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## FOREWORD

Recommendations for corrections, additions or deletions should be addressed to the:
Technology Services General Manager

City Power Johannesburg (MOC) Ltd

P O Box 38766

Booysens

2016

## INTRODUCTION

The City Power Johannesburg electrical network is an amalgamation of five separate electrical utility networks. These five networks are Johannesburg, Roodepoort, Midrand, Randburg, and the South. Each network was historically developed in a unique manner respective to one another due to the different local municipal authorities responsible at the time. As a result there are many different protection scheme types as well as associated relays installed on these networks as detailed in this document. In order to control the burgeoning relay manufacturer types and models on the system, the number of relay models and manufacturers thereof need to be controlled and limited for a period of time.

## 1   SCOPE

City Power will utilize this specification to evaluate major protection equipment that is required on the network. Only the major protection equipment evaluated and passed under this specification shall be deemed as fit for use by City Power.

## 2   NORMATIVE REFERENCES

The following documents contain provisions that through reference in the text constitute requirements of this standard. At the time of publication the editions indicated were valid. All standards and specifications are subject to revision and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the documents listed below.

IEC 61850-1: *Introduction and overview Part 1.*

IEC 61850-2: *Glossary: Part 2*

IEC 61850-3: *General Requirements Part 3*

IEC 61850-4: *Systems and Project Management Part 4*

IEC 61850-5: *Communication requirements for functions and device models Part 5*

IEC 61850-6: *Configuration description language for communication in electrical substations related to IEDs Part 6*

IEC 61850-7-1: *Basic communication structure for substation and feeder equipment. Principles and models Part 7-1*

IEC 61850-7-2: *Basic communication structure for substation and feeder equipment. Compatible logical node classes and data classes Part 7-2*

IEC 61850-8-1: *Specific Communication Service Mapping (SCSM). Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3 Part 8-1*

IEC 61850-9-1: *Specific Communication Service Mapping (SCSM). Sampled values over serial unidirectional multi-drop point to point link Part 9-1*

IEC 61850-9-2: *Specific Communication Service Mapping (SCSM) Sampled values over ISO/IEC 8802-3 Part 9-2*

IEC 61850-10: *Conformance testing Part 10*

EN 50263 1999: *Electromagnetic Compatibility (EMC) : Electromagnetic Emissions*

EN 60255-26-:2009 *Measuring relays and protection equipment - Part 26: Electromagnetic compatibility requirements*

IEC 61000-4-3 2010: *Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test* IEC 61000-4-11 2017 *Electromagnetic compatibility (EMC) - Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests*

IEC 60255-11 1979: *Electromagnetic Compatibility Immunity: Power Supply Immunity*

IEC 61000-4-8 2009: *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 61000-4-9 2016*: Electromagnetic compatibility (EMC) - Part 4-9: Testing and measurement techniques - Impulse magnetic field immunity test*

IEC 61000-4-2: 2008: *Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test.*

IEC 60255-26:2013: *Measuring relays and protection equipment - Part 26: Electromagnetic compatibility requirements*

IEC 60068-2-1: 2007: *: Environmental testing  - Test A: Cold*

IEC 60068-2-2 2007: *Environmental Environmental testing -  Test B: Dry heat*

IEC 60255-21-1 1998: *Class 1*

IEC 60255-21-2: 1998: *Class 1*

IEC 60255-21-3 1993: *: Electrical relays: Vibration, shock, bump and seismic tests on measuring relays and protection equipment: Seismic tests*

IEC 60529: 2015: *Degrees of protection provided by enclosures (IP Code)*

IEC 60255-1 2009: *Measuring relays and protection equipment - Part 1: Common requirements*

ENA TS 50-19: 2004*:  Standard Numbering For Small Wiring: for Switchgear And Transformers Together With Their Associated Relay Panels)*

SANS ISO 9001: *Quality Management*

OHSAS 18001: Occupational health and safety management systems

## 3 DEFINITIONS

The definitions and abbreviations in the above documents (Normative Reference) shall apply to this specification.

| | |
|---|---|
| OEM | Original Equipment Manufacturer. The manufacturer and source of the protection relay and not any intermediary, re-seller, modifier, or agent thereof. |
| IED | An intelligent electronic device. A protection relay that has an embedded microprocessor for protection and control functionality and is able to serially communicate to another device using a standard protocol. |
| SCADA | Supervisory control and data acquisition. The ability to receive and send information to and from a remote control Centre and a intelligent electronic device. |
| I/O | Relay inputs and outputs. The MAJOR PROTECTION EQUIPMENT's opto-isolated digital inputs and contact output relays used for protection, control and SCADA functionality. |
| BYCH | Bay Controller. Any MAJOR PROTECTION EQUIPMENT that has SCADA, automation and control functionality using integral I/O's and Boolean type programmable logic to execute such functionality. |
| Major Protection Equipment | Protection equipment that has significant strategic, functional and cost value e.g. protection relays, auxiliary tripping relays. |
| Supplier | An OEM or their official representatives based in South Africa |

## 4 NOTE

Nothing in this specification shall lessen the obligations of the supplier. The supplier shall be fully responsible for the design and supply of electronic intelligent devices; and its satisfactory performance in service. Approval by City Power shall not relieve the supplier of the responsibility for the adequacy of the design.

## 5 SERVICE CONDITIONS

The requirements in this specification apply to equipment for use under the following conditions:

5.1     indoors;

5.2     at an altitude above sea level up to 1 800 m;

5.3     at maximum ambient air temperatures for design purposes:

   a.   minimum -10 ⁰C  and maximum 45 ⁰C

   b.   daily average 30 ⁰C

   c.   yearly average 25 ⁰C

5.4      relative humidity: 30 % to 90 %;

5.5     maximum wind speed: 40m/s;

5.6     mean annual rain fall: 1065mm and

5.7     Maximum solar radiation:  21200 W/m

## 6 MAJOR PROTECTION EQUIPMENT: General hardware and software requirements

All IED digital inputs shall be of the opto-coupler type and must be rated to the station DC battery supply. The use of resistors to drop the voltage into the digital inputs shall not be accepted. All relays shall be of the flush mounting type.

The numeric relays shall utilise programmable scheme logic to configure the output relays, binary inputs, internal relay elements, timers and logic variables. Every digital input and output contact shall able to be freely incorporated into the user configurable programmable logic.

Operating of an IED element shall be clearly and positively indicated on the relay by an indicating LCD display.  Primary protection functions and important alarms shall at all times be indicated by a red LED.

The adjustable settings on all relays shall be easily accessible, from the relay LCD and a remote terminal.  At no time shall the downloading of new settings to the relay compromise the relay protection functions.

All major protection equipment output contacts shall be rated to the station DC battery supply.
The nominal voltage transformer input is 110 Vac.
The burden of each voltage input shall not exceed 1VA at nominal input voltage.
The nominal current transformer input is 1 Amp and/or 5 Amp as specified.
The current inputs shall be continuously rated for 300% of nominal current inputs.
The burden of each current input shall not exceed 1VA at nominal input current.

All major protection equipment shall perform extensive and continuous self-checking of hardware and software. A subsequent fault shall be indicated clearly on the face of the major protection equipment and the condition signaled immediately via an output contact

## 7 MAJOR PROTECTION EQUIPMENT: logic and setting Configurations

The major protection equipment shall have user programmable logic functionality as specified in order to execute the specified control and protection schemes. Every digital input and output contact shall able to be freely incorporated into the user configurable programmable logic.

The MAJOR PROTECTION EQUIPMENT programmable logic configurations shall have a minimum number of timers, Boolean functions, latch's, local and remote bit elements as specified.

## 8 MAJOR PROTECTION EQUIPMENT: IED Communication ports

The IED's shall be supplied with communications ports.  For a bay control type IED (See Section - Overview descriptions of the Major Protection Equipment: - BYCH), three communication ports are required; one port is required on the front face of the IED and two ports are required on the rear. The front port will be used for local engineering access and the rear ports for SCADA and remote engineering.

All other IED's require two communication ports; one port is required on the front face of the IED and one port is required on the rear. The front port will be used for local engineering access and the rear port for remote engineering.

It shall be possible change the settings, configure the logics and download fault records of any IED via the front face communication port using City Power,s laptops, notebooks or computers and the OEM's software.

The ports and the software shall be upgradeble to accommodate City Power,s expansion and needs.

For the BYCH, the first rear communication port shall communicate directly with the substation RTU using IEC61850. No intermediate protocol converter shall be allowed whether attached to the IED or remote to the IED.

The second rear communication port shall be utilised for an engineering channel from the substation to City Power - Protection offices (Reuven). It shall be possible to view and alter all relay settings and logic configurations remotely via the engineering channel. It shall also be possible to receive fault records remotely via the engineering channel. It shall be possible to link to the BYC engineering channel directly via a WAN connection and also via telephone modem.

## 9  MAJOR PROTECTION EQUIPMENT: DigSilent StationWare compatibility

All the IED type relays shall each be supplied with a settings file that can be used by DigSilent StationWare software for the import and export of the IED settings. The supplier shall be responsible to work with DigSilent in creating and providing the settings file. Only IED's supplied with a DigSilent StationWare settings file shall be considered for evaluation.

The contents of the DigSilent StationWare settings file must contain all(!) settings parameters with the following information: Name, Function/Chapter, Settings group, Range (also for enumeration types), Unit (e.g. 'A'), Description text, Type of parameter (integer, double, string, enum), Default value, Actual value.

## 10  DESCRIPTION OF THE MAJOR PROTECTION EQUIPMENT

### 10.1  BYCH - HV BAY CONTROLLER

The BYCH shall perform all high voltage level bay related functions such as local and remote control, command sequences, bay and station interlocking, data acquisition, data storage, event and alarm storage, outputs of commands and signal processing required for the different switchgear units of the bay.

The BYCH shall have an integral mimic, capable of controlling and displaying the status of plant devices per bay, and have a user-definable layout to suit the substation physical layout.  The mimic shall only allow operation if the bay has been selected to local control.

The interlocking software RAM or on-board memory shall be backed-up via non-volatile memory and in the case of a supply failure, on return of supply, automatically resume their function.  The software shall be re-programmable via the front port or the rear engineering access port in a straightforward manner.  Disturbance records and events shall be stored in non-volatile memory in order to ensure that data cannot be erased by the removal of the supply to the device.

The BYCH's shall communicate directly on a "peer-to-peer" or one-on-one basis using a direct fibre-optic connection; fibre-optic switches shall be allowed between the BYCH's for the fibre-optic connection. The BYCH's shall be able to send discrete binary signals to one another over the fibre-optic communication channel. All inter bay interlocking and automation i.e. between BYCH's, shall be done using IEC61850 GOOSE messaging over the fibre-optic channels.

### 10.2 BYCM - MV BAY CONTROLLER

The BYCM shall perform all medium voltage level bay related automation and interlocking functions such as automatic "chop-over" control, pairing station "flip-flop" control, and local transformer parallel interlocking.

The interlocking software RAM or on-board memory shall be backed-up via non-volatile memory and in the case of a supply failure, on return of supply, automatically resume their function. The software shall be re-programmable via the front port or the rear engineering access port in a straightforward manner.

The BYCM's shall communicate directly on a "peer-to-peer" or one-on-one basis using a direct fibre-optic connection; fibre-optic switches shall be allowed between the BYCM's for the fibre-optic connection. The BYCM's shall be able to send discrete binary signals to one another over the fibre-optic communication channel. All inter bay interlocking and automation i.e. between BYCH's, shall be done using IEC61850 GOOSE messaging over the fibre-optic channels.

### 10.3 MAINI – MULTI PURPOSE INCOMER OVERCURENT PROTECTION RELAY

An incomer is classified as a source of energy. A source may be a remote feeding station, a local transformer, a local generator etc. The MAINI IED shall protect the source from over loading and fault currents as well as the downstream equipment such as bus-bars and feeders. The IED shall monitor the tripping (opening) time of the CB to ensure that they do not exceed adjustable thresholds. The trip time shall be displayed on the IED LCD screen and an external alarm generated should an adjustable time threshold be exceeded. Each IED shall have a minimum number of protection elements shown below.

| Element | Qty | Type | Curve | Range (xIn) | Time Delay/Time Multiplier |
|---|---|---|---|---|---|
| O/C | 2 | Directional | Definite Time | 5-2000% | 0-10000 ms |
| E/F | 2 | Directional | Definite Time | 5-80% | 0-10000 ms |
| O/C | 1 | Directional | IDMT (SI, VI, EI) | 10-200% | 0.05 – 1.0 |
| E/F | 1 | Directional | IDMT (SI, VI, EI) | 5-80% | 0.05 – 1.0 |
| | | | | | |
| O/C | 2 | Non Directional | Definite Time | 5-2000% | 0-10000 ms |
| E/F | 2 | Non Directional | Definite Time | 5-80% | 0.05 – 1.0 |
| SE/F | 1 | Non Directional | Definite Time | 0.5-30% | 0-10000 ms |
| O/C | 2 | Non Directional | IDMT (SI, VI, EI) | 10-200% | 0.05 – 1.0 |
| E/F | 2 | Non Directional | IDMT (SI, VI, EI) | 5-80% | 0.05 – 1.0 |
| SE/F | 1 | Non Directional | IDMT (SI, VI, EI) | 0.5-10% | 0.05 – 1.0 |

Table 1: Summary of minimum protection element requirements per MAINI IED:

### 10.4 MAINF – MULTI PURPOSE BACKUP OVERCURRENT PROTECTION RELAY

The MAINF IED will protect the outgoing feeders of a substation from over loading and fault currents as well as any downstream equipment. Only non-directional protection is required and therefore the MAINF IED shall have the same non-directional protection elements as specified for the MAINI IED.

The IED shall monitor the tripping (opening) time of the CB to ensure that they do not exceed adjustable thresholds. The trip time shall be displayed on the IED LCD screen and an external alarm generated should an adjustable time threshold be exceeded.

