DAR):** three phases and autoreclose only for phase to ground faults
e. It shall be possible to initiate autoreclose in a distance relay in the neighbouring protection panel for protection of the same transmission line.

xv. The relay shall have communication channel supervision facilities.

xvi. The relay shall have high stability under transient conditions.

xvii. The relay shall have high stability for heavy through faults and CT saturation effects.

xviii. The relay shall be insensitive to DC Components and Harmonics.

xix. The relay shall be capable of communication between the two ends via directly connected Optical fibre cable.

xx. The relay shall have Direct Transfer tripping via the optical fibre cable, independent of differential scheme.

xxi. The relay shall have Line capacitive charging current compensation and withstand.

xxii. The relay shall have CT ratio (Amplitude) and phase angle correction in built in the relay

xxiii. Selectable minimum operating current, 10-150% of In for low set differential element.

xxiv. High set differential operating element

xxv. Relay Operate time of less than 30ms.

xxvi. The relay shall have Transformer inrush restraint

xxvii. The differential Relay shall restrain upon the loss of the communication channel and block the differential scheme and enable emergency overcurrent protection.

xxviii. Relay terminals shall be provided at the back and shall be suitable for termination of 2.5 mm2 cable. The terminal screws shall be design of star/flat type.

xxix. The relay shall have Distance to fault measurement, with automatic display on the Relay LCD Screen, where the distance to fault can be directly read/seen.

xxx. Display of Fault details on the LCD such as Fault Loop or Faulty phases, the Zone, and the Relay Operate time.

xxxi. Storage of at least Five (5) disturbance(oscillograph)

xxxii. Storage of at least Twenty (20) event records

xxxiii. Storage of at least Five (5) Trip records including value of phase and earth fault

xxxiv. currents and the relay tripping times

xxxv. Events and fault records shall not be erased even when the auxiliary DC supply is switched off.

xxxvi. Status indications of all input, output and internal functions.

xxxvii. Programmable binary inputs, which can be configured to perform, customized functions.

xxxviii. Programmable relay outputs (trips and alarm contacts) that can be configured to perform various tasks.

xxxix. Metering, including; U, I, P, Q, S, F & Cos Φ

xl. At least Sixteen (16) Binary inputs.

xli. At least twenty (20) Binary outputs

xlii. Human – Machine interface with visual display of measurements and internal operations of the relays. Facilities for scrolling should be provided. Default display should be programmable. It should be possible and convenient to program Relay settings from the HMI.

xliii. The bias and operate current on a phase basis in both magnitude and phase for both local and remote ends shall be accessible through the MMI.

xliv. 9 pins – RS232 port for connection to laptop PC shall be available on the front of the relay or any other suitable serial communication port.

xlv. Protocol applicable: Full IEC 61850-8-1 compliant & IEC 60870-5- 103.

xlvi. Appropriate communication ports to be provided for local and remote communication.

xlvii. Self – supervision with fault diagnosis and watchdog contact.

xlviii. LED indications for: Relay healthy(Green), relay faulty(Amber) and Protection operated (Red)

xlix. Shall have twelve (12) LEDs for various indications

l. Password Protection for relay settings.

li. Independent Latching of Trip commands, to prevent CB reclose.

lii. Except for the latched commands, all other relay Operations should be resettable with the Relay covers on.

liii. Upon Operation, the Relay will indicate the Faulted Phase(s), Time taken to Trip and Fault Current on the MMI. Additionally, the faulted phases, Issuance of Trip Command, and Communication failure between the two Relays should be indicated using Red LEDs.

liv. Fault Locator with automatic display on the Relay LCD Screen of the differential relay distance to fault in terms of Line percentage or distance in km. This information is for use by other operational staff to guide the maintenance/repair teams. The last distance to fault will always be displayed on the screen.

Note: In the bid submission the bidder shall demonstrate that the requirement of this clause is fully met. Requirement to use the keypad to access this information is not acceptable.

lv. **Binary Output Relays**: Two pairs of the binary output relays shall be rated to directly energise the circuit breaker trip coil. This output relays shall provide phase segregated outputs for each phase. This is to allow single phase trip and auto-reclose. This trip output relays shall have fast operating times of less than 5 ms

lvi. **Relay configuration:** The Manufacturer shall carry out relay configuration at the Factory to suit installation in existing transmission substations in KPLC Network. Existing Protection and control drawings for the substations shall be handed over to the manufacturer/supplier for relay configuration.

lvii. The FATs shall be carried out once the relays have been configured. Correct functionality of all relay Protection and Control Functions shall checked during the FATS, including correct operation on the single pole auto reclose scheme where applicable.

4.4.5. Line Current Differential Relay Type II:

The differential relay shall be used to protect a 66kV underground/Overhead Line.

4.4.5.1. The actual length of overhead Line or Under-ground cable to be protected shall be stated in the Scope of Supply or Price Schedule.

4.4.5.2. An underground all dielectric fibre cable to be laid in the same trench as the 66kV underground single-phase power cables will provide the communication channel for the Line current differential Protection Scheme.

4.4.5.3. Each relay shall interface directly with the underground single mode optical fibre cable.

4.4.5.4. Each Relay shall come with 20 metre fibre patch cords with ST connectors to connect with optical fibre cable at the ODF.

4.4.5.5. In addition to performing the differential function the relay shall incorporate back up distance protection and three-phase overcurrent and earth fault back-up protection functions.

4.4.5.6. The relays shall incorporate the following Protection Features: -

i. Fully numerical design with at least two groups of settings.
ii. Relays that have failed in service or mal-operated shall not be acceptable
iii. The relay shall be suitable for Flush mounting on the panel.
iv. Three phase tripping logic
v. Simultaneous tripping of relays at both ends even if there is little or no in-feed from one end.
vi. Phase segregated current differential measurement of both magnitude and phase angle.
vii. High speed discriminative Protection for all fault types.
viii. High sensitivity for detection of high resistive phase to earth faults
ix. Integrated Distance protection with at least three Zones of selectable Quadrilateral/mho comparator characteristics, with load encroachment discrimination.
x. Back up Overcurrent and earth fault protection with Definite Time and Inverse IEC Time-current Characteristics
xi. Three phase auto reclose Function
xii. Communication channel supervision facilities.
xiii. High stability under transient conditions.
xiv. High stability for heavy through faults and CT saturation effects.

xv. Insensitive to DC Components and Harmonics.

xvi. Be capable of communication between the two ends via directly connected Optical fibre cable.

xvii. Direct Transfer tripping via the optical fibre cable, independent of differential scheme.

xviii. Cable capacitive charging current compensation and withstand.

xix. CT ratio (amplitude) and phase angle correction in built in the relay

xx. Selectable minimum operating current, 10-150% of In.

xxi. Relay Operating time of less than 30ms.

xxii. Transformer inrush restraint

xxiii. The differential Relay shall restrain upon the loss of the communication channel and block the differential scheme and enable Emergency backup overcurrent and Earth fault protection. Relay terminals shall be provided at the Back and shall be suitable for termination of 2.5 mm2 cable. The terminal screws shall be of star or flat type.

xxiv. Distance to fault measurement, with automatic display on the relay LCD screen, where the distance to fault can be directly read/seen.

xxv. Display of Fault details on the LCD such as Fault Loop or Faulty phases, the Zone, and the Relay Operate time.

xxvi. Storage of at least five (5) disturbances (oscillographic)

xxvii. Storage of at least twenty (20)event records

xxviii. Storage of at least five(5) Trip records including value of phase and earth fault currents and the relay tripping times

xxix. Events and fault records shall not be erased even when the auxiliary DC supply is switched off.

xxx. Status indications of all input, output and internal function shall be displayed.

xxxi. Programmable binary inputs, which can be configured to perform customized functions.

xxxii. Programmable relay outputs (trips and alarm contacts) that can be configured to perform various tasks.

xxxiii. Metering parameters including; U, I, P, Q, S, F & CosΦ

xxxiv. At least Twelve (12) Binary inputs.

xxxv. At least Twelve (12) Output Relays/Contacts

xxxvi. Human – Machine interface with visual display of measurements and internal operations of the relays. Facilities for scrolling shall be provided. Default display shall be programmable. It shall be possible and convenient to program Relay settings from the MMI.

xxxvii. The bias and operate current on a phase basis in both magnitude and phase for both local and remote ends shall be accessible through the MMI.

xxxviii. Protocol applicable shall be Fully IEC 61850-8-1 compliant. Appropriate communication ports shall be provided for local and remote communication.

xxxix. 9 pin – RS232 port for connection to laptop PC shall be available on the front of the relay or any other suitable serial port.

xl. The relay shall have Self – supervision with fault diagnosis.

xli. LED indications for; Relay healthy(Green), relay faulty(Amber) and Protection Operated(Red) shall be provided.

xlii. Additional at least twelve (12) LEDs for various indications shall be provided.

xliii. Password Protection for relay settings.

xliv. Independent Latching of Trip commands, to prevent CB reclose.

xlv. Except for the latched commands, all other relay Operations shall be resettable with the Relay cover on.

xlvi. Upon operation, the Relay shall indicate the faulted phase(s), time taken to trip and Fault Current on the MMI. Additionally, the faulted phases, Issuance of Trip Command, and Communication failure between the two Relays shall be indicated using Red LEDs.

xlvii. Relay configuration: The Manufacturer shall carry out relay configuration at the factory to suit installation in existing transmission substations in KPLC Network. Existing Protection and control drawings for the substations shall be handed over to the manufacturer/supplier for relay configuration. The FATs shall be carried out once the relays have been configured. Correct functionality of all relay Protection and Control Functions shall checked during the FATS.

4.4.6. **Biased Differential Protection Relay for a Two or Three Winding Power Transformer:**

Note: *The relay offered must have been in service in Kenya Power for at Least 8 years and offered satisfactory service. Improved designs of previous relays are acceptable.*

4.4.6.1. The Relay shall have the following Functions and Features: -

i. Suitable for protection of a two or three winding power transformer, with a power rating of up to 90 MVA, with HV winding rated up to 245kV. Specific requirements will be stated in the Scope of supply or Price schedules.

ii. Relay shall be of Numerical design

iii. Flush mounting design

iv. Pick up setting range, for IDIFF >; 0.1 to 1.0 x rated current, as a minimum

v. Pickup on switch-on (factor of IDIFF>) 1.0 to 2.0

vi. High-set Element (IDIFF>>) with a setting range of 1.0 to 20.0 x rated current

vii. Independent definite time delay setting for IDIFF> and for IDIFF>> of 0.00 to 30.00 seconds as a minimum

viii. Magnetizing current inrush restraint feature, using 2nd harmonic restraint and /or zero crossing on the sine wave

ix. Setting range of I2fN/IfN of 10 to 50% as a minimum

x. Compensation for zero sequence currents that may appear on only one winding of the power transformer

xi. Measurement and indication on the LCD screen, of phase – HV&LV currents and relay differential and bias currents

xii. Storage of at least Five (5) Fault records and Ten (10) Event records

xiii. Events and fault records shall not be erased even when the auxiliary DC supply is switched off

xiv. The Fault flags should be visible on the LCD screen, and provide details of the phases that have operated and the fault current values.

xv. Over-fluxing protection function with at least two stages of alarm and trip functions

xvi. 5th harmonic restraint feature on the differential Element to prevent unnecessary tripping due to CT saturation or transformer over-excitation.

xvii. Over-excitation Protection with both alarm and trip elements

xviii. Stabilized against transient and steady-state fault currents caused e.g. by over-excitation of transformers, using fifth harmonic.

xix. Insensitive against DC offset currents and current transformer saturation.

xx. High stability also for different current transformer saturation

xxi. High-speed instantaneous trip on high-current transformer faults.

xxii.

xxiii. Independent of the conditioning of the star point(s) of the power transformer.

xxiv. High earth-fault sensitivity by detection of the star point current of an earthed transformer winding

xxv. Integrated matching of the transformer connection group

xxvi. Integrated matching of the transformation ratio including different rated currents of the transformer windings

xxvii. Dual Bias characteristics with two slopes to ensure relay stability for heavy through faults. The start and end of the two slopes shall be settable, in terms of the rated current.

xxviii. Unbalanced Load Protection

xxix. Thermal Overload Protection

xxx. Back up Overcurrent and Earth Fault protection for HV and/or LV winding

4.4.6.2. The following measurements shall be available in the relay:

i. Magnitudes and phase angles of the phase currents for the three phases on the HV side of Transformer

ii. Magnitudes and phase angles of the phase currents for the three phases on the LV side of Transformer

iii. Magnitude of differential current and restraining current for the three phases

iv. The disturbance recorder function shall have a capacity for eight (8) analogue and twelve (12) digital signals. The last four disturbance records will be available in the relay.

v. Red L.E.D to indicate that the relay has operated/issued trip command

vi. Relay Self diagnostic, with LED to indicate Relay failure and a contact for remote indication of relay failure status

vii. The relay shall have at least eight (8) LEDs for trip and alarms and at least four (4) binary inputs.

viii. The relay shall have at least our (4) outputs relays with normally open contacts for circuit breaker tripping and alarm annunciation. Two pairs of contacts shall be rated to directly energise the circuit breaker tripping coil.

ix. The relay shall have the ability to select output contacts to latched or non-latched status and the LCD screen where the settings and measurands can be read.

x. The relay shall have keypad for manual programming of settings and data access.

xi. The relay shall have front serial RS232 or USB or Ethernet Port for Relay communication with a laptop computer for relay configuration and parameter settings and download of fault records, events records and disturbance record.

xii. Relay terminals-shall be screw type terminals large enough to accommodate at least 2x2mm2 cable and shall be located at the back of the relay.

xiii. Four (4) sets of installation, commissioning, operation and maintenance manuals shall be provided.

xiv. Relay to Laptop connection cable shall be provided.

xv. Software for relay configuration and settings programming using Laptop computer shall be provided.

4.4.7. **Restricted Earth Fault Relay:**

NB: The relay Offered must have been in service in Kenya Power for at Least 8 years and offered satisfactory service. Improved designs of previous relays are acceptable.

4.4.7.1. This relay shall be used for protection of one winding of a power transformer.

4.4.7.2. This relay shall have the following functions and features: -

i. Relay shall be of Numerical, static type or Electro-Mechanical type.

ii. The Relay shall operate on high impedance principle.

iii. The relay shall be of numeric design.

iv. The relay shall be suitable for flush mounting on panel front.

v. The relay shall be of an independent relay and not a function in the differential relay.

vi. Relay shall reject harmonics produced by the system particularly third harmonics.

vii. Stabilising resistor and voltage dependent resistor (metrosil) of suitable rating shall be offered with the Relay based on maximum through Fault of 31kA.

viii. The relay current setting range shall be 0.05- 0.8 x rated current (In) as a minimum and an operating time < 25ms at 5 times the setting.

ix. The relay shall have four (4) LEDs for relay status indication and for trip and alarms annunciation as a minimum and two (2) binary inputs as a minimum

x. The relay shall have four (4) Binary Outputs as a minimum with LCD screen where the settings and measurands can be read

xi. The relay's REF operate current shall be displayed on the LCD screen and keypad for manual programming of settings and data access

xii. The relay shall have serial RS232, USB or Ethernet Port for relay configuration and programming of parameter settings and data download using a laptop computer.

xiii. The relay shall have an event recorder with capacity to store the last fifty (50) events

xiv. The relay shall have fault recorder with capacity to store the last ten (10) fault records

xv. The relay shall have a disturbance record with capacity to store the last four (4) disturbance records

xvi. The relay terminals shall be screw type terminals large enough to accommodate at least 4 mm^2 cable and shall be located at the back of the relay

4.4.8. Stabilizing Resistor

Each REF relay shall be supplied with an adjustable stabilizing resistor. For dimensioning of the stabilizing resistor consider maximum through fault phase –earth current of 31.5kA.

4.4.9. Voltage Dependent Resistor (Metrosil)

4.4.9.1. Each REF relay shall be supplied with a voltage dependent resistor (VDR) or metrosil to limit voltage across the REF high impedance circuit. The basis for the rated voltage of the VDR is the maximum phase-earth through fault of 31.5kA.

Note: *The Stabilising resistor and the Voltage dependent resistor shall preferably be housed in a box with terminals that allow connection of the REF relay to the resistor and VDR in the box. Several terminals will be provided to allow selection of required stabilizing resistor. The single box will be suitable for panel mounting.*

4.4.10. Feeder Protection and Bay Control Relay

NB: The relay Offered must have been in service in Kenya Power for at Least 8 years and offered satisfactory service. Improved designs of previous relays are acceptable.

4.4.10.1. This relay shall have the following functions and features: -

i. The Feeder Protection and bay control relay shall be of Numeric Design

ii. The relay shall be suitable for flush mounting

iii. The relay will have a large LCD screen measuring at least 7cm X 7cm where a mimic of the switchgear arrangement and status of the switchgear for the bay shall be displayed.

iv. The position of the Circuit Breaker, i.e. racked-in or withdrawn shall be indicated.

v. Circuit Breaker close and open push key buttons with symbols and colour codes as per the IEC standards shall be provided on the relay as well as switchgear selection key.

vi. A Local/Remote key selector switch shall be provided on the relay and the selected status of the selector switch indicated by means of an LED.

vii. The Relay offered shall have at least the following protection functions; -

(a) Three Phase Overcurrent and Earth Fault

(b) Sensitive earth fault

(c) Broken Conductor detection

(d) Autoreclose

(e) Circuit breaker contact wear

(f) Circuit breaker Failure protection

(g) Under and over frequency protection as well as rate of change protection

(h) Over voltage protection

Note1: *All the protection functions shall meet the requirements of each function as included in this specification.*

Note 2*: Earth Fault and Sensitive Earth Fault Protection elements shall be separate to allow independent settings to be applied.*

Note 3*: Earth Fault and Sensitive earth fault shall have separate CT inputs.*

Note 4*: Detailed specifications for three phase overcurrent, earth fault and sensitive earth fault functions are included elsewhere in these specifications.*

viii. The relay shall have a circuit breaker contact wear counter/monitor.

ix. The Relay shall measure and display (Metering) on the LCD screen the following power system parameters; Current (I), Voltage (V), Active Power (P), Reactive Power (Q), Frequency (HZ) and power factor (P.F).

x. The relay shall store at least twenty (20) fault records, Fifty (50) events and ten (10) disturbance records. The disturbance record shall have capacity to monitor Eight (8) analogue and ten (10) digital channels.

xi. It shall be possible to display instantaneous measurands on the screen alongside the bay mimic.

xii. The unit shall have an L.E.D to indicate relay healthy status (green colour) and relay faulty status (red colour). A separate Red L.E.D to indicate operation (Trip) of the protection functions.

xiii. The relay shall have at least Eight (8) programmable LEDs for displaying Protection function operations and other alarms.

xiv. The template for writing the alarm labels shall be provided with the relay

xv. The relay shall have at least twelve (12) binary inputs

xvi. The Relay shall have at least six (6) output relays

xvii. The relay shall be provided with IEC 61850-8-1 Communication protocol, and the corresponding communication port.

xviii. The Relay terminals shall be of screw type terminals large enough to accommodate at least 2x2.5mm2 cable and shall be located at the back of the relay.

xix. Front Serial RS232 or USB or Ethernet Port for relay communication with a laptop computer for relay configuration and parameter settings and download of fault records, events records and disturbance record for analysis.

4.4.11. **Auto reclose relay Function in the Feeder Protection Relay.**

This autoreclose function shall be housed within the feeder protection relay and shall have the following features: -

i. Selectable 1 – 3 auto-reclose shots

ii. Independently set dead time for each shot

iii. Autoreclose inhibit after manual close both from external CB close switch and from control key on the Relay front face.

iv. Each autoreclose shot shall be initiated by the selected protection function(s). Operation of protection function not selected to initiate a particular shot of autoreclose shall lead to lock-out of the relay, hence circuit breaker.

v. Autoreclose inhibition for over current high set element.

Note: The Protection Functions Offered shall satisfy the detailed specifications as included elsewhere in this specification for each of the protection and control functions.