### 10.5 PFCR - CAPACITOR BANK PROTECTION RELAY

The PFCR IED shall protect and control grounded and ungrounded single and double wye capacitor banks using both phase and neutral voltage differential protection. Phase current unbalance protection and neutral current unbalance shall also be provided to protect the capacitor banks. Compensation adjustment shall be provided to zero out small unbalances that are inherent in the bank as well as CT and VT errors. Control logic shall be provided for maintaining system V, VAR or PF (Power Factor) as well as the alarm and blocking of control operations. Over-current and voltage protection elements shall provide additional protection of the banks.

### 10.6 DIFFO - FIBRE OPTIC LINE DIFFERENTIAL RELAY

The DIFFO IED shall provide high speed, two-ended, phase segregated current differential protection of overhead lines and underground cables. The differential protection shall be current biased with two adjustable slopes. The IED shall also provide CT ratio correction, CT vector correction and inrush restraint to allow for CT mismatch and in-zone transformers. The IED's shall be connected using direct fibre (1300nm Single-Mode, 850nm Multi-Mode fibre) and multiplexed digital links (G.703, V.35, and X.21 interfaces). It shall be possible to send multiple discreet inter-trip signals over the protection communication channel. The IED shall have 1A and 5A CT inputs on one device to allow for CT mismatching.

### 10.7 DIFFPV – PILOT WIRE LINE BALANCED VOLTAGE DIFFERENTIAL RELAY

The DIFFPV relay shall provide two-ended current differential protection of overhead lines and underground cables. The relay's shall operate on a balanced voltage principle and be directly compatible with remote-end relay  The relay shall provide phase and earth fault protection on circuits and be very stable for through faults while providing suitable sensitivity for internal faults. The relays shall be of similar type and be linked to one another using a pair of copper pilot wires. The relays shall be suitable for pilot wires insulated to 4kV. The pilot wires shall be supervised and an alarm contact energized when an open or short circuit is detected.

### 10.8 DIFFPI – PILOT WIRE LINE CURRENT BALANCED DIFFERENTIAL RELAY

The DIFFPI relay shall provide two-ended current differential protection of overhead lines and underground cables. The relay's shall operate on a current balance principle and be directly compatible with remote end relays.. The relay shall provide phase and earth fault protection on circuits and be very stable for through faults while providing suitable sensitivity for internal faults. The relays shall be of similar l type and be linked to one another using a pair of copper pilot wires. The relays shall be suitable for pilot wires insulated to 5kV. The pilot wires shall be supervised and an alarm contact energized when an open or short circuit is detected.

### 10.9 DIFFT - TRANSFORMER DIFFERENTIAL AND RESTRICTED EARTH FAULT RELAY

A DIFFT IED is required to protect two winding and auto power transformers. The IED shall include low impedance REF protection for the transformer MV and HV windings. The differential current protection shall be phase segregated, biased and with two adjustable slopes. The IED shall also provide CT ratio correction, CT vector correction, and 2nd and 5th inrush restraint and blocking. A separate unrestrained differential element will provide fast clearance of high magnitude internal faults. The IED shall also cater for dc offset currents during transformer energisation. The REF elements shall function without the use of external stabilizing resistors or equipment of any kind. It shall be possible to apply REF to an auto transformer using internal programming logic only. The neutral phases shall have IDMT and definite time over-current protection elements. The IED shall provide a visual display on an integral LCD screen all the operating parameters (input current phasors, differential currents, bias currents, harmonics, and sequence currents).

### 10.10 DIFFZ - LINE DIFFERENTIAL AND DISTANCE RELAY

The DIFFZ IED shall provide high speed, two or three terminal, phase segregated current differential protection of overhead lines and underground cables. The IED's shall be connected using direct fibre (1300nm Single-Mode) and multiplexed digital links (G.703, V.35, IEEE C37.94 EIA-422 and X.21 interfaces). It shall be possible to send multiple

discreet inter-trip signals over the protection communication channel. The relay shall compare local and remote phase and sequence currents to provide fast operation and shall operate for unbalanced faults with currents below line charging current. Mismatched CTs shall be accommodated by relay settings. Distortion caused by CT saturation of one or both ends shall not cause a mal-operation. The IED shall also incorporate four zones of phase and ground mho distance and quadrilateral ground distance protection. Communications assisted distance schemes (e.g. Permissive Over-reach Transfer Trip) shall be provided. Two distance zones shall be settable for either forward or reverse direction. Both positive-sequence memory polarized and compensator-distance phase distance elements shall be available and the IED shall detect stable and unstable power swings. The IED shall have phase, residual ground, and negative sequence over-current elements with directional and non-directional control.

### 10.11 DIFFB – BUSBAR DIFFERENTIAL RELAY

A DIFFB IED is required to protect HV and EHV bus-bars. The protection shall be of the numerical low impedance type in a localised (central) or distributed configuration. Bus-zone protection IED's shall detect bus-bar faults quickly and selectively and thereby isolate the faulty zone only. The bus zone protection shall be capable of detecting three-phase, phase-to-phase and phase-to-earth faults, under all system conditions. The protection shall retain full stability in the event of a through fault. Each zone measuring unit shall use at least two independent criterions for its operation, e.g. current summation and phase angle comparison. A bus-zone protection IED shall be configurable with both main and check zone elements with automatic internal selection of current elements to the correct zones. Each of the bay measuring elements shall not be affected by line / transformer switching, heavy load transfer, power swings, unbalanced primary currents and voltage, voltage dependant current functions, external switching, sudden power reversal etc. The differential current protection function shall have adjustable bias and operating / restraint curves.

The bus-bar protection shall accept inputs from external breaker fail protection relays. Breaker failure protection shall be provided which shall monitor the feeder's phase currents by detectors in each phase. Each bay unit shall have integral CT circuit supervision, which shall detect CT circuit faults, flag these faults and prevent mal-operation during normal system operation. It shall not be necessary for the CT circuit supervision to await an over-current situation to detect a problem. The sensitivity of the IED shall be such that it shall not operate on load in the event of a bus zone protection CT or CT connection being faulty, i.e. open or short-circuited. Operation of current transformer supervision equipment must take the defective protection zone out of service. A low current transformer burden is required to allow the protection to be installed in series with other equipment on a common current transformer secondary circuit.

The bus zone IED shall not be affected by harmonic currents that as may be experienced in a multiple earthed power system or by a CT saturation. CT saturation shall not affect the performance of the bus-zone IED. CT saturation shall be detected within 2 ms of occurring and protection algorithms adjusted to compensate for the saturation. In the case of a distributed type bus-zone scheme, peripheral units shall be connected to the Central Unit via ruggedized Optic fibre Cable. Optical Fibre Connection interface for multimode glass fibre shall be of the type as per IEC 874-10, 850nm short-haul fibres, Min Length: 1000m. Central and Peripheral units shall be equipped with at least 12 LEDS of which at least 8 shall be user configurable. Graphical programmable user interface allowing user defined protection and control logic to be tailored to the specific application, shall be provided. Internal configurable CT ratio mismatching shall be provided.

### 10.12 ARCP - ARC PROTECTION RELAY

The main protection for metal-clad switchgear shall be arc protection utilizing both light and current to trip (i.e. a 2 out of 2 operation). This protection scheme shall be provided with individual light sensors in the bus-bar, cable box and circuit breaker compartments. A fault in a cable box shall only trip the single circuit breaker associated with that cable box. A fault in a circuit breaker compartment or bus-bar chamber shall only clear that section of the switchboard (zone) associated with the fault, i.e. all circuit breakers on the faulted zone

shall trip. Therefore the bus-bars and associated circuit breakers that are separated by bus section circuit breakers shall form separate zones that are cleared on a fault. Healthy bus-bar zones shall not be isolated. The arc protection system (arc and current) shall have continuous self-monitoring for internal hardware and software failure and a watchdog contact shall be provided for alarming any failure of the arc and current sensing equipment. The arc protection system shall have a master central unit with light and current sensing capability. The system shall be modular allowing for the addition of up to 4 zones.

### 10.13 AVR - TRANSFORMER AUTOMATIC VOLTAGE REGULATOR

A transformer automatic voltage regulator IED is required to control the MV output voltage i.e. secondary side voltage of a step-down power transformer. The regulator shall constantly compare the actual voltage value and a fixed or load-dependent set-point value and, depending on the deviation, determine the correcting action for the tap changer of the transformer. The regulator parameters shall be optimally adjusted to the dynamic time behaviour of the network voltage to allow for a high control quality at a low number of tap changer switching operations.

All regulators shall be able to control up to six transformers connected in parallel to one bus-bar without any additional devices. Parallel operation of transformers on one or several bus-bars shall be performed using Master-slave for identical transformers with equal tap change, $\Delta I \sin \phi$ for identical transformers with equal or different tap-changes, $\Delta I \sin \phi$ (S) for transformers with different powers and different or equal tap-changes, or freely switched in parallel using $\Delta \cos \phi$. The regulator shall monitor and record the transformer oil temperature directly via a PT 100 a mA transducer input.

The regulator shall trend, display and record the voltage that is to be regulated over time and the transformer oil temperature. The regulator shall have freely user programmable inputs and outputs. Every regulator shall constantly indicate which reactive current $I \sin \phi$ is being used. The regulator shall have integral user operated controls for placing the device on Auto or Manual mode, and Local or Remote control. All important information (tap-change position, voltage, etc.) shall be displayed on a large backlit LCD screen.

A statistics function shall be provided on the regulator to record the total number of tap-changer switching operations and switching operations per tap. Inputs for tap-changer position shall include potentiometer, mA transducer, and BCD (binary coded decimal). Outputs for tap changer position shall include hard wired mA and BCD.

### 10.14 STBYEF - STANDBY EARTH FAULT RELAY

A STBYEF IED is required to provide backup earth fault protection for all source downstream equipment as well as provide earth fault backup protection to MV faults of a step down transformer. The IED shall rejects harmonics caused by CT saturation. The STBYEF IED shall also be used for high impedance transformer REF applications by using external series stabilizing resistors and also non-linear resistors (Metrosils).

| Element | Qty | Type | Curve | Range (xIn) | Time Delay/Time Multiplier |
|---------|-----|------|-------|-------------|----------------------------|
| E/F | 2 | Non Directional | Definite Time | 5-80% | 0.05 – 1.0 |
| SE/F | 1 | Non Directional | Definite Time | 0.5-30% | 0-10000 ms |
| E/F | 2 | Non Directional | IDMT (SI, VI, EI) | 5-80% | 0.05 – 1.0 |
| SE/F | 1 | Non Directional | IDMT (SI, VI, EI) | 0.5-10% | 0.05 – 1.0 |

**Table 2: The IED with single element device with functionality.**

### 10.15 LO1 & LO2 & MTR - LOCKOUT RELAY

A LO1 and LO2 lockout relay is required to reinforce the main tripping contact of protection IED's, to prevent the closure of primary devices as well as provide an operational flag indication. A MTR is used for inter-tripping in a local substation environment when dc source isolation is required. The lockout relay output contacts shall be mechanically latched and manually hand reset with a user signed operating flag. The relays shall have a high operating speed and be of the high burden type providing immunity to capacitance

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discharge in the wiring. The relays shall have an instantaneous cut off contact to break the operating coil circuit once the relay mechanism has completely operated. The relays shall be of the electro-mechanical type.

### 10.16 TAUX - TRIP AUXILARY RELAY

A TAUX relay is required to supplement or multiply the main tripping contact of protection IED's, as well as provide an operational flag indication. The relay is also used for inter-tripping in a local substation environment with dc source isolation. The relay output contacts shall be self-resetting and with the user signed operating flag manually hand reset. The relays shall have a high operating speed and be of the high burden type providing immunity to capacitance discharge in the wiring. The relays shall have an economizing element to reduce the operating coil burden once the relay mechanism has completely operated. The relays shall be of the electro-mechanical type.

### 10.17 ALA - ALARM ANNUNCIATOR

An alarm annunciator is required to supplement the visual alarms provided by the protection IED's via their respective LED's. The alarm annunciator shall be specifically designed for use in high voltage protection panels which normally operate with a battery supplied control voltage. The annunciator shall operate on a normally open contact which closes on fault. On receipt of a closing contact, an appropriate LED shall flash. The LED colour shall be user configurable between red and amber. On acceptance of the alarm, the LED shall go steady. The LED shall stay on until a reset button is pressed. Subsequent alarms shall be recognized, i.e. If there are existing alarms on the system, a new alarm will initiate a flashing LED without affecting existing alarms. The acceptance and reset pushbuttons shall be integral to the annunciator unit. Each alarm LED shall have an integral user configurable label.

### 10.18 INTSP & INTRP - INTERTRIP SEND AND RECEIVE PILOT WIRE RELAY

An INTSP and INTRP relay is required to send signals between remote stations for protection purposes. Inter-tripping over copper pilot wire using a DC signal is used. Induced AC voltages that could cause false tripping shall be filtered out to enhance this immunity while maintaining high sensitivity to DC voltages. A manually resettable mechanical flag indicator shall be provided on both the send & receive elements of the relay.

### 10.19 INTSF & INTRF - INTERTRIP SEND AND RECEIVE FIBRE OPTIC RELAY

An INTSF and INTRF relay is required to send signals between remote stations for protection purposes. Inter-tripping over fibre optic cables is used. The relays shall be connected using direct fibre (1300nm Single-Mode, 850nm Multi-Mode fibre) and multiplexed digital links (G.703, V.35, and X.21 interfaces).

It shall be possible to send multiple discreet inter-trip signals over the protection communication channel. Each discreet inter-trip signal shall be clearly indicated on the relay via LED's. The Fibre optic channel shall be continuously monitored with an alarm output contact to increase scheme security.

### 10.20 MFST – MUTLI FUNCTION SCADA TRANSDUCER

A MFST is required to provide a local substation Remote Terminal Unit (RTU) with signals representing the operating parameters of the electrical network e.g. current, voltage, power, frequency, phase angle etc. The transducer is required to be multi-functional in order to save space within the protection panels. The transducer shall measure three phase unbalanced quantities. The transducer shall have DNP3 and IEC61870 communication protocol outputs to signal each analog type and range. The physical communication connection terminal shall be of the RS485 type. The transducers shall be pre-configured in the factory as per scheme requirements and further by a user programmable interface.