4.4.12. **Feeder Protection Relay:**

4.4.12.1. The Relay shall have the following protection functions and features in a single casing as a minimum: -

i. Three phase overcurrent
ii. Earth fault
iii. Sensitive Earth Fault
iv. Broken Conductor detection
v. Autoreclose function for three phase autoreclose.
vi. Under and Over Frequency Protection, including rate of change frequency protection

Note 1: *Earth Fault and Sensitive Earth Fault Protection elements shall be separate to allow independent settings to be applied. These functions will have separate CT inputs*

Note 2: *Earth Fault and Sensitive earth fault elements shall have separate CT Inputs.*

Note 3: *Detailed specifications for three phase overcurrent, earth fault and sensitive earth fault functions are included elsewhere in this specification. All requirements must be met.*

4.4.12.2. There shall be independent CT input for Earth Fault and for Sensitive Earth Fault Protection to allow independent connection of the Sensitive Earth Fault Protection Function to a separate Core type CT

4.4.12.3. Relay shall be of Numerical design.

4.4.12.4. Relays that have failed in service or mal-operated shall not be acceptable

4.4.12.5. The relays shall be suitable for flush mounting on the front of the panel

4.4.12.6. Current setting range for overcurrent function shall be 0.5In-2.0In as a minimum

4.4.12.7. Current setting range for earth fault function shall be 0.05In-0.8In as a minimum

4.4.12.8. Two stages of High Set Element for both overcurrent and earth fault protection function, with a setting range of 1-20In as a minimum and a definite time delay setting of 0 – 60 seconds as a minimum.

4.4.12.9. I.D.M.T characteristics for overcurrent and Earth fault protection function according to BS142 or IEC60255 i.e. Standard Inverse (SI), Very Inverse (VI), Extremely Inverse (EI), Long Time Inverse (LTI), including definite time for the high-set Elements.

4.4.12.10. Time setting multiplier 0.05 – 1.0 as a minimum

4.4.12.11. Current setting range for sensitive earth fault function 0.01In - 0.8In as a minimum

4.4.12.12. Definite time delay characteristic for Sensitive earth fault function; setting range, 0- 30 seconds as a minimum.

4.4.12.13. Requirements for the auto reclose function:

i. Three phases auto reclose

ii. Selectable 1 – 3 autoreclose shots

iii. Independently set dead time for each shot

iv. Autoreclose inhibit after manual close

v. Each autoreclose shot shall be initiated by the selected Protection Function(s). Operation of Protection Function not selected to initiate a particular shot of Autoreclose shall lead to Lock-out.

vi. Autoreclose inhibition for over current high set element

4.4.12.14. Data Storage:

i. Storage of at least five (5) fault/trip records

ii. Ten (10) event records

iii. Five (5) disturbance records

Note: *Events and fault records shall not be erased even when the auxiliary DC supply is switched off*

4.4.12.15. Configurable output relays for protection element pick up (start) and Trip outputs which can be used to back-trip upstream circuit breakers and for implementing blocking schemes for busbar protection.

4.4.12.16. Red L.E.D to indicate that the protection functions have operated and issued a trip output to Trip the circuit breaker.

4.4.12.17. Relay self-diagnostic, with LED to indicate relay healthy status (green colour) and relay failed status (red colour) and a watch dog contact for remote alarm

4.4.12.18. LEDs: The relay shall have a minimum eight (8) LEDs for alarms annunciation.

4.4.12.19. Binary Outputs: The relay shall have as a minimum twelve (12) Binary inputs.

4.4.12.20. Binary Outputs: The relay shall have a minimum four (4) outputs Relays. One (1) of the output relays shall be adequately rated to directly operate the circuit breaker trip coil.

4.4.12.21. LCD screen where the settings and measurands can be read

4.4.12.22. Keypad for manual programming of settings and data access

4.4.12.23. Relay Terminals-shall be screw type terminals large enough to accommodate at least 4mm2 cable and shall be located at the back of the relay

4.4.12.24. The relay applicable protocol shall be IEC 61850-8-1

4.4.12.25. Front Serial RS232 or USB or Ethernet Port for relay communication with a laptop computer for relay configuration and parameter settings and download of fault records, events records and disturbance records for analysis.

4.4.12.26. Software for configuration and relay parameter settings and also downloading and analysing the relay fault data shall be provided.

4.4.12.27. Relay to Laptop connection cable shall be provided

4.4.12.28. Auto reclose relay Function in the feeder protection relay. This auto reclose function shall be housed within the feeder protection relay: -

i. Selectable 1 – 3 auto reclose shots

ii. Independently set dead time for each shot

iii. Auto-reclose inhibit after manual close

iv. Each auto-reclose shot shall be initiated by the selected protection function(s). Operation of protection function not selected to initiate a particular shot of auto-reclose shall lead to lock-out of the relay.

v. Auto-reclose inhibition for over current high set element.

4.4.13. **Three- Phase Directional Overcurrent and Earth Fault Relay:**

NB: The relay Offered must have been in service in Kenya Power for at Least 8 years and offered satisfactory service. Improved designs of previous relays are acceptable.

The relay shall have the following functions and features: -

i. Relay must be of Numerical design.

ii. Shall be suitable for flush mounting on the front of the panel

iii. The Relay Offered must have been in Service in Kenya Power System and operated successfully for the eight (8) years. Improved designs of previous relays are acceptable. Relays that have failed in service or mal-operated shall not be acceptable

iv. The relay shall have a red L.E.D to indicate that the relay has operated to trip

v. Relay Self diagnostic, with LED to indicate relay healthy status (green colour) and relay failed status (red colour) and a watch dog contact for remote alarm shall be provided.

vi. Current setting range for overcurrent relay 0.5In-2.4x rated current (In), as a minimum

vii. Current setting range for earth fault relay 0.05In-0.8xrated current (In), as a minimum

viii. Quadrature connection for polarizing voltage

ix. Applicable on the LV side of a Dyn1 transformer

x. Overcurrent high set Element, with a setting range of 1-20 x rated current (In) as a minimum.

xi. Earth fault high set element, with a current setting range of 1-20 x rated current as a minimum.

xii. All stages of the Phase and Earth Fault elements shall be freely assigned the directional feature, as forward, reverse or non-directional.

xiii. Inverse Current-Time characteristics according to BS 142 or IEC 60255 and Definite time characteristics. The characteristic for each protection function shall be selectable.

xiv. The normal operating boundary shall be +/-90 degrees from relay characteristic angle.

xv. Relay sensitivity shall be 1% of rated value of current and polarizing voltage at an angle equal to the relay characteristic angle.

xvi. Time setting multiplier 0.05 – 1.0, as a minimum

xvii. Broken conductor detection feature

xviii. Circuit breaker contact wear monitor

xix. Storage of at least five (5) fault records and ten (10) event records

Note: *Events and fault records shall not be erased even when the auxiliary DC supply is switched off.*

xx. Storage of the last two disturbance records as a minimum.

xxi. Configurable output relays with ability to output starting elements to control tripping of other upstream protection relays.

xxii. The relay shall have as a minimum eight (8) LEDs for alarms annunciation

xxiii. The relay shall have as a minimum four (4) binary inputs.

xxiv. The Relay shall have as a minimum four (4) output relays and an LCD screen where the settings and measurands can be read.

xxv. Keypad for manual programming of settings and data access

xxvi. Relay Terminals-shall be screw type terminals large enough to accommodate at least 4mm2 cable and shall be located at the back of the relay

xxvii. Front Serial RS232 or USB or Ethernet port for relay communication with a laptop computer for relay configuration and parameter settings and download of fault records, events records and disturbance records for analysis.

4.4.14. **Three Phase Overcurrent and Earth Fault Relay:**

NB: The relay Offered must have been in service in Kenya Power for at Least 8 years and offered satisfactory service. Improved designs of previous relays are acceptable.

The relay shall have the following Functions and Features: -

i. Relay must be of Numerical Design

ii. Relays shall be suitable for Flush mounting on the panel front and current setting range for overcurrent relay shall be 0.5In-2.0In as a minimum

iii. Current setting range for earth fault relay shall be 0.05In-0.8In as a minimum

iv. I.D.M.T characteristics for overcurrent and earth fault protection function according to BS142 or IEC60255 i.e. Standard Inverse (SI), Very Inverse (VI), Extremely Inverse (EI), Long Time Inverse (LTI), including definite time for the high-set Elements.

v. The relays 'time setting multiplier 0.05 – 1.0, as a minimum and under frequency protection feature shall be provided.

vi. Relays Broken conductor detection protection feature shall be provided.

vii. High set element for both overcurrent and earth fault protection, with a setting range of 1-20 x rated current (In) and a definite time delay setting of– 60 seconds shall be provided.

viii. Circuit breaker contact wear monitor: Ability to store at least five (5) fault records and ten (10) event records

ix. Events and fault records shall not be erased even when the auxiliary DC supply is switched off.

x. Means of identifying fault type and stage of protection that has operated either by use of LEDs or by automatic display of the fault records details on the relay LCD.

xi. Trip and start contacts shall be freely configurable to the output relays with drop off /pickup ratio >90% and low transient overreach < 10%.

xii. Red L.E.D to indicate that the relay protection functions have operated/tripped and relay self-diagnostic, with LED to indicate relay healthy status (Green colour) and relay failed status (Red colour) and a watch dog contact for remote alarm shall be provided.

xiii. The relay shall have as a minimum eight (8) LEDs for alarms annunciation

xiv. The relay shall have as a minimum four (4) binary inputs.

xv. The Relay shall have as a minimum four (4) output relays

xvi. LCD screen where the settings and measurands can be read.

xvii. Relay Terminals-shall be screw type terminals large enough to accommodate at

least 4mm2 cable and shall be located at the back of the relay.

xviii. LCD screen Keypad for manual programming of settings and data access.

xix. The relay shall have front serial RS232 or USB or Ethernet Port for relay communication with a laptop computer for relay configuration and parameter settings and download of fault records, events records and disturbance records for analysis.

xx. Relay to Laptop connection cable shall be provided

4.4.15. **Earth Fault Relay:**

The Relay shall have the following functions and Features: -

i. Relay must be of Numerical Type

ii. Current setting range 0.05In-0.8In

iii. The Relay must have been in operation in Kenya Power System and operated successfully for the last eight (8) years. Improved designs of previous relays are acceptable.

iv. Shall be suitable for flush mounting on the front of the panel

v. Inverse Current – Time characteristics for Earth fault protection function according to BS142 or IEC60255 i.e. Standard Inverse (SI), Very Inverse (VI), Extremely Inverse (EI), Long Time Inverse (LTI), including definite time for the high-set Elements.

vi. Time setting multiplier 0.05 – 1.0 x rated current (In)

vii. High set Element with a setting range of 1-20 x rated current (In).

viii. Circuit breaker contact wear monitoring

ix. Ability to store at least five (5) Fault records, and ten (10) event records

x. Events and fault records shall not be erased even when the auxiliary DC supply is switched off.

xi. Trip and Start Contacts shall be freely configurable to the output Relays.

xii. Drop off /pickup ratio >90% and low transient overreach < 10%

xiii. Red L.E.D to indicate that the Relay has operated to trip

xiv. Relay Self diagnostic, with LED to indicate Relay failure and a contact for remote indication

xv. The relay shall have as a minimum four (4) LEDs for alarms annunciation

xvi. The relay shall have as a minimum four (4) binary inputs.

xvii. The Relay shall have as a minimum four (4) output relays

xviii. LCD screen where the Settings and measurands can be read

xix. Keypad for manual programming of settings and data access

xx. Relay Terminals-shall be screw type terminals large enough to accommodate at least 4mm2 cable and shall be located at the back of the relay

xxi. Front Serial RS232 or USB or Ethernet Port for relay communication with a

xxii. Laptop computer for Relay configuration and parameter settings and download of fault records, events records and disturbance records for analysis.

xxiii. Relay to Laptop connection cable

4.4.16. **Sensitive Earth Fault Relay:**

The Relay shall have the following functions and features: -

i. Relay must be of Numerical Type

ii. Should be suitable for flush mounting on the front of the panel

iii. The Relay must have been in operation in the Kenya Power System and operated successfully for the last eight (8) years. Improved designs of previous relays are acceptable.

iv. Relays that have failed in service or mal-operated shall not be acceptable

v. Current setting range for earth fault relay 0.0125In- 0.8In

vi. Definite time delay characteristic shall have setting range 0- 30seconds.

vii. Fault records, Event Records Events and fault records shall not be erased even when the auxiliary DC supply is switched off, drop off /pickup ratio >90% and low transient overreach < 10%.

viii. Red L.E.D to indicate that the Relay has operated to trip, relay self-diagnostic, with LED to indicate Relay failure and a contact for remote indication

ix. The relay shall have as a minimum four (4) LEDs for alarms annunciation

x. The relay shall have as a minimum four (4) binary inputs.

xi. The Relay shall have as a minimum four (4) output relays

xii. LCD screen where the settings and measurands can be read

xiii. Keypad for manual programming of settings and data access

xiv. Relay Terminals-shall be screw type terminals large enough to accommodate at least 2 x 2.5 mm2 cable and shall be located at the back of the relay

xv. Front Serial RS232 or USB or Ethernet Port for relay communication with a laptop computer for relay configuration and parameter settings and download of fault records, events records and disturbance records for analysis.

4.4.17. Electrical Reset – Trip Relay

The manufacturer shall have experience of a minimum of 15 years in the manufacture of trip relays

The relay shall be used to trip circuit breakers and shall have the following features: -

i. High burden tripping relay, immune to capacitance discharge currents and leakage currents

ii. At least Four (4) pairs of normally open (NO) and two (2) pairs of normally closed (NC) or 4NO/NC output contacts.

iii. Instantaneous operation; time <15ms

iv. The Relay shall be suitable for flush mounting

v. Flag or target shall be a red; L.E.D, or durable bulb or Red Mechanical flag

vi. The Relay shall be electrically reset, and the reset button shall be inbuilt on the relay and accessible without opening the relay cover or shall be supplied separately for panel flush mounting, in which case the reset button shall be illuminated with red colour.

vii. Contact rating – capable of carrying 30Amps for 3 seconds and 10A, continuously

viii. Relay terminals-shall be screw type large enough to accommodate at least 4mm2 cable and shall be located at the back of the relay

ix. Relay terminals shall be clearly marked

x. Relay contacts configuration shall preferably be drawn on the relay casing.

xi. Alternatively, a connection drawing shall be supplied with the relay.

xii. Size not greater than 24x19x6 cm

4.4.18. Self-Reset Trip Relay

The manufacturer shall have experience of a minimum of 15 years in the manufacture of trip relays

The relay shall be used to trip Circuit Breakers. The relay shall have the following features: -

i. High burden tripping relay, immune to capacitance discharge currents and leakage currents

ii. At least Four (4) pairs of normally open (NO) and two (2) pairs of normally closed (NC) or 4NO/NC output contacts.

iii. Instantaneous operation; time <15ms

iv. The Relay shall be suitable for flush mounting or for mounting on 35mm DIN rail, in which case the relay shall be supplied complete with the base

v. Flag or target shall be a red; L.E.D, or durable bulb or Red Mechanical flag

vi. The Relay shall be self-reset, once the relay initiating the trip resets.

vii. Contact rating – capable of carrying 30Amps for 3 seconds and 10A, continuously and the Relay terminals shall be clearly marked

viii. Relay Terminals-shall be screw type terminals large enough to accommodate at least

ix. 2 x 2.5 mm^2 cable and shall be located at the back of the relay

x. Drawing for relay connection shall be provided with the relay

xi. Relay contacts configuration shall preferably be drawn on the relay casing.

xii. Alternatively, a connection drawing shall be supplied with the relay.

xiii. Size not greater than 24x19x6 cm

4.4.19. **Low Power Current Transformers Overcurrent and Earth Fault Protective relays**

4.4.19.1. The relays shall be applicable to existing 11kV Indoor changeover systems which use Low Power CTs connected to the relay via RJ45 terminal.

4.4.19.2. The relay shall, via voltage set points, be able to determine healthy and unhealthy supply so as to initiate changeover to transfer load from an unhealthy supply to a healthy supply.

4.4.19.3. Through Low Power CTs (LPCTs) and set-point parameters for short circuit fault conditions, the relay shall block initiation of changeover due to an overcurrent and/or earth fault resulting to a trip operation.

4.4.19.4. **Performance Characteristics of Low Power Overcurrent and Earth Fault Relays**

These specifications indicate the required performance characteristics for each of the Protection Relays.

4.4.19.4.1. Rating

The protection relays shall have the following rated values:

(a) The power system where the relays are to be installed has nominal frequency of 50HZ

(b) The CT inputs shall be of Low Power CT design with RJ45 connection per phase to the relay, where the LPCT transducers conform to IEC 60044-8. Current sensing shall be selectable up to a minimum of 3000A (NB this is not fault current). Sensitive CT input shall be of 1A, screw type terminals.

(c) The rated VT secondary voltage is 110V AC, phase to phase (63.5V AC phase to ground)

(d) DC auxiliary rating is 24-250V DC.

(e) Relay trip operation shall be indicated by a red LED, for measurement relays.

4.4.19.4.2. Protection Functions

The relay shall have the following protection functions and features in a single casing as a minimum:

i. Three phase overcurrent
ii. Earth fault
iii. Sensitive Earth Fault
iv. Broken Conductor detection
v. Autoreclose function for three phase autoreclose.
vi. Under and Over voltage detection
vii. Under and Over Frequency Protection.

4.4.19.5. There shall be a dedicated CT input for Sensitive Earth Fault Protection to allow independent connection of the Sensitive Earth Fault Protection Function to a separate Core balance type CT

4.4.19.6. Current setting range for overcurrent function shall be 0.1In-2.4In as a minimum for IDMT.

4.4.19.7. Current setting range for earth fault function shall be 0.1In-1In as a minimum for IDMT.

4.4.19.8. Two stages of High Set Element for both overcurrent and earth fault protection function, with a setting range of 1-20In (over current) and 1-15In (earth fault) as a minimum and a definite time delay setting of 0 – 60 seconds as a minimum.

4.4.19.9. I.D.M.T characteristics for overcurrent and Earth fault protection function according to BS142 or IEC60255 i.e. Standard Inverse (SI), Very Inverse (VI), Extremely Inverse (EI), Long Time Inverse (LTI), including definite time for the high-set Elements.

4.4.19.10. Time setting multiplier 0.1 – 1.0 as a minimum

4.4.19.11. Current setting range for sensitive earth fault function 0.1In - 1In as a minimum

4.4.19.12. Definite time delay characteristic for Sensitive earth fault function; setting range, 0- 30 seconds as a minimum.

4.4.19.13. The relay shall be able to measure Overvoltage and under voltage for both phase to phase and phase to ground voltages. It should measure phase rotation by use of phase voltages connected.

4.4.19.14. Under voltage setting range shall be from 5% to 115% U_n as a minimum.

4.4.19.15. Overvoltage setting range shall be from 50% to 140%U_n as a minimum.

4.4.19.16. Timing for both under and Overvoltage shall be 0.05 to 200s definite time as a minimum.

4.4.19.17. Requirements for the auto reclose function shall be:

i. Three phases auto reclose
ii. Selectable 1 – 3 autoreclose shots (minimum 3 shots)
iii. Independently set dead time for each shot
iv. Autoreclose inhibit after manual close
v. Each autoreclose shot shall be initiated by the selected Protection Function(s). Operation of Protection Function not selected to initiate a particular shot of Autoreclose shall lead to Lock-out.
vi. Autoreclose inhibition for over current high set element

4.4.19.18. **Data Storage:**

i. Storage of at least fifteen (15) fault/trip records
ii. At least Fifty (50) event records
iii. At least fifteen (15) disturbance records

Note: *Events and fault records shall not be erased even when the auxiliary DC supply is switched off*

4.4.19.19. Configurable output relays for protection element pick up (start) and Trip outputs. Trip output can be used to circuit breakers of the protected circuit.

4.4.19.20. Red L.E.D to indicate that the protection functions have operated and issued a trip output to Trip the circuit breaker.