### 10.21 DIFFC – CIRCULATING CURRENT RELAY

A DIFFC shall be used to protect short lengths of cables/lines usually situated with a substation boundary where any remote current transformer cabling to the relay does not exceed 50m in length. The DIFFC relay shall be actually be a MAINF IED used in a high impedance circulating current differential application with external series stabilizing resistors and non-linear resistors (Metrosils).

### 10.22 DCVMR – DC VOLTAGE MONITORING RELAY

A DCVMR will be used to monitor the station DC supply. If the station DC drops below a critical threshold level, a trip to the circuit breaker will be issued to protect the primary plant. The relay shall be capable of monitoring an over-voltage or under-voltage condition with a subsequent trip output. The trip output shall be delayed to prevent spurious operations. Indication LED's shall be provided on the relay to show the supply voltage, over/under voltage, timing and active output states. The relay settings shall be tamper proof in the form of password protection or a clear sealable cover.

### 10.23 MAINFO - MULTI PURPOSE MAIN FEEDER RELAY

The MAINFO relay shall protect the incoming feeders of a substation from over loading and fault currents as well as any downstream equipment. Both directional and non-directional protection is required and therefore the MAINFO shall have the same protection elements as specified for the MAINI.

The IED shall also provide high speed, two-ended, phase segregated current differential protection of overhead lines and underground cables. The differential protection shall be current biased with two adjustable slopes. The IED shall also provide CT ratio correction. The IED's shall be connected using direct fibre (1300nm Single-Mode), or multiplexed digital links (G.703, V.35, and X.21 interfaces). It shall be possible to send multiple discreet inter-trip signals over the protection communication channel. The IED shall have 1A and 5A CT inputs on one device to allow for CT mismatching.

The IED shall monitor the tripping (opening) time of the CB to ensure that they do not exceed adjustable thresholds. The trip time shall be displayed on the IED LCD screen and an external alarm generated should an adjustable time threshold be exceeded.

### 10.24 RADIALF - RADIAL FEEDER OVER CURRENT RELAY

The RADIALF relay shall protect the outgoing feeders of a substation from over loading and fault currents as well as any downstream equipment. Only non-directional protection is required and therefore the RADIAL shall have the same non-directional protection elements as specified for the MAINI.
The relay shall monitor the tripping (opening) time of the CB to ensure that they do not exceed adjustable thresholds. The trip time shall be displayed on the IED LCD screen and an external alarm generated should an adjustable time threshold be exceeded

## 11  DOCUMENTATION

11.1  Technical product catalogue and two operating manuals shall be provided in hard and soft copies.

11.2  Full detailed dimensions drawings shall be provided.

11.3  A copy of all test reports shall be provided.

11.4  A copy of proposed maintenance schedules shall be provided in hard and soft copies.

## 12  MARKING AND LABELLING

12.1  The following information shall appear in legible and indelible marking on the outside of the IED's.

12.1.1 The manufacturer's name or trademark;

12.1.2 Serial number for tracking

12.1.3 Year of manufacturing

# 13 TRAINING

13.1 The suppliers shall provide comprehensive training courses on the configuration, installation, operation and maintenance of the antennas.

13.2 The suppliers shall provide technical support on system and equipment queries for the duration of the contract.

# 14 QUALITY MANAGEMENT

A quality management system shall be set up in order to assure quality of all devices during design, development, production and servicing. Guidance on the requirements for a quality management system may be found in the following standards: ISO 9001. The details shall be subject to agreement between the purchaser and supplier.

# 15 HEALTH AND SAFETY

A health and safety plan shall be set up in order to ensure proper management and compliance of the devices during installation, operation, maintenance, and decommissioning phases. Guidance on the requirements of a health and safety plan may be found in OHSAS 18001 standards. This is to ensure that the asset conforms to standard operating procedures and City Power SHERQ Policy.The details shall be subject to agreement between City Power and the Supplier..

# 16 ENVIRONMENTAL MANAGEMENT

An environmental management plan shall be set up in order to ensure the proper environmental management and compliance of the devices during their entire life cycle (i.e. during design, development, production, installation, operation and maintenance, decommissioning as well as disposal phases). Guidance on the requirements for an environmental management system may be found in ISO 14001 standards. The details shall be subject to agreement between City Power and the Supplier. This is to ensure that the asset created conforms to environmental standards and City Power SHERQ policy

## ANNEXURE A - Bibliography

None

# ANNEXURE B - Revision information

| DATE | REV. NO. | NOTES |
|---|---|---|
| March 2014 | 0 | First issue |
| March 2015 | 1 | Second issue |
| May 2018 | 2 | Third issue |
| | | Updated committee members |
| | | Nominative reference; added ENA TS 50-19:2004 |
| | | Nominative reference; updated with IEC 60255-26-:2009 |
| | | Nominative reference; updated with IEC 61000-4-3 2010 |
| | | Nominative reference;  updated with IEC 61000-4-8 2009 |
| | | Nominative reference; updated with IEC 61000-4-9 2016 |
| | | Nominative reference; updated with IEC 60255-26 2013 |
| | | Nominative reference; updated with IEC 61000-4-2: 2008 |
| | | Nominative reference; updated with IEC 60068-2-2 2007 |
| | | Nominative reference; updated with IEC 60255-21-3 1993 |
| | | Nominative reference; updated with IEC 60529: 2015 |
| | | Clause 10.7: replaced branding with end relay. |
| | | Clause 10.8: replaced branding with end relay |
| | | Clause 10.23: Added entire clause as a new item. |
| | | Clause 10.24 :Added entire clause as a new item. |
| | | Clause 11 :Added entire clause as a new item |
| | | Clause 12 :Added entire clause as a new item. |
| | | Clause 15 :Added entire clause as a new item. |
| | | Annex C:         Added new schedules for clauses 10.23, 10.24, as items 24 and 25 |

# ANNEXURE C - BYCH – TECHNICAL SCHEDULES

**Schedule A:  Purchaser's specific requirements**
**Schedule B:  Guarantees and technical particulars of equipment offered**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| **10.1** | **DESCRIPTION TECHNICAL DETAIL FOR A HV BAY CONTROLLER MAJOR PROTECTION EQUIPMENT (BYCH).** | | |
| | Manufacturer | State | |
| | Type/Model | State | |
| | **Minimum Functionality** | | |
| 10.1.1 | DigSilent StationWare settings file | State | |
| 10.1.2 | Graphical Man-Machine Interface (HMI) with mimic display | Yes | |
| 10.1.3 | HMI control of circuit breakers | >=2 | |
| 10.1.4 | HMI control of 2 pole switching devices | >=10 devices | |
| 10.1.5 | SCADA control of circuit breakers and 2 pole devices | Yes | |
| 10.1.6 | Password protection | Yes | |
| 10.1.7 | Breaker Fail protection | Yes | |
| 10.1.8 | 3 stage under frequency protection | State | |
| 10.1.9 | Breaker condition monitoring | State | |
| 10.1.10 | User programmable logic | Yes | |
| 10.1.11 | Fault waveform recording with a minimum of 4 records | Yes | |
| 10.1.12 | Sequential event recording with a minimum of 100 events | Yes | |
| 10.1.13 | Multi shot Auto Re-close | State | |
| 10.1.14 | Trip circuit supervision | Yes | |
| 10.1.15 | Synchronizing Check and Energisation Check (Dead Bus /Dead Line included) | State | |
| 10.1.16 | Integral Local/Remote selector switch | Yes | |
| 10.1.17 | Alarm annunciation on HMI and LED's | Yes | |
| 10.1.18 | Voltage and Current Measuring Functions | Yes | |
| 10.1.19 | 3 phase maximum demand power, three phase real power, apparent power and power factor display on LCD. | Yes | |
| 10.1.20 | Internal hardware and Software Supervision | Yes | |
| 10.1.21 | Minimum Programmable Heavy Duty Tripping Output Relays | >=8 | |
| | Minimum number of Binary Inputs | 16 to 60 | |
| | Minimum number of user programmable and configurable indication LED's | State | |
| 10.1.22 | User programmable logic | Yes | |
| 10.1.23 | Rear Data Communication ports for remote engineering access and DNP3.0 and IEC60870,  RS485/ ETHERNET/ RS232 | State | |
| 10.1.24 | Front Local Data Communication Port RS232 / USB | State | |
| 10.1.25 | Internal clock synchronization | Yes | |
| 10.1.26 | Relay casing material | Steel or Aluminium | |
| | | | |
| | | | |
| | | | |

**SPECIFICATION FOR PROTECTION RELAYS** REFERENCE  REV

             **CP_TSSPEC_214**  **2**

             PAGE  **19** OF **60**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| | **Technical Details** | | |
| 10.1.27 | Number of Voltage Inputs | >=3 | |
| 10.1.28 | Rated Voltage Input (Un) | 110V | |
| 10.1.29 | Rated Voltage Withstand: Continuously | State | |
| 10.1.30 | Number of Current Inputs | >=4 | |
| 10.1.31 | Rated Frequency (fn) | 50Hz | |
| 10.1.32 | Rated Current (In) | 1A or 5A | |
| 10.1.33 | Thermal Current Withstand: Continuous | State | |
| 10.1.34 | Thermal Current Withstand: Continuous rating | State | |
| 10.1.35 | Thermal Current Withstand: 1s | State | |
| 10.1.36 | Input Impedance: (In = 1A) | State | |
| 10.1.37 | Output Contact Rated Voltage | 110V or 230V ac/dc | |
| 10.1.38 | Power/ Signal Contact Thermal Withstand capability: Continuous | State | |
| 10.1.39 | Power/ Signal Contact Thermal Withstand capability: 3s | State | |
| 10.1.40 | Power/ Signal Contact Thermal Withstand capability: 0.5s | State | |
| 10.1.41 | Power Contact Thermal Breaking capability: L/R = 40ms @ 110VDC | State | |
| 10.1.42 | Binary Input Voltage Range | 30V or 110V dc | |
| 10.1.43 | Rated Auxiliary Supply Voltage | 30V or 110V dc | |
| 10.1.44 | Rated Auxiliary Supply Voltage Operation Range | 80% - 120% | |
| 10.1.45 | CTs terminals connection type | Ring or Flat | |
| 10.1.46 | Maximum relay dimensions in mm (width, height, depth) | 300, 300, 300 | |
| 10.1.47 | Maximum Power Consumption | State | |
| | Maximum Power Consumption (VA) | State | |
| | | | |

**Note: Ticks, Cross [√, X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.**

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          Name in block letters    Signature

Full name of company: _____

# ANNEXURE C - BYCM – TECHNICAL SCHEDULES

**Schedule A: Purchaser's specific requirements**
**Schedule B: Guarantees and technical particulars of equipment offered**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| **10.2** | **TECHNICAL DETAIL FOR A MV BAY CONTROLLER MAJOR PROTECTION EQUIPMENT (BYCM).** | | |
| | Manufacturer | State | |
| | Type/Model | State | |
| | **Minimum Functionality** | | |
| 10.2.1 | DigSilent StationWare settings file | State | |
| 10.2.2 | SCADA control of circuit breakers and 2 pole devices | Yes | |
| 10.2.3 | Password protection | Yes | |
| 10.2.4 | Breaker Fail protection | Yes | |
| 10.2.5 | 3 stage under frequency protection | State | |
| 10.2.6 | Breaker condition monitoring | State | |
| 10.2.7 | User programmable logic | Yes | |
| 10.2.8 | Fault waveform recording with a minimum of 4 records | Yes | |
| 10.2.9 | Sequential event recording with a minimum of 100 events | Yes | |
| 10.2.10 | Multi shot Auto Re-close | State | |
| 10.2.11 | Trip circuit supervision | Yes | |
| 10.2.12 | Synchronizing Check and Energisation Check (Dead Bus /Dead Line included) | Yes | |
| 10.2.13 | Integral Local/Remote selector switch | Yes | |
| 10.2.14 | Alarm annunciation on HMI and LED's | Yes | |
| 10.2.15 | Voltage and Current Measuring Functions | Yes | |
| 10.2.16 | 3 phase maximum demand power, three phase real power, apparent power and power factor display on LCD. | Yes | |
| 10.2.17 | Internal hardware and Software Supervision | Yes | |
| 10.2.18 | Minimum Programmable Heavy Duty Tripping Output Relays | >=8 | |
| 10.2.19 | Minimum Programmable Signal Output Relays | 10 to 15 | |
| 10.2.20 | Minimum number of Binary Inputs | 16 to 40 | |
| 10.2.21 | Minimum number of user programmable and configurable indication LED's | State | |
| 10.2.22 | User programmable logic | | |
| 10.2.23 | Rear Data Communication ports for remote engineering access and DNP3.0 and IEC60870, RS485/ ETHERNET/ RS232 | | |
| 10.2.24 | Front Local Data Communication Port RS232 / USB | | |
| 10.2.25 | Relay casing material | Steel or Aluminium | |
| | **Technical Details** | | |
| 10.2.26 | Number of Voltage Inputs | >=4 | |
| 10.2.27 | Rated Voltage Input (Un) | >=110V | |
| 10.2.28 | Rated Voltage Withstand: Continuously | >= Un | |
| 10.2.29 | Number of Current Inputs | >=4 | |

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| 10.2.30 | Rated Frequency (fn) | 50Hz | |
| 10.2.31 | Rated Current (In) | >=1A | |
| 10.2.32 | Thermal Current Withstand: Continuous | State | |
| 10.2.32 | Thermal Current Withstand: 1s | State | |
| 10.2.33 | Input Impedance: (In = 1A) | State | |
| 10.2.34 | Output Contact Rated Voltage: 110/230V AC/DC | State | |
| 10.2.36 | Power/ Signal Contact Thermal Withstand capability: Continuous | State | |
| 10.2.37 | Power/ Signal Contact Thermal Withstand capability: 3s | State | |
| 10.2.38 | Power/ Signal Contact Thermal Withstand capability: 0.5s | State | |
| 10.2.39 | Power Contact Thermal Breaking capability: L/R = 40ms @ 110VDC | State | |
| | Binary Input Voltage Range | 110 – 220 V dc | |
| 10.2.40 | Rated Auxiliary Supply Voltage | 110 – 220 V dc | |
| 10.2.41 | Rated Auxiliary Supply Voltage Operation Range | 80% - 120% | |
| 10.2.42 | CT and VT connection terminal type | Ring or Flat | |
| 10.2.43 | Maximum Power Consumption (VA) | State | |
| 10.2.30 | | | |
| | | | |

**Note: Ticks, Cross [√, X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.**

Tender Number: _____

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                                   Name in block letters          Signature

Full name of company: _____

# ANNEXURE C - MAINI – TECHNICAL SCHEDULES

**Schedule A:  Purchaser's specific requirements**
**Schedule B:  Guarantees and technical particulars of equipment offered**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| **10.3** | **TECHNICAL DETAIL FOR A MULTI PURPOSE MAIN INCOMER OVER CURRENT RELAY (MAINI).** | | |
| | Manufacturer | State | |
| | Type/Model | State | |
| | **Minimum Functionality** | | |
| 10.3.1 | DigSilent StationWare settings file | State | |
| 10.3.2 | Multiple element directional and non-directional over-current protection | Yes | |
| 10.3.3 | Multiple element directional and non-directional earth fault protection | Yes | |
| 10.3.4 | Sensitive earth fault protection<br>Note: This functionalitycan be provided as a separate relay: if so then– see STBYEF relayand compete STBYEF technical schedule) | Yes | |
| 10.3.5 | LCD Display Interface | Yes | |
| 10.3.6 | Password protection | Yes | |
| 10.3.7 | Breaker Fail protection | Yes | |
| 10.3.8 | 3 stage under frequency protection | State | |
| 10.3.9 | Breaker I$^2$t condition monitoring | State | |
| 10.3.10 | Internal trip timer (CB opening time) with alarm output (element or logics) | Yes | |
| 10.3.11 | Fault waveform recording with a minimum of 4 records | Yes | |
| 10.3.12 | Sequential event recording with a minimum of 100 events | Yes | |
| 10.3.13 | Multi shot Auto Re-close | State | |
| 10.3.14 | Trip circuit supervision | Yes | |
| 10.3.15 | Synchronizing Check and Energization Check (Dead Bus /Dead Line included) | State | |
| 10.3.16 | 3 phase maximum demand power, three phase real power, apparent power and power factor display on LCD. | Yes | |
| 10.3.17 | Internal hardware and Software Supervision | Yes | |
| 10.3.18 | Minimum Programmable Heavy Duty Tripping Output Relays | >=2 | |
| 10.3.19 | Minimum Programmable Signal Output | >=4 | |
| 10.3.20 | Minimum Number of Binary Inputs | >=6 | |
| 10.3.21 | Minimum number of user programmable and configurable indication LED's | State | |

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| 10.3.22 | User programmable logic | Yes | |
| 10.3.23 | Rear Data Communication ports for remote engineering access and DNP3.0 and IEC60870, RS485/ ETHERNET/ RS232 | State | |
| 10.3.24 | Front Local Data Communication Port RS232 / USB | State | |
| 10.3.25 | Internal clock synchronization | Yes | |
| 10.3.26 | Relay casing material | Steel or Aluminium | |
| 10.3.27 | **Technical Details** | | |
| 10.3.28 | Number of Voltage Inputs | >=3 | |
| 10.3.29 | Rated Voltage Input (Un) | 110V | |
| 10.3.30 | Rated Voltage Withstand: Continuously | State | |
| 10.3.31 | Number of Current Inputs | >=4 | |
| 10.3.32 | Rated Frequency (fn) | 50Hz | |
| 10.3.33 | Rated Current (In) | 1A or 5A | |
| 10.3.34 | Thermal Current Withstand: Continuous | State | |
| 10.3.35 | Thermal Current Withstand: Continuous rating | State | |
| 10.3.36 | Thermal Current Withstand: 1s | State | |
| 10.3.37 | Input Impedance: (In = 1A) | State | |
| 10.3.38 | Output Contact Rated Voltage | 110V or 230V ac/dc | |
| 10.3.24 | Power/ Signal Contact Thermal Withstand capability: Continuous | State | |
| 10.3.25 | Power/ Signal Contact Thermal Withstand capability: 3s | State | |
| 10.3.26 | Power/ Signal Contact Thermal Withstand capability: 0.5s | State | |
| 10.3.27 | Power Contact Thermal Breaking capability: L/R = 40ms @ 110VDC | State | |
| 10.3.28 | Binary Input Voltage Range | 30V or 110V dc | |
| 10.3.29 | Rated Auxiliary Supply Voltage | 30V or 110V dc | |
| 10.3.30 | Rated Auxiliary Supply Voltage Operation Range | 80% - 120% | |
| 10.3.31 | CTs terminals connection type | Ring or Flat | |
| 10.3.32 | Maximum relay dimensions in mm (width, height, depth) | 300, 300, 300 | |
| 10.3.33 | Maximum Power Consumption | State | |

**Note: Ticks, Cross [√, X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.**

Tender Number: _____

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Name in block letters          Signature

Full name of company: _____

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## ANNEXURE C - MAINF – TECHNICAL SCHEDULES

**Schedule A:  Purchaser's specific requirements**
**Schedule B:  Guarantees and technical particulars of equipment offered**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| **10.4** | **TECHNICAL DETAIL FOR A MULTI PURPOSE MAIN FEEDER OVER CURRENT RELAY (MAINF).** | | |
| | Manufacturer | State | |
| | Type/Model | State | |
| | **Minimum Functionality** | | |
| 10.4.1 | DigSilent StationWare settings file | State | |
| 10.4.2 | Multiple element over-current protection | Yes | |
| 10.4.3 | Multiple element earth fault protection | Yes | |
| 10.4.4 | Sensitive earth fault protection Note: This functionalitycan be provided as a separate relay: if so then– see STBYEF relayand compete STBYEF technical schedule) | Yes | |
| 10.4.5 | LCD Display Interface | Yes | |
| 10.4.6 | Password protection | Yes | |
| 10.4.7 | Breaker Fail protection | Yes | |
| 10.4.8 | 3 stage under frequency protection | State | |
| 10.4.9 | Breaker I$^2$t condition monitoring | State | |
| 10.410 | Internal trip timer (CB opening time) with alarm output (element or logics) | Yes | |
| 10.4.11 | Fault waveform recording with a minimum of 4 records | Yes | |
| 10.4.12 | Sequential event recording with a minimum of 100 events | Yes | |
| 10.4.13 | Multi shot Auto Re-close | State | |
| 10.4.14 | Trip circuit supervision | Yes | |
| 10.4.15 | 3 phase current display on LCD. | Yes | |
| 10.4.16 | Internal hardware and Software Supervision | Yes | |
| 10.4.17 | Minimum Programmable Heavy Duty Tripping Output Relays | >=2 | |
| 10.4.18 | Minimum Programmable Signal Output Relays | >=4 | |
| 10.4.19 | Minimum Number of Binary Inputs | >=6 | |
| 10.4.20 | Minimum number of user programmable and configurable indication LED's | State | |
| 10.4.21 | User programmable logic | Yes | |
| 10.4.22 | Rear Data Communication ports for remote engineering access and DNP3.0 and IEC60870,  RS485/ ETHERNET/ RS232 | State | |
| 10.4.23 | Front Local Data Communication Port RS232 / USB | State | |
| 10.4.24 | Relay casing material | Steel or Aluminium | |

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| | **Technical Details** | | |
| 10.4.25 | Number of Current Inputs | >=4 | |
| 10.4.26 | Rated Frequency (fn) | 50Hz | |
| 10.4.27 | Rated Current (In) | 1A or 5A | |
| 10.4.28 | Thermal Current Withstand: Continuous | State | |
| 10.4.29 | Thermal Current Withstand: Continuous rating | State | |
| 10.4.30 | Thermal Current Withstand: 1s | State | |
| 10.4.31 | Input Impedance: (In = 1A) | State | |
| 10.4.32 | Output Contact Rated Voltage | 110/230V AC/DC | |
| 10.4.33 | Power/ Signal Contact Thermal Withstand capability: Continuous | State | |
| 10.4.34 | Power/ Signal Contact Thermal Withstand capability: 3s | State | |
| 10.4.35 | Power/ Signal Contact Thermal Withstand capability: 0.5s | State | |
| 10.4.36 | Power Contact Thermal Breaking capability: L/R = 40ms @ 110VDC | State | |
| 10.4.37 | Binary Input Voltage Range | 30V or 110 Vor 220V dc | |
| 10.4.38 | Rated Auxiliary Supply Voltage | 30V or 110 or 220V dc | |
| 10.4.39 | Rated Auxiliary Supply Voltage Operation Range | 80% - 120% | |
| 10.4.40 | CTs terminals connection type | Ring or Flat | |
| 10.4.41 | Maximum relay dimensions in mm (width, height, depth) | 300, 300, 300 | |
| 10.4.42 | Maximum Power Consumption | State | |
| | Setting | 1 or 0 | |

**Note: Ticks, Cross [√, X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.**

Tender Number: _____

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                Name in block letters         Signature

Full name of company: _____

# ANNEXURE C - PFCR – TECHNICAL SCHEDULES

**Schedule A:  Purchaser's specific requirements**
**Schedule B:  Guarantees and technical particulars of equipment offered**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| **10.5** | **TECHNICAL DETAIL FOR A CAPACITOR BANK PROTECTION RELAY (PFCR).** | | |
| | Manufacturer | State | |
| | Type/Model | State | |
| | **Minimum Functionality** | | |
| 10.5.1 | DigSilent StationWare settings file | Yes | |
| 10.5.2 | 3 Stage - 3 Phase Over current Protection | Yes | |
| 10.5.3 | Ground over current protection | Yes | |
| 10.5.4 | Phase over current Protection | Yes | |
| 10.5.5 | Phase current unbalance | Yes | |
| 10.5.6 | Neutral current unbalance | Yes | |
| 10.5.7 | Power elements real and reactive | Yes | |
| 10.5.8 | Over/under voltage Protection | Yes | |
| 10.5.9 | Over/under Frequency Protection | Yes | |
| 10.5.10 | Voltage Differential Protection | Yes | |
| 10.5.11 | Current Unbalance Protection | Yes | |
| 10.5.12 | Automatic Capacitor Bank Control (Voltage, VAR, PF, etc.) | Yes | |
| 10.5.13 | Voltage and Current Measuring Functions | Yes | |
| 10.5.14 | Internal hardware and Software Supervision | Yes | |
| 10.5.15 | Password protection | 2 levels | |
| 10.5.16 | Breaker Fail protection | Yes | |
| 10.5.17 | Minimum Programmable Heavy Duty Output Relays | 4 | |
| 10.5.18 | Minimum Programmable Signal Output Relays | 10 | |
| | Minimum Number of Binary Inputs | 6 | |
| 10.5.19 | User programmable logic | Yes | |
| 10.5.20 | Minimum number of user programmable and configurable indication LED's | 6 | |
| 10.5.21 | Rear Data Communication ports for remote engineering access and DNP3.0 and IEC60870,  RS485/ ETHERNET/ RS232 | Yes | |
| 10.5.22 | Front Local Data Communication Port RS232 / USB | Yes | |
| 10.5.23 | Internal clock synchronization - demodulated IRIG-B (non BNC external connector) | IRIG-B122 | |
| 10.5.24 | Relay casing material | Steel or Aluminium | |
| | **Technical Details** | | |
| 10.5.25 | Number of Voltage Inputs | 6 | |
| 10.5.26 | Rated Voltage (Un) | 100V / 110V | |
| 10.5.27 | Rated Voltage Withstand: Continuously | 2 x Un | |

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| 10.5.28 | Number of Current Inputs | 4 | |
| 10.5.29 | Rated Frequency (fn) | 50Hz | |
| 10.5.30 | Rated Current (In) | 1A | |
| 10.5.31 | Rated Current of Fifth Element (In) | 0.2A/1A | |
| 10.5.32 | Thermal Current Withstand: Continuous | 4 x In | |
| 10.5.33 | Thermal Current Withstand: Continuous for In = 0.2A | 7.5 x In | |
| 10.5.34 | Thermal Current Withstand: 1s | 100 x In | |
| 10.5.35 | Input Impedance: (In = 1A) | < 1 VA | |
| 10.5.36 | Output Contact Rated Voltage | 250V AC/DC | |
| 10.5.37 | Power/ Signal Contact Thermal Withstand capability: Continuous | 5A | |
| 10.5.38 | Power/ Signal Contact Thermal Withstand capability: 0.5s | 30A/10A | |
| 10.5.39 | Binary Input Voltage Range | 110/220 V dc | |
| 10.5.40 | Rated Auxiliary Supply Voltage | 110 – 220 V dc | |
| 10.5.41 | Rated Auxiliary Supply Voltage Operation Range | 80% - 120% | |
| 10.5.42 | Fault waveform recording with a minimum of 4 records | Yes | |
| 10.5.43 | Sequential event recording with a minimum of 100 time tagged events | Yes | |
| 10.5.44 | All terminals connection type | Ring | |
| 10.5.45 | Maximum Power Consumption | State | |
| | | | |

**Note: Ticks, Cross [√, X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.**

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                                   Name in block letters          Signature