4.4.19.21. Auto reclose relay Function in the feeder protection relay. This auto reclose function shall be housed within the feeder protection relay: -

i. Selectable 1 – 3 auto reclose shots
ii. Independently set dead time for each shot
iii. Auto-reclose inhibit after manual close

iv. Each auto-reclose shot shall be initiated by the selected protection function(s). Operation of protection function not selected to initiate a particular shot of auto-reclose shall lead to lock-out of the relay.

v. Auto-reclose inhibition for over current high set element.

4.4.19.22. **Additional specifications:**

The relay shall have the following functions and features:

i. Relay self-diagnostic, with LED to indicate relay failed status (red colour) and a watchdog contact for remote alarm

ii. LEDs: The relay shall have a minimum eight (8) LEDs for alarms annunciation.

iii. Binary Inputs: The relay shall have as a minimum ten (10) Binary Inputs of 24-250VDC.

iv. Binary Outputs: The relay shall have a minimum eight (8) outputs voltage free Relays. One (1) of the output relays shall be adequately rated to directly operate the circuit breaker trip coil.

v. LCD screen where the settings and measurands can be read and set.

vi. Keypad for manual programming of settings and data access

vii. Relay Terminals-shall be screw type terminals large enough to accommodate at least $4mm^2$ cable and shall be located at the back of the relay (except for phase CT inputs which are LPCT terminals).

viii. The relay applicable protocol shall be IEC 61850-8-1

ix. Software for configuration and relay parameter settings and also downloading and analysing the relay fault data shall be provided.

x. Relays Broken conductor detection protection feature shall be provided.

xi. Circuit breaker contact wear monitor function to be available.

xii. Events and fault records shall not be erased even when the auxiliary DC supply is switched off.

xiii. Means of identifying fault type and stage of protection that has operated either by use of LEDs or by automatic display of the fault records details on the relay LCD or both.

xiv. Trip and start contacts shall be freely configurable to the output relays with drop off /pickup ratio >90% and low transient overreach < 10%.

4.4.19.23. **Communication**

i. The relay shall have front serial RS232 or USB or Ethernet Port for relay communication with a laptop computer for relay configuration and parameter settings and download of fault records, events records and disturbance records for analysis.
ii. Relay to Laptop connection cable shall be provided

4.4.20. **Trip circuit supervision Relay Type I:**

The manufacturer shall have experience of a minimum of 15 years in the manufacture of Trip Circuit Supervision relays

The relay shall have the following features: -

i. Continuous supervision of trip circuit for circuit breaker in both OPEN & CLOSED positions
ii. Trip Circuit Healthy – Red/Green L.E.D ON
iii. Trip circuit fail –Green/Red L.E.D OFF
iv. Two (2) normally closed (NC) and two (2) normally open(NO) or 2 C/O (change-over) output contacts
v. The relay shall have a time delay of at least 150mS to avoid transient operations
vi. Contact ratings – 30 Amps for 3 seconds and 5 Amps continuously.
vii. Suitable for Flush mounting on the relay panel
viii. Relay Terminals-shall be screw type terminals large enough to accommodate at least 4mm2 cables and shall be located at the back of the relay and relay terminals shall be clearly marked.
ix. Relay shall be supplied complete with the base.
x. Relay contacts configuration shall preferably be drawn on the relay casing.
xi. Alternatively, a connection drawing shall be supplied with the relay.
xii. Size not greater than 16x9x9 cm

4.4.21. **Trip circuit supervision Relay Type II:**

The manufacturer shall have experience of a minimum of 15 years in the manufacture of Trip Circuit Supervision relays

The relay shall have the following Features: -

i. Continuous supervision of trip circuit for circuit breaker in both OPEN & CLOSED positions
ii. Trip Circuit Healthy – Red/Green L.E.D ON

iii. Trip circuit fail - Green/Red L.E.D OFF

iv. Two (2) normally closed (NC) and two (2) normally open (NO) or 2C/O (change-over) output contacts.

v. The relay shall have a time delay of at least 150mS to avoid operation due to transient DC supply interruptions.

vi. Contact ratings – 30 Amps for 3 seconds and 5 Amps continuously.

vii. Suitable for DIN Rail (35 mm) Mounting

viii. Relay Terminals-shall be screw type terminals large enough to accommodate at least 2 x 2.5 mm^2 cable and shall be located at the back of the relay

ix. Relay terminals shall be clearly marked

x. Relay shall be supplied complete with the base

xi. Relay contacts configuration shall preferably be drawn on the relay casing.

xii. Alternatively, a connection drawing shall be supplied with the relay.

Note: The manufacturer for the auxiliary relays below shall have a least 15 years' experience in the manufacture of auxiliary relays for transformer mechanical protection Trip function

4.4.22. **Auxiliary relays For Transformer Mechanical Protection Trip Function Type I:**

The relays shall be used as repeat relays for power transformer mechanical protection functions.

The Relay shall have the following features: -

i. High speed operation; < 20 ms for tripping

ii. One (1) element in one casing/relay

iii. Hand reset contacts

iv. Manually reset Operation indication/mechanical flag (Red in colour)

v. Shall be suitable for 35mm DIN rail mounting inside the panel

vi. At Least Three (3) pairs of normally open (NO) output contacts

vii. Relay Terminals-shall be screw type terminals large enough to accommodate at least 2.5 mm2 cables and located at the back of the relay.

viii. Contact ratings – 30 Amps for 3 seconds and 10 Amps continuously.

ix. Relay terminals shall be clearly marked, with indelible numbers

x. Relay shall be supplied complete with base.

xi. Relay contacts configuration shall preferably be drawn on the relay casing.

xii. Alternatively, a connection drawing shall be supplied with the relay.

xiii. Size not greater than 24x18x10 cm

4.4.23. **Auxiliary relays For Transformer Mechanical Protection Trip Function Type II:**

The Relay shall have the following features: -

i. High speed operation < 20 ms for Tripping

ii. One element (1) in one casing

iii. Self-reset contacts

iv. Manually reset Operation Indication flag – Red in colour

v. Provision of hand operation to close relay contacts for testing

vi. Shall be suitable for DIN Rail (35mm) mounting at the back of the panel

vii. At Least Three (3) pairs of normally open(NO) output contacts

viii. Complete relay including the relay base (socket).

ix. Contact ratings – 30 Amps for 3 seconds and 5 Amps continuously.

x. Relay Terminals-shall be screw type terminals large enough to accommodate at least 2.5 mm2 cable

xi. The Relay terminals shall be clearly marked.

xii. Relay contacts configuration shall preferably be drawn on the relay casing.

xiii. Alternatively, a connection drawing shall be supplied with the relay.

xiv. Relay shall be supplied complete with base

xv. Size not greater than 10x5x5 cm

4.4.24. **Auxiliary relays For Transformer Protection Alarm Function Type III:**

The relay shall have the following features: -

i. Moderate speed of operation < 35ms for Alarm

ii. One (1) element in one casing/relay

iii. Self-reset contacts

iv. Provision of hand operation to close relay contacts for testing

v. Manually reset operation indication flag – Red in colour

vi. Shall be suitable for DIN Rail mounting at the back of the panel

vii. At least Three (3) NO (Normally open) output contacts per element

viii. Contact ratings - 30 Amps for 3 seconds and 10 Amps continuously.

ix. Complete relay including the relay base (socket)

x. Relay Terminals-shall be screw type terminals large enough to accommodate at least 2.5 mm^2 cable

xi. Relay terminals shall be clearly marked

xii. Relay contacts configuration shall preferably be drawn on the relay casing

xiii. Relay supplied complete with base

xiv. Size not greater than 10x5x5 cm

4.4.25. **Bistable Auxiliary relays:**

The Relay shall have the following features: -

i. The manufacturer shall have at least 10 years' experience in the manufacture of Bistable auxiliary relays for use in Protection and Control Panels.

ii. Application of alternate control pulses cause the contacts to change from one state to the other.

iii. If the supply is interrupted, the contacts remain in their previous position even when the voltage is restored.

iv. Equipped with two DC coils, one for each contact position

v. Two identical stable latched positions with position indicators

vi. Rated DC supply110V DC; +10% & -20%

vii. Contacts at least 5NO + 5NC Contacts

viii. Contact ratings – 30 Amps for 3 seconds and 10 Amps continuously.

ix. Operating time ≤ 25 ms

x. Suitable for mounting on 35 mm DIN rail

xi. Coils not continuously energized- connected through contacts for cut-off after operation

xii. The terminals shall be screw type and large enough to accommodate 2x2.5 mm2 cable

xiii. Relay shall be supplied complete with the base

4.4.26. **DC Supply under Voltage Relay.**

The Relay shall have the following features: -

i. Shall have a settable range for under voltage pick up, of 30-80% of the rated DC Voltage
ii. Relay nominal voltage 110V DC
iii. Shall have an accuracy of $< \pm 4\%$
iv. Shall be self-reset when the voltage returns to normal level
v. Shall have a built-in indication LED (green) and a Built in Operation LED (red)
vi. Shall have at least 2 NC auxiliary contacts (contacts close for under voltage conditions)
vii. The Relay shall be rated for continuous operation at the rated DC voltage.
viii. Shall be suitable for mounting Flush mounting
ix. The terminals shall be screw type and large enough to accommodate 2.5 mm^2 cable

4.4.27. **Annunciator Relay Type I**

The manufacturer shall have a minimum experience of 15 years in the manufacture of the annunciator relay. The Annunciator relays shall have compact design. The Relay shall have the following features:

i. The Annunciator shall be designed to receive station equipment status information through hardwired contacts, hence provide a common point through which alarms can be monitored.
ii. The relay shall be compact and integrated into one common device. Relays with individual alarm covers are not acceptable.
iii. The relay shall be suitable to read and acknowledge alarms locally or remotely
iv. The relay shall be fully programmable via keypad and/or Laptop.
v. The status of the alarms shall be retained even with loss of auxiliary dc power supply. On power, up the last alarm status will be displayed.
vi. Shall have Silence, Accept, Reset and Test push buttons, to control the Alarms
vii. The single relay shall be equipped with at least thirty-six (36) separate alarm elements in a single casing. Each alarm to be independently programmable
viii. The relay shall be of digital design
ix. The relay shall be suitable for flush panel mounting
x. Each of the elements shall be freely assigned to one of two common output alarms; Urgent, and Non-urgent alarm.

xi. Each Alarm Element shall have a red L.E.D. to indicate alarm ON status. It shall also have provision for fixing of Identification Label changeable at site. A flashing alarm element shall be clearly visible.

xii. The Urgent and Non-Urgent common alarms shall be freely configurable to the output relays.

xiii. It shall have high immunity against electrical interference.

xiv. Relay Terminals-shall be of screw type, large enough to accommodate at least

xv. 2x2.5 mm2 cable and shall be located at the back of the relay

xvi. Relay terminals shall be clearly marked with indelible writing

xvii. Relay contacts configuration shall preferably be drawn on the relay casing

xviii. At least two output relays one for urgent and the other for non-urgent alarm

xix. The relay shall be supplied with field configurable labels.

xx. At least two (2) pairs of Normally Open (NO) out-put contacts for each out-put relay

4.4.28. **Annunciator Relay Type II:**

The manufacturer shall have a minimum experience of 15 years in the manufacture of the annunciator relay. The relay shall have the following functions and features: -

i. The Annunciator shall be designed to receive station equipment status information through hardwired contacts, hence provide a common point through which alarms can be monitored.

ii. The relay shall be compact and integrated into one common device. Relays with individual alarm covers are not acceptable.

iii. The relay shall be suitable to read and acknowledge alarms locally or remotely

iv. The relay shall be fully programmable via keypad and/or Laptop.

v. The status of the alarms shall be retained even with loss of auxiliary dc power supply, on power up the last alarm status will be displayed.

vi. The relay shall be of digital design

vii. The relay shall be suitable for flush panel mounting. The Relay shall have the following features: -

viii. Shall have Silence, Accept, Reset and Test push buttons, to control the Alarms

ix. The single relay shall be equipped with sixteen (16) separate alarm Elements in a single casing.

x. The Relay Offered must have been in Service in Kenya Power System and operated successfully for the last 4 years. Improved designs of previous relays are acceptable.

xi. Relays offers from Manufacturers who have not supplied relays before are not acceptable for this tender.

xii. Relays that have failed in service or mal-operated shall not be acceptable

xiii. Each of the elements shall be freely assigned to one of two common output Alarms; Urgent and NON-urgent Alarm.

xiv. Each Alarm Element shall have a Red L.E.D. to indicate ON status. It shall also have provision for fixing of Identification Label changeable on site. A flashing Alarm element shall be clearly visible.

xv. The Urgent and Non-Urgent common alarms shall be freely configurable to the output Relays.

xvi. It shall have high immunity against electrical interference

xvii. Relay Terminals-shall be of screw type, large enough to accommodate at least 2x2.5 mm^2 cable and shall be located at the back of the relay

xviii. Relay terminals shall be clearly marked, with indelible writing

xix. Relay contacts configuration shall preferably be drawn on the relay casing

xx. At least two out-put relays one for urgent and the other for non-urgent alarm

xxi. Drawings for wiring of the relay shall be supplied with the relay.

4.4.29. **Annunciator Relay Type III:**

The manufacturer shall have a minimum experience of 15 years in the manufacture of the annunciator relay. The Relay shall have the following features: -

i. The Annunciator shall be designed to receive station equipment status information through hardwired contacts, hence provide a common point through which alarms can be monitored.

ii. The relay shall be compact and integrated into one common device. Relays with individual alarm covers are not acceptable.

iii. The relay shall be suitable to read and acknowledge alarms locally or remotely

iv. The relay shall be fully programmable via keypad and/or Laptop.

v. The status of the alarms shall be retained even with loss of auxiliary dc power supply. On power, up the last alarm status will be displayed.

vi. The relay shall be of digital design

vii. The relay shall be suitable for flush panel mounting

viii. Shall have Silence, Accept, Reset and Test push buttons, to control the alarms

ix. The single relay shall be equipped with at least eight (8) but not more than sixteen (16) separate alarm elements in a single casing.

x. Relays that have failed in service or mal-operated shall not be acceptable

xi. Each of the elements shall be freely assigned to one of two common output alarms; Urgent and NON-urgent Alarm.

xii. Each alarm element shall have a red L.E.D. to indicate ON status. It shall also have provision for fixing of Identification Label changeable at site. A flashing alarm element shall be clearly visible when standing in front of the annunciator relay

xiii. The Urgent and Non-Urgent common alarms shall be freely configurable to the output relays.

xiv. It shall have high immunity against electrical interference.

xv. Relay terminals-shall be screw type, large enough to accommodate at least

xvi. 2x2.5 mm^2 cable and shall be located at the back of the relay

xvii. Relay terminals shall be clearly marked, with indelible writing

xviii. Relay contacts configuration shall preferably be drawn on the relay casing

xix. At least two output relays one for urgent and the other for non-urgent alarm

xx. A Drawing for wiring of the relay shall be supplied with the relay.

4.4.30. **Electronic Hooter:**

The manufacturer shall have a minimum experience of 10 years in the manufacture of the switch.

The Hooter shall have the following features: -

i. The hooter is for use in substations to announce abnormal conditions. It is to be mounted on the control panel inside the substation control building.

ii. It shall suitable for Flush mounting on the panel

iii. Maximum output 80-110 dB(A), preferably with flashing LED

iv. Bezel size from 96x96 mm up to 110x110 mm

v. Rated frequency 50 HZ

vi. Siren Tone; selectable tones including siren tone acceptable.

vii. Rated voltage shall be 240V AC; +/-10 % or rated DC supply voltage of 110V DC and 30V DC

viii. Protection degree shall be IP 20

ix. Operating mode shall be continuous

x. Operating temperature of up to 500C

xi. Terminals shall be screw type and suitable for connection of 2.5 mm ^{2} cable

xii. Terminals shall be indelibly marked

4.4.31. **Anti-condensation Heater:**

The manufacturer shall have a minimum of 10 years' experience in the manufacture of the heater. The heater shall be used in protection and control panels and marshalling boxes in the substation to prevent condensation. The heater shall have the following features: -

i. The heater should be suitable for mounting inside Protection or Control panels with Protection Relays and other measuring and control devices.

ii. The Heater shall be rated at 75W and 240V AC and should be suitable for preventing condensation within the panels which have dimensions of 2200x800x800 mm for the climatic conditions specified in section

iii. The heater body shall be of extruded aluminium profile or stainless steel

iv. The heater shall have natural convection and be of durable construction.

v. The heater shall be suitable for horizontal or vertical mounting on a DIN rail (35 mm) or flat surface inside the panel

vi. The terminals shall be screw type and large enough to accommodate 2.5 mm^2 cable

4.4.32. **Hygrostat:**

The manufacturer shall have a minimum of 10 years' experience in the manufacture of the hydrostat. This device shall be used for switching ON and OFF anti-condensation heaters in protection and control panels and inside switchyard mechanism boxes, in Air Insulated Substations. The hygrostats shall have the following features:

i. Temperature control with a variable setting of 0-600C, as a minimum

ii. Humidity setting with a variable setting of 50 – 90%, as a minimum

iii. Suitable for mounting on 35 mm DIN rail

iv. Two normally open (2NO) Contacts, suitable for switching on the heater. The contact rating shall be declared in the bid.

v. Rated power supply for the hygrostat shall be 240 V AC ±10%

Note: *The manufacturer of the control switches shall have minimum experience of 10 years in the manufacture of the control switches.*

4.4.33. **Discrepancy Switch for Circuit Breaker Control:**

The manufacturer shall have minimum experience of 15 years in the manufacture of the switch.

The control switch shall have the following features: -

i. Suitable flush mounting
ii. Press and Turn operation for Circuit Breaker close and open operation.
iii. As a minimum three (3) pairs of Normally Open(NO) contacts for circuit breaker close operation and two (2) pairs of Normally Open(NO) contacts for circuit breaker open operation.
iv. White colour continuous illumination for discrepancy in circuit breaker status. The illumination shall be by white LED bulb.
v. The discrepancy switch shall be sturdy and durable.
vi. The position for circuit breaker close and the position for circuit breaker open Operations shall be clearly marked on the escutcheon plate supplied with the switch.
vii. The top of the switch having the escutcheon plate shall have a rectangular outer shape.
viii. The switch shall have screw type terminals large enough to accommodate 2x2.5mm2 cable
ix. Switch terminals shall be indelibly marked, white numbers on black background
x. The switch contacts configuration shall preferably be drawn on the switch
xi. Switch to be supplied with white illumination LED bulb
xii. The lamp shall be rated at below 4 W power consumption
xiii. The switch shall be supplied with a drawing showing how the switch operates and contact configuration.
xiv. Switch Offered shall be type DK10 or equivalent in terms of size, quality and durability.

4.4.34. **Circuit Breaker Close/Open Control Switch:**

NB: The manufacturer shall have experience of a minimum of 10 years in the manufacture of Circuit breaker control switches

The control switch shall have the following features: -

i. The switch shall have a mechanical interlock to prevent accidental operation of the switch. Pistol Grip make is preferred.

ii. It shall have a Close, Neutral and Open positions engraved on an escutcheon plate fixed on the switch, in black letters on white background. After an operation, the switch shall return to the neutral Position by spring Action.

iii. The switch shall have screw type terminals suitable for connection of 2.5 mm2 cable.

iv. Contacts configuration for open and for close operation shall as a minimum be; two (2) Normally Open (NO) contacts.

v. As a minimum, the Contact ratings shall be 30 Amps for 3 seconds and 10 Amps continuously.