Full name of company: _____

## ANNEXURE C DIFFO– TECHNICAL SCHEDULES

**Schedule A: Purchaser's specific requirements**
**Schedule B: Guarantees and technical particulars of equipment offered**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| 10.6 | **TECHNICAL DETAIL FOR A FIBER OPTIC LINE DIFFERENTIAL RELAY (DIFFO).** | | |
| | Manufacturer | State | |
| | Type/Model | State | |
| | **Minimum Functionality** | | |
| 10.6.1 | DigSilent StationWare settings file | State | |
| 10.6.2 | Phase segregated current differential protection over fibre | Yes | |
| 10.6.3 | Internal CT mismatch correction | Yes | |
| 10.6.4 | Internal CT vector compensation | Yes | |
| 10.6.5 | Internal inrush current detection | Yes | |
| 10.6.6 | LCD Display Interface | Yes | |
| 10.6.7 | Password protection | State | |
| 10.6.8 | Breaker Fail protection | Yes | |
| 10.6.9 | Fault waveform recording with a minimum of 4 records | Yes | |
| 10.6.10 | Sequential event recording with a minimum of 100 events | Yes | |
| 10.6.12 | 3 phase current display on LCD. | Yes | |
| 10.6.13 | Internal hardware and Software Supervision | Yes | |
| 10.6.14 | Minimum Programmable Heavy Duty Tripping Output Relays | >=2 | |
| 10.6.15 | Minimum Programmable Signal Output Relays | >=4 | |
| 10.6.16 | Minimum Number of Binary Inputs | >=6 | |
| 10.6.17 | Minimum number of user programmable and configurable indication LED's | State | |
| 10.6.18 | User programmable logic | Yes | |
| 10.6.19 | Rear Data Communication ports for remote engineering access and DNP3.0 and IEC60870, RS485/ ETHERNET/ RS232 | State | |
| 10.6.20 | Front Local Data Communication Port RS232 / USB | State | |
| 10.6.21 | Internal clock synchronization | Yes | |
| 10.6.22 | Relay casing material | Steel or Aluminium | |
| 10.6.23 | **Technical Details** | | |
| 10.6.24 | Number of Current Inputs | >=4 | |
| 10.6.25 | Rated Frequency (fn) | 50Hz | |
| | | | |
| 10.2.26 | Thermal Current Withstand: Continuous | State | |
| 10.3.27 | Thermal Current Withstand: 1s | State | |
| 10.3.28 | Input Impedance: (In = 1A) | State | |
| 10.3.29 | Output Contact Rated Voltage | 110V or 230V ac/dc | |
| | | | |

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|------|-------------|------------|------------|
| 10.3.30 | Power/ Signal Contact Thermal Withstand capability: Continuous | State | |
| 10.3.31 | Power/ Signal Contact Thermal Withstand capability: 3s | State | |
| 10.3.32 | Power/ Signal Contact Thermal Withstand capability: 0.5s | State | |
| 10.3.33 | Power Contact Thermal Breaking capability: L/R = 40ms @ 110VDC | State | |
| 10.3.34 | Binary Input Voltage Range | 30V or 110Vdc | |
| 10.3.35 | Rated Auxiliary Supply Voltage | 30V or 110Vdc | |
| 10.3.36 | Rated Auxiliary Supply Voltage Operation Range | 80% - 120% | |
| 10.3.37 | CTs terminals connection type | Ring or Flat | |
| 10.3.38 | Maximum relay dimensions in mm (width, height, depth) | 300, 300, 300 | |
| 10.3.39 | Maximum Power Consumption | State | |
| | | | |
| 10.3.38 | Maximum Power Consumption | State | |

**Note: Ticks, Cross [√, X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.**

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# ANNEXURE C - DIFFPV – TECHNICAL SCHEDULES

**Schedule A:  Purchaser's specific requirements**
**Schedule B:  Guarantees and technical particulars of equipment offered**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|------|-------------|------------|------------|
| 10.7 | **TECHNICAL DETAIL FOR A PILOT WIRE LINE BALANCED VOLTAGE DIFFERENTIAL RELAY (DIFFPV).** | | |
| | Manufacturer | State | |
| | Type/Model | State | |
| | **Minimum Functionality** | | |
| 10.7.1 | Current differential protection over copper wire pair | Yes | |
| 10.7.2 | Balanced voltage operating principle | Yes | |
| 10.7.3 | Compatible with remote end relays. | Yes | |
| 10.7.4 | Minimum Heavy Duty Tripping Output Relays | 2 | |
| 10.7.5 | Trip operation flag | Yes | |
| 10.7.6 | Relay casing material | Steel or Aluminium | |
| | **Technical Details** | | |
| 10.7.7 | Operating time at 10 x In | < 100ms | |
| 10.7.8 | Number of Current Inputs | 4 | |
| 10.7.9 | Rated Frequency (fn) | 50Hz | |
| 10.7.10 | Rated Current (In) | 1A or 5A | |
| 10.7.11 | Thermal Current Withstand: Continuous | 1.3 x In | |
| 10.7.12 | Thermal Current Withstand: 0.5s | 30 x In | |
| 10.7.13 | Input Impedance: (In = 1A) | < 1VA | |
| 10.7.14 | 50 Hz insulation level | 4kV | |
| 10.7.15 | Output Contact Rated Voltage | 250V AC/DC | |
| 10.7.16 | Power Contact Thermal Withstand capability:  Continuous | 6A | |
| 10.7.17 | All terminals connection type | Ring | |
| 10.7.28 | Maximum relay dimensions in mm (width, height, depth) | 160, 200, 250 | |
| | | | |
| | | | |
| | | | |

**Note: Ticks, Cross [√, X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.**

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# ANNEXURE C - PWSRV – TECHNICAL SCHEDULES

**Schedule A:  Purchaser's specific requirements**
**Schedule B:  Guarantees and technical particulars of equipment offered**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| 10.7B | **TECHNICAL DETAIL FOR A PILOT WIRE SUPERVISION RELAY (PWSRV) FOR THE LINE BALANCED VOLTAGE DIFFERENTIAL RELAY (DIFFPV).** | | |
| | Manufacturer | State | |
| | Type/Model | State | |
| | **Minimum Functionality** | | |
| | Supervision of ac circuit copper wire pair (pilot circuit) interconnecting protective relays | Yes | |
| 7B.1 | Pilot circuit insulation | 5kV | |
| | DC injection method | Yes | |
| | Compatible with remote end relay | Yes | |
| | Minimum Alarm Output Relays | 2 | |
| | Alarm flag for pilot short-circuit | Yes | |
| | Alarm flag for pilot open-circuit | Yes | |
| | Alarm and indication of power supply failure | Yes | |
| | Relay casing material | Steel or Aluminium | |
| | **Technical Details** | | |
| | AC supervision voltage Vn | 110V or 220V | |
| 7B.2 | DC auxiliary voltage | 32/110V | |
| | Rated Frequency (fn) | 50Hz | |
| | Range of pilot loop resistance | 0 to 10kΩ | |
| | Allowable continuous ac pilot current | 50mA | |
| | Allowable short time ac pilot current | 1500mA | |
| | Output Contact Rated Voltage | 250V AC/DC | |
| | Output Contact Continuous rating | 5A AC/DC | |
| | Output Contact Break rating | 25W, L/R = 0.04s | |
| | All terminals connection type | Ring | |
| | AC power consumption | State | |
| | DC power consumption | State | |
| | Maximum relay dimensions in mm (width, height, depth) | 160, 200, 250 | |

**Note: Ticks, Cross [√, X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.**

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## ANNEXURE C - DIFFPI – TECHNICAL SCHEDULES

**Schedule A: Purchaser's specific requirements**
**Schedule B: Guarantees and technical particulars of equipment offered**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| | **TECHNICAL DETAIL FOR A PILOT WIRE LINE BALANCED CURRENT DIFFERENTIAL RELAY (DIFFPI).** | | |
| | Manufacturer | State | |
| **8A** | Type/Model | State | |
| | **Minimum Functionality** | | |
| | Current differential protection over copper wire pair | Yes | |
| **8A.1** | Balanced voltage operating principle | Yes | |
| | Compatible with remote end relay | Yes | |
| | Minimum Heavy Duty Tripping Output Relays | 2 | |
| | Relay casing material | Steel or Aluminium | |
| **ITEM** | **Technical Details** | | |
| | Operating time at 10 x In | < 100ms | |
| **8A.2** | Number of Current Inputs | 4 | |
| | Rated Frequency (fn) | 50Hz | |
| | Rated Current (In) | 1A or 5A | |
| | Thermal Current Withstand: Continuous | 1.3 x In | |
| | Thermal Current Withstand: 0.5s | 30 x In | |
| | Input Impedance: (In = 1A) | < 1VA | |
| | 50 Hz insulation level | 5kV | |
| | Output Contact Rated Voltage | 250V AC/DC | |
| | Power Contact Thermal Withstand capability: Continuous | 6A | |
| | All terminals connection type | Ring | |
| | Maximum relay dimensions in mm (width, height, depth) | 160, 200, 250 | |

**Note: Ticks, Cross [√, X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.**

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# ANNEXURE C - PWSRI – TECHNICAL SCHEDULES

**Schedule A:  Purchaser's specific requirements**
**Schedule B:  Guarantees and technical particulars of equipment offered**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
|  | **TECHNICAL DETAIL FOR A PILOT WIRE SUPERVISION RELAY (PWSRI) FOR THE LINE BALANCED CURRENT DIFFERENTIAL RELAY (DIFFPI).** |  |  |
|  | Manufacturer | State |  |
| 8B | Type/Model | State |  |
|  | **Minimum Functionality** |  |  |
|  | Supervision of ac circuit copper wire pair (pilot circuit) interconnecting protective relays | Yes |  |
| 8B.1 | Pilot circuit insulation | 5kV |  |
|  | DC injection method | Yes |  |
|  | Compatible with remote end relay | Yes |  |
|  | Minimum Alarm Output Relays | 2 |  |
|  | Alarm flag for pilot short-circuit | Yes |  |
|  | Alarm flag for pilot open-circuit | Yes |  |
|  | Alarm and indication of power supply failure | Yes |  |
|  | Relay casing material | Steel or Aluminium |  |
|  | **Technical Details** |  |  |
|  | AC supervision voltage Vn | 110V or 220V |  |
| 8B.2 | DC auxiliary voltage | 32 or 110V |  |
|  | Rated Frequency (fn) | 50Hz |  |
|  | Range of pilot loop resistance | 0 to 10kΩ |  |
|  | Allowable continuous ac pilot current | 50mA |  |
|  | Allowable short time ac pilot current | 1500mA |  |
|  | Output Contact Rated Voltage | 250V AC/DC |  |
|  | Output Contact Continuous rating | 5A AC/DC |  |
|  | All terminals connection type | Ring |  |
| **ITEM** | AC power consumption | State |  |
|  | DC power consumption | State |  |
|  | Maximum relay dimensions in mm (width, height, depth) | 160, 200, 250 |  |
|  |  |  |  |

**Note: Ticks, Cross [√, X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.**

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# ANNEXURE C - DIFFT – TECHNICAL SCHEDULES

**Schedule A: Purchaser's specific requirements**
**Schedule B: Guarantees and technical particulars of equipment offered**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| | **TECHNICAL DETAIL FOR A TRANSFORMER DIFFERENTIAL RELAY (DIFFT).** | | |
| **9** | Manufacturer | State | |
| **10.4** | Type | State | |
| | **Minimum Functionality** | | |
| | DigSilent StationWare settings file | State | |
| | Integrated Two Winding Differential restrained and unrestrained protection | Yes | |
| 10.4.1 | Restricted Earth Fault Functions suitable for star (Y) and auto-transformers | Yes | |
| 10.4.2 | Under voltage protection | Yes | |
| 10.4.3 | Over/under frequency protection | Yes | |
| 10.4.4 | Neutral over current protection | Yes | |
| 10.4.5 | Second Harmonic Restraint for Transformer Inrush | Yes | |
| 10.4.6 | Fifth Harmonic Restraint with Adjustable Deactivation Level | Yes | |
| 10.4.7 | Internal CT Ratio Correction and Vector Group Matching | Yes | |
| 10.4.8 | Phase Current and Angle Display to Confirm Vector Group matching | Yes | |
| 10.4.9 | Fault recording with a minimum of 4 waveform records | Yes | |
| 10.4.10 | Sequential event recording with a minimum of 100 time tagged events | Yes | |
| 10.4.11 | Over-fluxing Protection V/F | State | |
| 10.4.12 | User configurable Indication LEDs | State | |
| 10.4.13 | Voltage and Current Measuring Functions | Yes | |
| 10.4.14 | Internal hardware and Software Supervision | Yes | |
| 10.4.15 | Minimum Programmable Heavy Duty Output Relays | >=4 | |
| 10.4.16 | Minimum Programmable Signal Output Relays | >=5 | |
| 10.4.17 | Minimum Number of Binary Inputs | >=14 | |
| 10.4.18 | User programmable logic | Yes | |
| 10.4.19 | Minimum Number of Indication LED's | State | |
| 10.4.20 | | | |
| 10.4.21 | Rear Data Communication ports for remote engineering access and DNP3.0 and IEC60870, RS485/ ETHERNET/ RS232 | State | |
| 10.4.22 | Relay casing material | Steel or Aluminium | |
| 10.4.23 | Internal hardware and Software Supervision | Yes | |

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| 10.4.24 | **Technical Details** | | |
| 10.4.25 | Password protection | Yes | |
| | Breaker Fail protection | Yes | |
| 10.4.26 | Number of Voltage Inputs | >=4 | |
| 10.4.27 | Rated Voltage (Un) | 110V | |
| 10.4.28 | Rated Voltage Withstand: Continuously | State | |
| 10.4.29 | Number of phase current Inputs | >=6 | |
| 10.4.30 | Number of neutral current Inputs | >=2 | |
| 10.4.31 | Rated Frequency (fn) | 50Hz | |
| 10.4.32 | Rated Current of phase elements (In) | 1A or 5A | |
| 10.4.33 | Rated Current of Neutral Elements (In) | 1A or 5A | |
| 10.4.34 | Thermal Current Withstand: Continuous | State | |
| 10.4.35 | Thermal Current Withstand: Continuous rating | State | |
| 10.4.36 | Thermal Current Withstand: 1s | State | |
| 10.4.37 | Input Impedance: (In = 1A) | State | |
| 10.4.38 | Output Contact Rated Voltage | 110V or 230V ac/dc | |
| 10.4.39 | Power/ Signal Contact Thermal Withstand capability: Continuous | State | |
| 10.4.40 | Power/ Signal Contact Thermal Withstand capability: 0.5s | State | |
| 10.4.41 | Binary Input Voltage Range | 110V or 220 V dc | |
| 10.4.42 | Rated Auxiliary Supply Voltage | 110V or 220 V dc | |
| 10.4.43 | Rated Auxiliary Supply Voltage Operation Range | 80% - 120% | |
| 10.4.44 | CTs terminals connection type | Ring or Flat | |
| 10.4.45 | Maximum Power Consumption | State | |
| 10.4.47 | Internal clock synchronization - demodulated IRIG-B (non BNC external connector) | IRIG-B122 | |
| | MAXIMUM Power Consuption | STATE | |