4.4.35. Push Button Switches for Circuit Breaker Close/Open Operation – Type I

NB: The manufacturer shall have experience of a minimum of 10 years in the manufacture of Circuit breaker close/open push button control switches

The control switch shall have the following features: -

i. Shall be shrouded or well recessed in their housing to minimize the risk of in-advertent operation

ii. Shall be non-retaining type, made of non-hygroscopic materials and fitted to avoid any possibility of sticking

iii. The contacts shall be shrouded to minimize ingress of dust and accidental contact.

iv. Shall have two pairs of Normally Open Contacts (2NO)

v. Shall be Suitable for flush mounting

vi. Screw type terminals suitable for connection of 2.5 mm^2 cable

vii. The push button for close operation should be Red in colour and integrally labelled "CB ON"

viii. The push button for open operation should be Green in colour and integrally labelled "CB OFF"

ix. Contacts rated to carry 16 Amps, 220V DC

4.4.36. **Push Button Switch for Alarm /Trip Relay Reset – Type II**

NB: The manufacturer shall have experience of a minimum of 10 years in the manufacture of Circuit breaker control switches

The push button switch shall have the following features: -

i. Shall be shrouded or well recessed in their housing to minimize the risk of inadvertent operation

ii. Shall be non-retaining type, made of non-hygroscopic materials and fitted to avoid any possibility of sticking

iii. The contacts shall be shrouded to minimize ingress and should have two pairs of Normally Closed Contacts (2NC)

iv. Shall be suitable for flush mounting

v. Screw type terminals suitable for connection of 2.5 mm^2 cable

vi. The push button shall be blue in colour

vii. The contacts shall be rated to carry 5 Amps, 220V DC

Note: The manufacturer of selector switches shall have experience of a minimum of 10 years in the manufacture of the control selector switches

4.4.37. **Local/Remote Selector Switch:**

For use on Protection and control panels and on switchgear installed in the switchyard

i. Shall be suitable for flush mounting on the Panel

ii. Shall have two position selection, Local and Remote

iii. Shall have Two pairs of change-over contacts(NOC)

iv. Shall have contact Rating 6A, 440V AC/220V DC

v. Locate and Remote positions indelibly labelled on an escutcheon plate fixed on the switch.

vi. It shall have screw type terminals suitable for connection of 4 mm^2 cable

4.4.38. **OFF/Local/Remote Selector Switch:**

For use on outdoor Circuit Breakers and Transformer Tap Changers

i. Shall be suitable for flush mounting on the Plate

ii. It shall have three position selection, OFF, Local and Remote

iii. It shall have Four pairs of change-over contacts

iv. Contact Rating 16A, 440V AC/220V DC

v. OFF, Locate and Remote positions indelibly labelled on an escutcheon plate fixed on the switch.

vi. Screw type terminals suitable for connection of 4 mm^2 cable

4.4.39. **ON/OFF Selector Switch:**

For use on outdoor Protection and Control Panels

i. Suitable for flush mounting on the Panel

ii. Two position selection, ON and OFF

iii. Two pairs of change-over contacts

iv. Contact Rating 4Amps, 220V DC

v. ON and OFF positions indelibly labelled on an escutcheon plate fixed on the switch.

vi. Screw type terminals suitable for connection of 2.5 mm^2 cable

4.4.40. **Semaphores for Isolator and Earth Switch Position Indication**

The manufacturer shall have at least 10 years' experience in the manufacture of the semaphores. This device shall be used to remotely mimic on the control panel, the position (open or closed) of disconnectors/Isolators, which are located in the switchyard. The Status Indicator shall have the following features: -

i. Shall be suitable for flush mounting

ii. With Red L.E.D for closed (ON) status indication and Green L.E.D for open (OFF) status Indication.

iii. Shall be of circular or rectangular front appearance

iv. The Unit shall have screw type terminals large enough to accommodate 2x2.5mm2 cable

v. The Terminals shall be indelibly marked

4.4.41. **LED Indicating Lamps:**

The manufacturer shall have at least five years' experience in the manufacture of LED indicating lamps. The lamps are primarily for indicating the status of switchgear in the substation. They shall have the following features: -

i. The LED indicating lamps shall be complete with lamp and mounting base

ii. These shall be suitable for mounting on the front of the control panel (Flush mounting).

iii. The Indicators Lamps shall be of LED type

iv. The Lamp Indicators should be rated for 4W power consumption or less.

v. The lamp indicators should be designed for continuous operation and to give a long operating life of at least 10 years.

vi. Red LED indicators shall be of the high brightness type

Note1: The colour and quantities of the LED Indicating lamps will be specified in the Bill of materials and price schedules

Note 2: The manufacturer of Miniature Circuit Breakers (MCBs) shall experience of at least 15 years in the manufacture of the MCBs

4.4.42. **Miniature Circuit Breaker Type I:**

These shall be for use on the secondary side of Voltage transformer and shall have the following features: -

i. Shall be three pole unit

ii. Shall be rated operating voltage, 400V AC

iii. Rated Insulation voltage shall be 600V AC

iv. Rated frequency shall be 50 HZ

v. Degree of Protection shall be: IP20

vi. Setting value of thermally delayed Overload release, 3 A

vii. Overcurrent release set at 20A

viii. Rated continuous current for contacts of 6 Amps

ix. MCB should have an Auxiliary 1 NC & 1 NO contact.

x. Contact Position Indication: ON / OFF

xi. Suitable for fixing on a DIN rail

xii. Screw type terminals suitable for connection of at least 2x4.0 mm^2 stranded cables

4.4.43. **Miniature Circuit Breaker Type II:**

For protection of LV AC circuits rated at 415VAC & 240 VAC

i. Shall have two tripping mechanisms, delayed thermal tripping mechanism for overload and the electromechanical tripping mechanism for short circuit protection

ii. Tripping characteristic shall be type C

iii. The MCB shall be three pole configurations

iv. Rated short-circuit capacity is 6kA, at 415V AC

v. Contact Position Indication: ON / OFF

vi. One normally closed (1 NC) auxiliary contact

vii. Degree of Protection: IP20

viii. Indelibly labelled screw terminals, suitable for connection of up to 6 mm^2, stranded cable.

ix. Electrical endurance of at least 10,000 cycles

x. Mechanical endurance of at least 20,000 cycles

xi. Rated current of 16 Amps

xii. Rated operational voltage of 415 V AC and maximum operating voltage of 600VAC

xiii. Suitable for fixing on a DIN rail

4.4.44. **Miniature Circuit Breaker Type III:**

For protection of LV AC circuits rated at 415VAC & 240 VAC and shall have the following operating functions: -

i. Should have two tripping mechanisms, delayed thermal tripping mechanism for overload and the electromechanical tripping mechanism for short circuit protection

ii. Tripping characteristic type C

iii. One pole configuration

iv. Rated short-circuit capacity is 6kA, at 415V AC

v. Contact Position Indication: ON / OFF

vi. One normally closed (1 NC) auxiliary contact

vii. Degree of Protection: IP20

viii. Indelibly labelled screw terminals, suitable for connection of up to 6 mm2, stranded cable.

ix. Electrical endurance of at least 10,000 cycles

x. Mechanical endurance of at least 20,000 cycles

xi. Rated current of 16 Amps

xii. Rated operational voltage of 415 V AC and maximum operating voltage of 600V AC

xiii. Suitable for fixing on a DIN rail

4.4.45. **Miniature Circuit Breaker Type IV**

For protection of LV DC circuits rated at 30V DC, 110V DC & 220V DC and shall have the following operating functions: -

i. Shall have two tripping mechanisms, delayed thermal tripping mechanism for overload and the electromechanical tripping mechanism for short circuit protection

ii. Tripping characteristic type C

iii. Two pole configurations

iv. Rated short-circuit capacity is 6kA, at 415V AC/ 220V DC

v. Contact Position Indication: ON / OFF

vi. One normally closed (1 NC) auxiliary contact and degree of protection: IP20

vii. Indelibly labelled screw terminals, suitable for connection of up to 4 mm2, stranded cable.

viii. Electrical endurance of at least 10,000 cycles

ix. Mechanical endurance of at least 20,000 cycles

x. Rated current of 6Amps

4.4.46. **Miniature Circuit Breaker Type V:**

For protection of LV DC circuits rated at 30V DC, 110V DC & 220V DC and shall have the following operating functions: -

i. Shall have two tripping mechanisms, delayed thermal tripping mechanism for
ii. Overload and the electromechanical tripping mechanism for short circuit protection
iii. Tripping characteristic type C
iv. Two pole configurations
v. Rated short-circuit capacity is 6kA, at 415V AC/ 220V DC
vi. Contact Position Indication: ON / OFF
vii. One normally closed (1 NC) auxiliary contact
viii. Degree of Protection: IP20
ix. Indelibly labelled screw terminals, suitable for connection of up to 4 mm2, stranded cable.
x. Electrical endurance of at least 10,000 cycles
xi. Mechanical endurance of at least 20,000 cycles
xii. Rated current of 4Amps

4.4.47. **Miniature Circuit Breaker Type VI**

For protection of LV DC circuits rated at 30V DC, 110V DC & 220V DC and shall have the following operating functions: -

i. Shall have two tripping mechanisms, delayed thermal tripping mechanism for
ii. Overload and the electromechanical tripping mechanism for short circuit protection
iii. Tripping characteristic type C
iv. Two pole configurations
v. Rated short-circuit capacity is 6kA, at 415V AC/ 220V DC
vi. Contact Position Indication: ON / OFF
vii. One normally closed (1 NC) auxiliary contact

viii. Degree of Protection: IP20

ix. Indelibly labelled screw terminals, suitable for connection of up to 6 mm2, stranded cable.

x. Electrical endurance of at least 10,000 cycles

xi. Mechanical endurance of at least 20,000 cycles

xii. Rated current of 10Amps

4.4.48. Multi-Functional Power Meter

The manufacturer shall have at least 10 years' experience in the manufacture of the instrument.

i. This is a power measurement meter for panel mounting

ii. The unit shall be of numerical design

iii. The unit shall have a large LCD display for displaying four (4) or more lines of measurands simultaneously.

iv. The keypad shall be simple to allow scrolling between the various measurands

v. The unit shall measure instantaneous values of; rms voltage, both phase – phase and phase to ground, phase currents, active power, reactive power, apparent power, energy, frequency, power factor and phase angle per phase

vi. The Unit shall measure time stamped maximum and minimum demand for current and power (MW & MVA)

vii. The unit shall also measure unbalance voltage and current

viii. The unit shall measure Total harmonic distortion(THD) and Total Demand Distortion(TDD) for current and voltage

ix. The unit shall have the following input ratings, 1Amps and 110V AC phase to phase.

x. The unit should be able to continuously withstand 2Amps and 260 V AC

xi. The unit shall be for flush mounting on the front of the panel

xii. The unit shall be for 3 phases, 4 –wire connection on the secondary of current and voltage transformers

xiii. The unit shall be equipped with an RS232 port for programming the unit to ensure correct measurement and display of the parameters. The CT and VT ratios shall be programmable. Alternatively, programming can be achieved through the keypad.