**Note: Ticks, Cross [√, X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.**

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# ANNEXURE C - DIFFZ – TECHNICAL SCHEDULES

**Schedule A:  Purchaser's specific requirements**
**Schedule B:  Guarantees and technical particulars of equipment offered**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|------|-------------|------------|------------|
| | **TECHNICAL DETAIL FOR A LINE IMPEDANCE AND DIFFERENTIAL RELAY (DIFFZ).** | | |
| | Manufacturer | State | |
| **10** | Type | State | |
| | **Minimum Functionality** | | |
| | DigSilent StationWare settings file | Yes | |
| **10.1** | Phase Segregated Differential protection | Yes | |
| | Single Mode 1300nm fibre optic connections | Yes | |
| | 4 Zone Phase Fault Impedance Protection | Yes | |
| | 4 Zone Earth Fault  Impedance Protection | Yes | |
| | Switch onto Fault Protection | Yes | |
| | Phase and neutral over current protection | Yes | |
| | Fault location | Yes | |
| **ITEM** | Phase and neutral Negative Sequence current protection | Yes | |
| | Sensitive earth fault protection | Yes | |
| | Inter-trip Commands Across Communication Channel | Yes | |
| | Communications assisted distance schemes | Yes | |
| | Fuse Fail Supervision | Yes | |
| | Primary Service Value Display | Yes | |
| | CT saturation detection | Yes | |
| | Internal CT Ratio Correction | Yes | |
| | Phase Current and Angle Display | Yes | |
| | Circuit Breaker Fail Protection | Yes | |
| | Fault recording with a minimum of 4 waveform records | Yes | |
| | Sequential event recording with a minimum of 100 events | Yes | |
| | Internal Hardware and Software Supervision | Yes | |
| | Minimum Programmable Heavy Duty Tripping Output Relays | 4 | |
| | Minimum Programmable Signal Output Relays | 10 | |
| | Minimum Number of Binary Inputs | 5 | |
| | Minimum Number of Indication LED's | 6 | |
| | Maximum Relay Trip Operating Time | $\leq$ 20 ms | |
| | User programmable logic | Yes | |
| | Rear Data Communication ports for remote engineering access and DNP3.0 and IEC60870, RS485/ ETHERNET/ RS232 | Yes | |

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| | Front Local Data Communication Port RS232 / USB | Yes | |
| | Internal clock synchronization - demodulated IRIG-B (non BNC external connector) | IRIG-B122 | |
| | Relay casing material | Steel or Aluminium | |
| | **Technical Details** | | |
| | Rated Current (In) | 1A | |
| 10.2 | Phase impedance protection characteristic | Mho | |
| | Ground  impedance protection characteristic | Mho and Quadrilateral | |
| | Phase and Neutral over current protection curves | IEC SI, VI, EI | |
| | Thermal Current Withstand: Continuous | 3 A | |
| | Thermal Current Withstand: 10s | 25 A | |
| | Thermal Current Withstand: 1s | 100 A | |
| | CT Input Impedance: (In = 1A) | < 1 VA | |
| | Output Contact Rated Voltage | 250V ac/dc | |
| | Power/ Signal Contact Thermal Withstand capability: Continuous | 5A | |
| | Power/ Signal Contact Thermal Withstand capability: 1s | 50 A | |
| | Power Contact Thermal Breaking capability: L/R = 40ms @ 110VDC | 0.3 A or 30 W | |
| | Binary Input Voltage Range | 110 – 220 V dc | |
| | Rated Auxiliary Supply Voltage | 110 – 220 V dc | |
| | Rated Auxiliary Supply Voltage Operation Range | 80% - 120% | |
| | All terminals connection type | Ring | |
| | Maximum Power Consumption | State | |
| | Rated Current (In) | 1A | |
| | | | |

**Note: Ticks, Cross [√, X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.**

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## ANNEXURE C - DIFFB – TECHNICAL SCHEDULES

**Schedule A:  Purchaser's specific requirements**
**Schedule B:  Guarantees and technical particulars of equipment offered**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|------|-------------|------------|------------|
| | **TECHNICAL DETAIL FOR A BUSBAR DIFFERENTIAL RELAY (DIFFB).** | | |
| | Manufacturer | State | |
| **12** | Type | State | |
| | **Minimum Functionality** | | |
| | DigSilent StationWare settings file | Yes | |
| **12.1** | Low impedance (Numerical) type | Yes | |
| | 3 Phase segregated differential protection | Yes | |
| | Stub bus (end zone) protection | Yes | |
| | Phase current and angle comparison | Yes | |
| | Selective zone tripping | Yes | |
| | Automatic zone selection | Yes | |
| | Breaker failure protection | Yes | |
| | Minimum tripping time | $\leq$ 20 ms | |
| | Number of Zones | 4 main + 1 check zone | |
| | Number of Circuit Breakers in a Zone | 1 to 19 | |
| | Current Transformer Supervision | Yes | |
| | CT saturation detection | Yes | |
| | Internal CT Ratio Correction | Yes | |
| | Phase Current and Angle Display | Yes | |
| | Circuit Breaker Fail Protection | Yes | |
| | Fault recording with a minimum of 4 waveform records | Yes | |
| | Sequential event recording with a minimum of 100 events | Yes | |
| | Internal Hardware and Software Supervision | Yes | |
| | Heavy Duty Trip Output Relays | 3 per circuit breaker | |
| | Programmable Signal Output Relays | 10 | |
| | Binary Inputs | Specify | |
| | User programmable logic | Yes | |
| | Rear Data Communication ports for remote engineering access and DNP3.0 and IEC60870, RS485/ ETHERNET/ RS232 | Yes | |
| | Front Local Data Communication Port RS232 / USB | Yes | |
| | Internal clock synchronization - demodulated IRIG-B (non BNC external connector) | IRIG-B122 | |
| | Relay casing material | Steel or | |

| ITEM | DESCRIPTION | Aluminium | SCHEDULE B |
|------|-------------|-----------|------------|
| | **Technical Details** | | |
| | Rated Current (In) | 1A | |
| **12.2** | Thermal Current Withstand: Continuous | 3 A | |
| | Thermal Current Withstand: 10s | 25 A | |
| | Thermal Current Withstand: 1s | 100 A | |
| | **DESCRIPTION** | **SCHEDULE A** | **SCHEDULE B** |
| | CT Input Impedance: (In = 1A) | < 1 VA | |
| **ITEM** | Output Contact Rated Voltage | 250V ac/dc | |
| | Power/ Signal Contact Thermal Withstand capability: Continuous | 5A | |
| | Power/ Signal Contact Thermal Withstand capability: 1s | 50 A | |
| | Power Contact Thermal Breaking capability: L/R = 40ms @ 110VDC | 0.3 A or 30 W | |
| | Binary Input Voltage Range | 110 – 220 V dc | |
| | Rated Auxiliary Supply Voltage | 110 – 220 V dc | |
| | Rated Auxiliary Supply Voltage Operation Range | 80% - 120% | |
| | All terminals connection type | Ring | |
| | Maximum Power Consumption | State | |

**Note: Ticks, Cross [√, X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.**

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# ANNEXURE C - ARCP – TECHNICAL SCHEDULES

**Schedule A:  Purchaser's specific requirements**
**Schedule B:  Guarantees and technical particulars of equipment offered**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|------|-------------|------------|------------|
| | **TECHNICAL DETAIL FOR AN ARC PROTECTION RELAY (ARCP).** | | |
| | Manufacturer | State | |
| **13** | Type | State | |
| | **Minimum Functionality** | | |
| | Operation on simultaneous current and light | Yes | |
| **13.1** | Master unit current sensing with information sent over communication channel to slave units | Yes | |
| | Individual metal-clad switchgear cable chamber tripping | Yes | |
| | 3-phase current measurement or 2-phase and earth-fault current measurement | Yes | |
| | Continuous self-supervision of sensor loop, operating voltages and cabling between central units and extension units | | |
| | Circuit Breaker Fail Protection | Yes | |
| | Internal Hardware and Software Supervision | Yes | |
| | Minimum Heavy Duty Tripping Output Relays per zone | 3 | |
| | Maximum Trip Operating Time | $\leq$ 10 ms | |
| | Relay casing material | Steel or Aluminium | |
| | **Technical Details** | | |
| | Number of Current Inputs | 3 | |
| **13.2** | Rated Frequency (fn) | 50Hz | |
| | Rated Current (In) | 1A and 5A | |
| | Thermal Current Withstand: 1s | 60 x In | |
| | Input Impedance: (In = 1A) | < 1VA | |
| | Output Contact Rated Voltage | 250V ac/dc | |
| | Trip  Contact Thermal Withstand capability: 3s | 15A | |
| | Rated Auxiliary Supply Voltage | 110V dc | |
| | Rated Auxiliary Supply Voltage Operation Range | 80% - 120% | |
| | CT terminals connection type | Ring | |
| | Maximum Power Consumption | State | |

**Note: Ticks, Cross [√, X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.**

Tender Number: _____

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<div align="center">Name in block letters            Signature</div>

Full name of company: _____

## ANNEXURE C - AVR – TECHNICAL SCHEDULES

**Schedule A:  Purchaser's specific requirements**
**Schedule B:  Guarantees and technical particulars of equipment offered**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| **10.5** | **TECHNICAL DETAIL FOR A TRANSFORMER AUTOMATIC VOLTAGE REGULATOR (AVR).** | | |
| | Manufacturer | State | |
| | Type | State | |
| | **Minimum Functionality** | | |
| 10.5.1 | DigSilent StationWare settings file | State | |
| 10.5.2 | Three Phase Over-current and Under-voltage Blocking | Yes | |
| 10.5.3 | Line Voltage Drop Compensation | Yes | |
| 10.5.4 | Tap Position Indication | Yes | |
| 10.5.5 | Transformer Paralleling Control. | State | |
| 10.5.6 | Ohm, BCD, mA tap-changer inputs | Yes | |
| 10.5.7 | Local and remote Tap Change Control | Yes | |
| 10.5.8 | Definite and Inverse Time Voltage Control Characteristic | State | |
| 10.5.9 | External Blocking Input | State | |
| 10.5.10 | User programmable logic | State | |
| 10.5.11 | Minimum Number of Indication LED's | State | |
| 10.5.12 | Minimum Programmable Signal Output Relays | State | |
| 10.5.13 | Minimum Number of Binary Inputs | >=6 | |
| 10.5.14 | Rear Data Communication ports for remote engineering access and DNP3.0 and IEC60870,  RS485/ ETHERNET/ RS232 | State | |
| 10.5.15 | Front Local Data Communication Port RS232 / USB | State | |
| 10.5.16 | Internal clock synchronization - | State | |
| 10.5.17 | Relay casing material | Steel or Aluminium | |
| 10.5.18 | Internal hardware and Software Supervision | Yes | |
| | **Technical Details** | | |
| 10.5.19 | Selectable Voltage Input (Un) | 110V | |
| 10.5.20 | Continuous Voltage Withstand | State | |
| 10.5.21 | Rated Frequency (fn) | 50Hz | |
| 10.5.22 | Rated Current (In) | 1A or 5A | |
| 10.5.23 | Thermal Current Withstand: Continuous | State | |
| 10.5.24 | Thermal Current Withstand: 10s | State | |

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|------|------------|------------|------------|
| 10.5.25 | Thermal Current Withstand: 1s | State | |
| 10.5.26 | Input Impedance: (In = 1A) | State | |
| 10.5.27 | Output Contact Rated Voltage | 110V or 230V ac/dc | |
| 10.5.28 | Control/ Signal Contact Thermal Withstand capability: Continuous | State | |
| 10.5.29 | Control/ Signal Contact Thermal Withstand Capability: 3s | State | |
| 10.5.30 | Control/ Signal Contact Thermal Withstand Capability: 0.5s | State | |
| 10.5.31 | Binary Input Voltage Range | 110V or 220V dc | |
| 10.5.32 | Rated Auxiliary Supply Voltage | 110V or 220V dc | |
| 10.5.33 | Rated Auxiliary Supply Voltage Operation Range | 80% - 120% | |
| 10.5.34 | Maximum Power Consumption | State | |

**Note: Ticks, Cross [√, X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.**

Tender Number: _____

Tenderer's Authorised Signatory: _____

Name in block letters          Signature

Full name of company: _____

## ANNEXURE C - STBYEF – TECHNICAL SCHEDULES

**Schedule A: Purchaser's specific requirements**
**Schedule B: Guarantees and technical particulars of equipment offered**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| **10.6** | **TECHNICAL DETAIL FOR STRANDBY EARTH FAULT RELAY (STBYEF).** | | |
| | Manufacturer | State | |
| | Type | State | |
| | **Minimum Functionality** | | |
| 10.6.1 | DigSilent StationWare settings file | State | |
| 10.6.2 | EF and SEF over current protection | Yes | |
| 10.6.3 | Internal hardware and Software Supervision | Yes | |
| 10.6.4 | Minimum Programmable Heavy Duty Output Relays | >=2 | |
| 10.6.5 | Minimum Programmable Signal Output Relays | >=2 | |
| 10.6.6 | Minimum Number of Binary Inputs | >=2 | |
| 10.6.7 | User programmable logic | State | |
| 10.6.8 | Minimum Number of Indication LED's | State | |
| 10.6.9 | Rear Data Communication ports for remote engineering access and DNP3.0 and IEC60870, RS485/ ETHERNET/ RS232 | State | |
| 10.6.10 | Front Local Data Communication Port RS232 / USB | State | |
| 10.6.11 | Internal clock synchronization | State | |
| 10.6.12 | Relay casing material | Steel or Aluminium | |
| 10.6.13 | Internal hardware and Software Supervision | Yes | |
| | **Technical Details** | | |
| 10.6.14 | Password protection | State | |
| 10.6.15 | Breaker Fail protection | State | |
| 10.6.16 | Rated Current (In) | 1A or 5A | |
| 10.6.17 | Rated Current of SEF Element (In) | 0.2A or 1A | |
| 10.6.18 | Thermal Current Withstand: Continuous | State | |
| 10.6.19 | Thermal Current Withstand: Continuous for SEF input | State | |
| 10.6.20 | Thermal Current Withstand: 1s | State | |
| 10.6.21 | Input Impedance: (In = 1A) | State | |
| 10.6.22 | Output Contact Rated Voltage | 110/230V ac/dc | |
| 10.6.23 | Power/ Signal Contact Thermal Withstand capability: Continuous | State | |

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| 10.6.24 | Power/ Signal Contact Thermal Withstand capability: 0.5s | State | |
| 10.6.25 | Binary Input Voltage Range | 30V or 110 or 220V dc | |
| 10.6.26 | Rated Auxiliary Supply Voltage | 30V or 110 or 220V dc | |
| 10.6.27 | Rated Auxiliary Supply Voltage Operation Range | 80% - 120% | |
| 10.6.28 | Fault recording with a minimum of 4 waveform records | Yes | |
| 10.6.29 | Sequential event recording with a minimum of 100 time tagged events | Yes | |
| 10.6.30 | CTs terminals connection type | Ring or Flat | |
| 10.6.31 | Maximum Power Consumption | State | |

**Note: Ticks, Cross [√, X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.**

Tender Number: _____

Tenderer's Authorised Signatory: _____

 Name in block letters          Signature

Full name of company: _____

## ANNEXURE C – LO1 & LO2 & MTR – TECHNICAL SCHEDULES

**Schedule A: Purchaser's specific requirements**
**Schedule B: Guarantees and technical particulars of equipment offered**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| **10.7** | **TECHNICAL DETAIL FOR A LOCKOUT AND MASTER TRIP (LO1 & LO2 & MTR) ELECTROMECHANICAL RELAY** | | |
| | Manufacturer | State | |
| | Type | State | |
| | **Minimum Functionality** | | |
| 10.7.1 | Mechanically Latched contacts | Yes | |
| 10.7.2 | Flagged Indication | Yes | |
| 10.7.3 | Hand Reset contacts | Yes | |
| 10.7.4 | Number of Power Normally open Contacts | >=3 | |
| 10.7.5 | Number of Power Normally closed Contacts | >=3 | |
| 10.7.6 | Instantaneous coil break contact | Yes | |
| | **Technical Details** | | |
| 10.7.7 | Maximum Operation time | State | |
| 10.7.8 | Rated Supply Voltage | 30V or 110V or 220V dc | |
| 10.7.9 | Rated Supply Voltage Operation Range | 80% - 120% | |
| 10.7.10 | Output Contact Rated Voltage | 110V or 230V ac/dc | |
| 10.7.11 | Contact dc current continuous capability | State | |
| 10.7.12 | Contact dc current 3 second capability | State | |
| 10.7.13 | Contact dc current Breaking capability: resistive/inductive | State | |
| 10.7.14 | Capacitive discharge immunity | State | |
| 10.7.15 | CTs terminals connection type | Ring or Flat | |
| 10.7.16 | Maximum Power Consumption | State | |
| 10.7.17 | Maximum relay dimensions in mm (width, height, depth) | 300, 300, 300 | |

**Note: Ticks, Cross [√, X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.**

Tender Number: _____

Tenderer's Authorised Signatory: _____
             Name in block letters       Signature

Full name of company: _____

# ANNEXURE C – TAUX – TECHNICAL SCHEDULES

**Schedule A:  Purchaser's specific requirements**
**Schedule B:  Guarantees and technical particulars of equipment offered**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|------|-------------|------------|------------|
| 17 | **TECHNICAL DETAIL FOR A TRIP AUXILIARY RELAY (TAUX).** | | |
| | Manufacturer | State | |
| | Type | State | |
| 17.1 | **Minimum Functionality** | | |
| | Flagged Indication hand reset | Yes | |
| | Self - Reset contacts | Yes | |
| | Number of Power Normally open Contacts | 10/20 | |
| | High burden | Yes | |
| 17.2 | **Technical Details** | | |
| | Maximum Operation time | <15ms | |
| | Rated Supply Voltage | 32/110/220V dc | |
| | Rated Supply Voltage Operation Range | 80% - 120% | |
| | Output Contact Rated Voltage | 300V ac/dc | |
| | Contact dc current continuous capability | 1250W | |
| | Contact dc current 3 second capability | 7500W | |
| | Contact dc current Breaking capability: resistive/inductive | 100W/50W | |
| | Capacitive discharge immunity | 10µF @ rated voltage | |
| | All terminals connection type | Ring | |
| | Maximum relay dimensions in mm (width, height, depth) | 220, 200, 250 | |
| | Maximum Power Consumption | State | |

**Note: Ticks, Cross [√, X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.**

Tender Number: _____

Tenderer's Authorised Signatory: _____
                          Name in block letters                Signature

Full name of company: _____

# ANNEXURE C – ALA – TECHNICAL SCHEDULES

**Schedule A:  Purchaser's specific requirements**
**Schedule B:  Guarantees and technical particulars of equipment offered**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|------|-------------|------------|------------|
| **18** | **TECHNICAL DETAIL FOR AN ALARM ANNUNCIATOR (ALA).** | | |
| | Manufacturer | State | |
| | Type | State | |
| **18.1** | **Minimum Functionality** | | |
| | Programmable NO / NC Alarm channel activation | Yes | |
| | Integral user configurable alarm labels | Yes | |
| **18.2** | **Technical Details** | | |
| | Minimum Number of Alarm Inputs | 8 | |
| | Minimum Number of Alarm LED's | 8 | |
| | Binary Input Voltage Range | 110/220V dc ±20% | |
| | Rated Supply Voltage | 110/220V dc | |
| | Rated Supply Voltage Operation Range | 80% - 120% | |
| | Maximum unit dimensions in mm (width, height, depth) | 150x200x180 | |
| | All terminal connection type | Ring | |
| | Maximum Power Consumption | State | |
| | | | |

**Note: Ticks, Cross [√, X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.**

Tender Number: _____

Tenderer's Authorised Signatory: _____
                                      Name in block letters          Signature

Full name of company: _____

## ANNEXURE C – INTSP and INTRP – TECHNICAL SCHEDULES

**Schedule A:  Purchaser's specific requirements**
**Schedule B:  Guarantees and technical particulars of equipment offered**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| 19 | **TECHNICAL DETAIL FOR AN INTERTRIP SEND AND RECEIVE PILOT WIRE RELAY (INTSP and INTRP).** | | |
| | Manufacturer | State | |
| | Type | State | |
| 19.1 | **Minimum Functionality** | | |
| | Insulation rating | 15kV RMS | |
| | Impulse rating | 1.2/50 5kV | |
| | AC immunity of receive element | 300V @ 50Hz | |
| | Operate time at nominal DC voltage | <30ms | |
| | Hand reset operation flag annunciation | Yes | |
| | Minimum Heavy Duty Tripping Output contacts (self-reset) | 4 | |
| | Relay casing material | Steel or Aluminium | |
| 19.2 | **Technical Details** | | |
| | Rated Frequency (fn) | 50Hz | |
| | Output Contact Rated Voltage | 250V ac/dc | |
| | Contact Thermal Withstand capability: Continuous | 12A | |
| | Contact Thermal Withstand capability: 0.5s | 30A | |
| | Contact Thermal Breaking capability: L/R = 40ms @ 125VDC | 0.4A | |
| | Binary Input Voltage Range | 110V DC±20% | |
| | Rated Auxiliary Supply Voltage | 110V dc | |
| | Rated Auxiliary Supply Voltage Operation Range | 80% - 120% | |
| | All terminal connection type | Ring | |
| | Maximum Power Consumption | State | |
| | Maximum relay dimensions in mm (width, height, depth) | 120,180,300 | |

**Note: Ticks, Cross [√, X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.**

Tender Number: _____

Tenderer's Authorised Signatory: _____

Name in block letters          Signature

Full name of company: _____

## ANNEXURE C – INTSF and INTRF – TECHNICAL SCHEDULES

**Schedule A:  Purchaser's specific requirements**
**Schedule B:  Guarantees and technical particulars of equipment offered**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| 20 | **TECHNICAL DETAIL FOR AN INTERTRIP SEND AND RECEIVE FIBRE OPTIC RELAY (INTSF and INTRF).** | | |
| | Manufacturer | State | |
| | Type | State | |
| 20.1 | **Minimum Functionality** | | |
| | Signal transfer time with direct fibre connection | <20ms | |
| | Hand reset operation flag annunciation | Yes | |
| | Minimum no. of independent communication channels | 8 | |
| | Minimum Heavy Duty Tripping Output contacts per channel (self-reset) | 1 | |
| | Minimum binary inputs per channel | 1 | |
| | Hardware Self-diagnosis and alarm | Yes | |
| | Communication channel self-diagnosis and alarm | Yes | |
| | Relay casing material | Steel or Aluminium | |
| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
| 20.2 | **Technical Details** | | |
| | LED's for each input and output activation | Yes | |
| | Output Contact Rated Voltage | 250V ac/dc | |
| | Contact current continuous capability | 6A | |
| | Contact current making capability | 30A | |
| | Contact current Breaking capability: L/R = 40ms @ 125VDC | 0.3A | |
| | Binary Input Voltage Range | 110/220 V dc | |
| | Rated Auxiliary Supply Voltage | 110 - 220 V dc | |
| | Rated Auxiliary Supply Voltage Operation Range | 80% - 120% | |
| | All terminal connection type | Ring | |
| | Maximum Power Consumption | State | |

**Note: Ticks, Cross [√, X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.**

Tender Number: _____

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                           Name in block letters                Signature

Full name of company: _____

# ANNEXURE C – MFST – TECHNICAL SCHEDULES

**Schedule A: Purchaser's specific requirements**
**Schedule B: Guarantees and technical particulars of equipment offered**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| 21 | **TECHNICAL DETAIL FOR A MULTI FUNCTION SCADA TRANSDUCER (MFST).** | | |
| | Manufacturer | State | |
| | Type | State | |
| 21.1 | **Minimum Functionality** | | |
| | Measurement selection single phase | V, I, F, P, Q, S, , Tan φ, Cos φ | |
| | Measurement selection 3 phase, three/four wire unbalanced | V1 V2 V3, U12 U23 U31, I1 I2 I3, F, P1 P2 P3 Pt, Q1 Q2 Q3 Qt, S1 S2 S3 St, Tan φ, Cos(φ1 φ2 φ3 φt), φ1 φ2 φ3 φt, φ (U12/U23, U23/U31, U31/U12), φ(V1/V2, V2/V3, V3/V1) | |
| | Accuracy Class | 0.5 | |
| | Analog outputs | 1 to 4 | |
| | Current Inputs | 1A and 5A | |
| | Voltage Inputs | 100 to 480 V (ph-ph) or 100/√3 to 480/√3 V (ph-N) | |
| | Operating Frequency | 50Hz | |
| | Mounting | Plate mounted with screws | |
| | Data Communication port for engineering access RS485/ ETHERNET | Yes | |
| 21.2 | **Technical Details** | | |
| | Analogue outputs (Io = output current) | | |
| | Analog output range | ± 1 mA, ± 5 mA, ± 20 mA, ± 1V, ± 10V selectable | |
| | Acceptable resistive load | 15V/Io | |
| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
| | Acceptable capacitive load | 0.1microfarad | |
| | Overrun | 1.2xIo | |
| | Peak to peak residual wave | +/-0.2% of Io | |
| | Programmable response time and accuracy (as per IEC60688) | 100ms (class 0.5) | |
| | Transfer curve (selectable) | Linear (2 slope) | |

| | | | |
|---|---|---|---|
| | Current Input (In = Nominal Current) | | |
| | Rated value | 0 to 10A max | |
| | Max measured current on primary | 25000A | |
| | Acceptable overload | 50xIn for 1 sec | |
| | Burden | <0.15VA | |
| | Voltage Input | | |
| | Rated value | 57.7Vac to 480Vac for 3 phase 57.7Vac to 276Vac for single phase | |
| | Frequency | 42.5 ….. 57.5 Hz | |
| | Max measured voltage on primary | 650 kV (ph-ph) | |
| | Acceptable overloads | 520Vac continuous, 800Vac for 10 sec for 3 phase 300Vac continuous, 460Vac for 10 sec for single phase | |
| | Burden | <0.2A | |
| | Input impedance | 400kohm | |
| | **Auxiliary power supply** | | |
| | Rated Auxiliary Supply Voltage Operation Range | 20 to 50 V dc and 80 to 265 V dc | |
| | All terminal connection type | Mobile stirrup clamp with connection screw | |
| | Maximum relay dimensions in mm (width, height, depth) | 120,90,125 | |
| | | | |
| | Maximum Power Consumption | State | |

**Note: Ticks, Cross [√, X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.**

Tender Number: _____

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Full name of company: _____

## ANNEXURE C – DIFFC – TECHNICAL SCHEDULES

**Schedule A: Purchaser's specific requirements**
**Schedule B: Guarantees and technical particulars of equipment offered**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| **22** | **TECHNICAL DETAIL FOR A CIRCULATING CURRENT RELAY (DIFFC).** | | |
| | Manufacturer | State | |
| | Type/Model | State | |
| **22.1** | Minimum Functionality | | |
| | DigSilent StationWare settings file | Yes | |
| | Multiple element over-current protection | Yes | |
| | Multiple element earth fault protection | Yes | |
| | Sensitive earth fault protection | Yes | |
| | Breaker Fail protection | Yes | |
| | 3 stage under frequency protection | Yes | |
| | Breaker $I^2t$ condition monitoring | Yes | |
| | Internal trip timer (CB opening time) with alarm output | Yes | |
| | Fault waveform recording with a minimum of 4 records | Yes | |
| | Sequential event recording with a minimum of 100 events | Yes | |
| | Multi shot Auto Re-close | Yes | |
| | Trip circuit supervision | 2 circuits | |
| | 3 phase current display on LCD. | Yes | |
| | Internal hardware and Software Supervision | Yes | |
| | Minimum Programmable Heavy Duty Tripping Output Relays | 2 | |
| | Minimum Programmable Signal Output Relays | 6 | |
| | Minimum Number of Binary Inputs | 6 | |
| | Minimum number of user programmable and configurable indication LED's | 6 | |
| | User programmable logic | Yes | |
| | Rear Data Communication ports for remote engineering access and DNP3.0 and IEC60870, RS485/ ETHERNET/ RS232 | Yes | |
| | Front Local Data Communication Port RS232 / USB | Yes | |
| | Internal clock synchronization - demodulated IRIG-B (non BNC external connector) | IRIG-B122 | |
| | Relay casing material | Steel or Aluminium | |
| **22.2** | **Technical Details** | | |
| | Number of Current Inputs | 4 | |
| | Rated Frequency (fn) | 50Hz | |
| | Rated Current (In) | Dual 1A or 5A | |
| | Thermal Current Withstand: Continuous | 4 x In | |