Note: *Programming will be conducted at site during installation.*

xiv. RS 485 port shall be provided for remote communication.

xv. Communication protocol shall be IEC 61850 and IEC 60870-5-104

xvi. The accuracy of measurement shall be at least class 1.0

xvii. Shall have inbuilt real-time clock and calendar

xviii. It shall be possible to display all the measured parameters on the screen through the pre-programmed display screen. The screen to be displayed shall be selectable using the keys on the front of the unit

xix. The software and the PC to power meter unit connection cable shall be supplied with the units. At least eight communication cables devices shall be required

xx. All the terminals shall be clearly marked

xxi. The measurement range for power shall at least be up to 90 MVA.

xxii. The meter shall be powered with 110V DC; or 110V DC /110V AC

4.4.49. **Tap Position Indication Transducer:**

4.4.49.1. This shall be used in Power transformers with On Load Tap Changer (OLTC) to provide mA output to drive the tap position Indicator on the Remote Tap Changer Control Panel (RTCCP) in the substation control room and also for connection to the SCADA for supervisory indication of the OLTC Tap Position.

4.4.49.2. The Transducer shall be connected to a bridge of resistors and the input signal processed to produce mA, the magnitude of which corresponds to the Tap Position.

4.4.49.3. The transducer shall be configurable for the value of tap step resistor and the output mA.

4.4.49.4. The following specifications shall apply: -

i. Supply voltage; 240V AC and/or 110V DC

ii. Programmable output; 0-10mA, 0-20 mA or 4-20 mA

iii. Measuring range; 17 Tap positions (16 tap steps)

iv. For DIN rail mounting

v. Resistor per step configurable from 10 Ω to 250

vi. Accuracy class 0.25%

vii. Response time shall be < 1 sec.

viii. Rugged and vibration resistant construction

ix. Temperature range; 0 - +50oC

x. Complies with IEC 60688 standard

4.4.50. **Tap Position Indicator**

Shall be used for remote Indication of the Transformer on Load Tap Changer Tap Position and the following specification shall apply: -

i. It shall have a bar graph meter configured to indicate both a numerical value and a bar indication of relative position of the OLTC.

ii. The TPI should have provision for settings Tap Limits above and below which the bar changes colour to call attention to this violation. An output contact for audible alarm shall also be provided.

iii. Input should be 0 – 20 mA for Tap Positions 1 to 17 (16 tap steps). Configurable mA input, and number of tap steps is preferred.

iv. Shall be suitable for flush mounting

4.4.51. **Transducers:**

The manufacturer for the Transducers shall have a minimum experience of 10 years in the manufacture of the instruments.

4.4.52. **MW Transducer**

The Transducer shall have the following features: -

i. DIN rail mounting

ii. Connection shall be 3-Phase, 4-Wire

iii. Inputs 110V AC and 1Amp

iv. Programmable output characteristic

v. Output shall be 0 - ±20 mA

vi. Auxiliary power supply shall be 110 V AC/DC

vii. Relay Terminals-shall be screw type terminals large enough to

viii. Shall accommodate at least 4mm2 cable

ix. Screw type terminals

x. Terminals indelibly marked

4.4.53. **MVAr Transducer**

The Transducer shall have the following features: -

i. DIN rail mounting

ii. Connection shall be 3-Phase, 4-Wire

iii. Inputs 110V AC and 1Amp

iv. Programmable output characteristic

v. Output shall be 0 - ±20 mA

vi. Auxiliary power supply shall be 110 V AC/DC

vii. Relay Terminals-shall be screw type terminals large enough to accommodate at least 4mm2 cable

viii. Screw type terminals

ix. Terminals indelibly marked

4.4.54. **Current Transducer**

The Transducer shall have the following features: -

i. Input 0- 1Amp

ii. Output 0 – 20 mA

iii. Auxiliary power supply shall be 110 V AC/DC

iv. Relay Terminals-shall be screw type terminals large enough to accommodate at least 4 mm^2 cable

4.4.55. **Voltage Transducer**

The Transducer shall have the following Features:

i. DIN rail mounting
ii. Input 0- 110 V AC
iii. Output 0 – 20 mA
iv. Auxiliary power supply shall be 110 V AC, separately connected.
v. Relay Terminals-shall be screw type terminals large enough to accommodate at least $4mm^2$ cable
vi. Screw type terminals
vii. Terminals indelibly marked

4.4.56. **Indicating Instruments Driven by Transducer output:**

The manufacturer for the instrument shall have a minimum experience of 10 years in the manufacture of the instruments.

4.4.57. **MW Instrument**

The Instrument shall have the following features: -

i. Indicating Range, 0 – 23 MW for Transducer input of 0-20 mA
ii. Full Scale Deflection, 30 MW, Import and Export
iii. Black Scale on white background
iv. Red Line at 23 MW
v. Dimensions, 96 X 96 mm
vi. Suitable for Flush Mounting on the panel
vii. The Instrument shall have screw type terminals

4.4.58. **MVAr Instrument**

The Instrument shall have the following features: -

i. Indicating Range, 0 – 23 MVAr for Transducer output of 0-20 mA
ii. Full Scale Deflection, 30 MVAr, Import and Export

iii. Black Scale on white background

iv. Dimensions, 96 X 96 mm

v. Suitable for Flush Mounting on the panel

vi. The Instrument shall have screw type terminals

4.4.59. **Indicating Instruments Directly connected:**

NB: The manufacturer for the instrument shall have a minimum experience of 10 years in the manufacture of the instruments.

4.4.59.1. All the instruments shall be of Moving Iron type with an IP Protection Class shall be IP54.

4.4.59.2. Accuracy class shall be 1.5, with maximum tolerated error of ±1.5% of final scale value and an overload withstand shall be at least 20% continuous

4.4.59.3. All instruments shall be suitable for continuous operation under Tropical Climatic conditions

4.4.59.4. The Insulation withstand shall be in accordance with IEC 51.

4.4.59.5. The manufacturer for the Instrument shall have as a minimum 10 years' experience in the manufacture of the instruments.

4.4.60. **Ammeter with MDI – 200A**

The Instrument shall have the following features: -

i. Flush mounting

ii. Indicating Range, 0 – 200A for current input of 0 – 1A

iii. Full Scale Deflection, 300 A

iv. Red Line at 200 A

v. Shall have a resettable maximum demand current indicator having a different colour from the normal pointer as well as the normal instantaneous current pointer

vi. Black Scale on white background

vii. Dimensions, 96 X 96 mm

viii. Suitable for Flush Mounting on the panel

ix. The instrument shall have screw type terminals large enough to accommodate 4mm^2 cable

4.4.61. **Ammeter with MDI– 400A**

The Instrument shall have the following features: -

i. Flush mounting
ii. Indicating Range, 0 – 400A for current input of 0 – 1A
iii. Full Scale Deflection, 600 A
iv. Red Line at 400 A
v. Black Scale on white background
vi. Dimensions, 96 X 96 mm
vii. Shall have a resettable maximum demand current indicator having a different colour from the normal pointer as well as the normal instantaneous current pointer
viii. Suitable for Flush Mounting on the panel
ix. The instrument shall have screw type terminals large enough to accommodate 4mm2 cable

4.4.62. **Ammeter with MDI– 800A**

The Instrument shall have the following features: -

i. Flush mounting
ii. Indicating Range, 0 – 800A for current input of 0 – 1A
iii. Full Scale Deflection, 1000 A
iv. Red Line at 800 A
v. Black Scale on white background
vi. Dimensions, 96 X 96 mm
vii. Shall have a resettable maximum demand current indicator having a different colour from the normal pointer as well as the normal instantaneous current pointer
viii. Suitable for Flush Mounting on the panel
ix. The instrument shall have screw type terminals large enough to accommodate 4mm2 cable

4.4.63. **Ammeter Selector Switch**

For use on Protection and Control Panels, for measurement of all three phase currents, using one ammeter.

i. Suitable for flush mounting on the Panel

ii. Four position selections, R, Y, and B & OFF, indelibly labelled on an escutcheon plate fixed on the switch.

iii. The phase current measured on the ammeter, corresponds to the selected phase on the switch, while the other two phases will be shorted at the switch.

iv. Contact Rating 10Amps

v. Screw type terminals suitable for connection of 2 x 2.5 mm^2 cable

4.4.64. **Voltmeter – 220kV**

The Instrument shall have the following features: -

i. Indicating Range, 0 – 220kV for voltage input of 0 – 110V AC

ii. Full Scale Deflection, 270kV

iii. Red Line at 220kV

iv. Black Scale on white background

v. Dimensions, 96 X 96 mm

vi. Suitable for Flush Mounting on the panel

vii. The instrument shall have screw type terminals large enough to accommodate 4mm2 cable

4.4.65. **Voltmeter – 132kV**

The Instrument shall have the following features: -

i. Indicating Range, 0 – 132kV for voltage input of 0 – 110V AC

ii. Full Scale Deflection, 150kV

iii. Red Line at 132kV

iv. Black Scale on white background

v. Dimensions, 96 X 96 mm

vi. Suitable for Flush Mounting on the panel

vii. The instrument shall have screw type terminals large enough to accommodate 4mm2 cable

4.4.66. **Voltmeter – 66kV**

The Instrument shall have the following features: -

i. Indicating Range, 0 – 66kV for voltage input of 0 – 110V AC

ii. Full Scale Deflection, 72kV

iii. Red Line at 66kV

iv. Black Scale on white background

v. Dimensions, 96X96 mm

vi. Suitable for Flush Mounting on the panel

vii. The instrument shall have screw type terminals large enough to accommodate 4mm2 cable

4.4.67. **Voltmeter – 33kV**

The Instrument shall have the following features: -

i. Indicating Range, 0 – 33kV for voltage input of 0 – 110V AC

ii. Full Scale Deflection, 36kV

iii. Red line at 33 kV

iv. Black Scale on white background

v. Dimensions, 96 X 96 mm

vi. Suitable for Flush Mounting on the panel

vii. The instrument shall have screw type terminals large enough to accommodate 4mm2 cable