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|------|-------------|------------|------------|
| | Thermal Current Withstand: Continuous for In = 0.2A | 7.5 x In | |
| | Thermal Current Withstand: 1s | 100 x In | |
| | Input Impedance: (In = 1A) | < 1VA | |
| | Output Contact Rated Voltage | 250V AC/DC | |
| | Power/ Signal Contact Thermal Withstand capability: Continuous | 5A | |
| | Power/ Signal Contact Thermal Withstand capability: 3s | 15A/8A | |
| | Power/ Signal Contact Thermal Withstand capability: 0.5s | 30A/10A | |
| | Power Contact Thermal Breaking capability: L/R = 40ms @ 110VDC | 0.2 A or 30 W | |
| | Binary Input Voltage Range | 30 – 110 V dc | |
| | Rated Auxiliary Supply Voltage | 30 – 110 V dc | |
| | Rated Auxiliary Supply Voltage Operation Range | 80% - 120% | |
| | All terminals connection type | Ring | |
| | Maximum relay dimensions in mm (width, height, depth) | 150, 270, 250 | |
| | Maximum Power Consumption | State | |

**Note: Ticks, Cross [√, X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.**

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                                   Name in block letters          Signature

Full name of company: _____

# ANNEXURE C – TAUX – TECHNICAL SCHEDULES

**Schedule A: Purchaser's specific requirements**
**Schedule B: Guarantees and technical particulars of equipment offered**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| 23 | **TECHNICAL DETAIL FOR A DC VOLTAGE MONITORING RELAY (DCVMR )** | | |
| | Manufacturer | State | |
| | Type/Model | State | |
| 23.1 | **Minimum Functionality** | | |
| | Monitoring function | Under-voltage monitoring | |
| | Operating principle | Output contact relays energize if the measured value falls below the adjusted threshold value and the timer times-out. | |
| 23.2 | **Technical Details** | | |
| | Measuring inputs pulse rating t < 1 s | 600 V | |
| | Measuring inputs continuous rating | 300 V | |
| | Threshold pickup setting value | Adjustable within the selected measuring range. | |
| | Accuracy within the control supply voltage tolerance. | ≤ 1 % | |
| | Contact outputs* | 2 x change over | |
| | Contact output rating* | 250 V DC | |
| | Contact output current rating * | 6 A continuous 30 A make 100 A for 1 s | |
| | Contact output break capacity * | 250 V, 0.2 A, L/R = 40ms | |
| | Rated control supply voltage | 24-240V AC/DC | |
| | Rated control supply voltage tolerance | -15...+10 % | |
| | Connection Type | Screw Terminals | |
| | Selectable measuring ranges | Yes | |
| | Measuring range A | 20-60 V DC | |
| | Measuring range B | 60-250 V DC | |
| | Mounting. | DIN rail (IEC 60715) | |
| | Operating delay time | 1 to 30 s adjustable | |
| | Ambient operating temperature | -20...+60 °C | |
| | Transient overvoltage protection | Yes | |
| | Rated frequency | 50 Hz | |
| | Wire connection size with ferrule | 1 x 1.5 mm² flexible wire | |
| | Settings tamper protection | Password or | |

| | | | |
|---|---|---|---|
| | | sealable clear cover | |
| | Status indication LED's | 3 | |
| | Product Standard: | IEC 60255-6 | |
| | a.Low Voltage Directive | 2006/95/EC | |
| | b.EMC Directive | 2004/108/EC | |
| | c.RoHS Directive | 2002/95/EC | |
| | Vibration (sinusoidal) (IEC 60255-21-1) | class 2 | |
| | Shock (IEC 60255-21-2) | class 2 | |
| | Interference immunity | IEC 61000-6-2 | |
| | Interference immunity to electrostatic discharge. | IEC 61000-4-2, Level 3 | |
| | Interference immunity to radiated, radio-frequency, electromagnetic field. | IEC 61000-4-3, Level 3 | |
| | Interference immunity to electrical fast transient / burst. | IEC 61000-4-4, Level 3 | |
| | Interference immunity to surge. | IEC 61000-4-5, Level 3 | |
| | Interference immunity to conducted disturbances, induced by radio-frequency fields. | IEC 61000-4-6, Level 3 | |
| | Rated insulation voltage (IEC 60947-1, IEC 60255-5) supply / measuring circuit / outputs. | 600 V | |
| | Rated insulation voltage (IEC 60947-1, IEC 60255-5) supply / outputs. | 250 V | |
| | Rated impulse withstand voltage Uimp (IEC 60947-1, IEC 60255-5) supply / measuring circuit / outputs. | 6 kV 1.2/50 µs | |
| | Rated impulse withstand voltage (IEC 60947-1, IEC 60255-5) supply / outputs. | 4 kV 1.2/50 µs | |
| | Pollution degree (IEC 60255-5). | 3 | |
| | Overvoltage category (VDE 0110, IEC 664, IEC/EN 60255-5). | III | |
| | Interference emission. | IEC 61000-6-3 | |
| | Interference emission high-frequency radiated. | IEC 22, Class B | |
| | Interference emission high-frequency conducted. | IEC 22 | |
| | Maximum Power Consumption | State | |

\* If the DCVMR output contacts cannot meet the minimum requirements, then an auxiliary relay may be supplied to meet the specification.

**Note: Ticks, Cross [√, X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.**

Tender Number: _____

Tenderer's Authorised Signatory: _____
                                   Name in block letters         Signature

Full name of company: _____

## ANNEXURE C – MAINFO – TECHNICAL SCHEDULES

**Schedule A: Purchaser's specific requirements**
**Schedule B: Guarantees and technical particulars of equipment offered**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| **10.23** | **TECHNICAL DETAIL FOR A MULTI PURPOSE MAIN FEEDER RELAY (MAINFO).** | | |
| | Manufacturer | State | |
| | Type/Model | State | |
| | **Minimum Functionality** | | |
| 10.23.1 | DigSilent StationWare settings file | State | |
| 10.23.2 | Phase Segregated Differential protection | Yes | |
| 10.23.3 | Single Mode 1300nm fibre optic connections | Yes | |
| 10.23.4 | Inter-trip Commands Across Communication Channel | Yes | |
| 10.23.5 | Internal CT Ratio Correction | Yes | |
| 10.23.6 | Multiple element directional and non-directional over-current protection | Yes | |
| 10.23.7 | Multiple element directional and non-directional earth fault protection | Yes | |
| 10.23.8 | Sensitive earth fault protection Note: This functionalitycan be provided as a separate relay: if so then– see STBYEF relayand compete STBYEF technical schedule) | Yes | |
| 10.23.9 | LCD Display Interface | Yes | |
| 10.23.10 | Password protection | Yes | |
| 10.23.11 | Breaker Fail protection | Yes | |
| 10.23.12 | Internal trip timer (CB opening time) with alarm output ( Element or Logics) | Yes | |
| 10.23.13 | Fault waveform recording with a minimum of 4 records | Yes | |
| 10.23.14 | Sequential event recording with a minimum of 100 events | Yes | |
| 10.23.15 | Trip circuit supervision | Yes | |
| 10.23.16 | 3 phase maximum demand power, three phase real power, apparent power and power factor display on LCD. | Yes | |
| 10.23.17 | Internal hardware and Software Supervision | Yes | |
| 10.23.18 | Minimum Programmable Heavy Duty Tripping Output Relays | >=2 | |
| 10.23.19 | Minimum Programmable Signal Output | >=4 | |
| 10.23.20 | Minimum Number of Binary Inputs | >=6 | |
| 10.23.21 | Minimum number of user programmable and configurable indication LED's | State | |
| 10.23.22 | User programmable logic | Yes | |
| 10.23.23 | Rear Data Communication ports for remote engineering access and DNP3.0 over  RS485/ ETHERNET/ RS232 | State | |
| 10.23.24 | Front Local Data Communication Port RS232 / USB | State | |
| 10.23.25 | Internal clock synchronization | Yes | |
| 10.23.26 | Relay casing material | Steel or Aluminium | |
| | **Technical Details** | | |
| 10.23.27 | Number of Voltage Inputs | (three) | |
| 10.23.28 | Rated Voltage Input (Un) | 110V | |

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| 10.23.29 | Rated Voltage Withstand: Continuously | State | |
| 10.23.30 | Number of Current Inputs | >=4 | |
| 10.23.31 | Rated Frequency (fn) | 50Hz | |
| 10.23.32 | Rated Current (In) | 1A or 5A | |
| 10.23.33 | Thermal Current Withstand: Continuous | State | |
| 10.23.34 | Thermal Current Withstand: Continuous for In = 0.2A | State | |
| 10.23.35 | Thermal Current Withstand: 1s | State | |
| 10.23.36 | Input Impedance: (In = 1A) | State | |
| 10.23.37 | Output Contact Rated Voltage | 110V or 230V ac/dc | |
| | Power/ Signal Contact Thermal Withstand capability: Continuous | State | |
| | Power/ Signal Contact Thermal Withstand capability: 3s | State | |
| | Power/ Signal Contact Thermal Withstand capability: 0.5s | State | |
| | Power Contact Thermal Breaking capability: L/R = 40ms @ 110VDC | State | |
| | Binary Input Voltage Range | 30V or 110V dc | |
| | Rated Auxiliary Supply Voltage | 30V or 110V dc | |
| | Rated Auxiliary Supply Voltage Operation Range | 80% - 120% | |
| | CTs terminals connection type | Ring or Flat | |
| | Maximum relay dimensions in mm (width, height, depth) | 300, 300, 300 | |
| | Maximum Power Consumption | State | |
| | | | |

**Note: Ticks, Cross [√, X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.**

Tender Number: _____

Tenderer's Authorised Signatory: _____

                        Name in block letters            Signature

Full name of company: _____

## ANNEXURE C – RADIALF – TECHNICAL SCHEDULES

**Schedule A: Purchaser's specific requirements**
**Schedule B: Guarantees and technical particulars of equipment offered**

| ITEM | DESCRIPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| **10.24** | **TECHNICAL DETAIL FOR A RADIAL FEEDER RELAY (RADIALF).** | | |
| | Manufacturer | State | |
| | Type/Model | State | |
| | **Minimum Functionality** | | |
| | DigSilent StationWare settings file | State | |
| | Multiple element over-current protection | Yes | |
| | Multiple element earth fault protection | Yes | |
| | Sensitive earth fault protection Note: This functionalitycan be provided as a separate relay: if so then– see STBYEF relayand compete STBYEF technical schedule) | Yes | |
| | LCD Display Interface | Yes | |
| | Password protection | Yes | |
| | Breaker Fail protection | Yes | |
| | Internal trip timer (CB opening time) with alarm output (element or logics) | Yes | |
| | Fault waveform recording with a minimum of 4 records | Yes | |
| | Sequential event recording with a minimum of 100 events | Yes | |
| | Trip circuit supervision | Yes | |
| | 3 phase current display on LCD. | Yes | |
| | Internal hardware and Software Supervision | Yes | |
| | Minimum Programmable Heavy Duty Tripping Output Relays | >=2 | |
| | Minimum Programmable Signal Output Relays | >=4 | |
| | Minimum Number of Binary Inputs | >=6 | |
| | number of user programmable and Nonfigurable indication LED's | State | |
| | User programmable logic | Yes | |
| | Rear Data Communication ports for remote engineering access and DNP3.0 over RS485/ ETHERNET/ RS232 | State | |
| | Front Local Data Communication Port RS232 / USB | State | |
| | Internal clock synchronization | Yes | |

# SPECIFICATION FOR PROTECTION RELAYS

| | DESCRPTION | SCHEDULE A | SCHEDULE B |
|---|---|---|---|
| | Relay casing material | Steel or Aluminium | |
| | **Technical Details** | | |
| | Number of Current Inputs | >=4 | |
| | Rated Frequency (fn) | 50Hz | |
| | Rated Current (In) | 1A or 5A | |
| | Thermal Current Withstand: Continuous | State | |
| | Thermal Current Withstand: Continuous rating | State | |
| | Thermal Current Withstand: 1s | State | |
| | Input Impedance: (In = 1A) | State | |
| | Output Contact Rated Voltage | 110V or 230V ac/dc | |
| | Power/ Signal Contact Thermal Withstand capability: Continuous | State | |
| | Power/ Signal Contact Thermal Withstand capability: 3s | State | |
| | Power/ Signal Contact Thermal Withstand capability: 0.5s | State | |
| | Power Contact Thermal Breaking capability: L/R = 40ms @ 110VDC | State | |
| | Binary Input Voltage Range | 30V or 110V dc | |
| | Rated Auxiliary Supply Voltage | 30V or 110V dc | |
| | Rated Auxiliary Supply Voltage Operation Range | 80% - 120% | |
| | CTs terminals connection type | Ring or Flat | |
| | Maximum relay dimensions in mm (width, height, depth) | 300, 300, 300 | |
| | Maximum Power Consumption | State | |

**Note: Ticks, Cross [√, X], Astrick [*], Word [Noted] or TBA ["To Be Advice"] will not be accepted.**

Tender Number: _____

Tenderer's Authorised Signatory: _____

                                Name in block letters            Signature

Full name of company: _____

## Items – PROTECTION EQUIPMENT
## Deviation schedule

| Any deviations offered to this specification shall be listed below with reasons for deviation. In addition, evidence shall be provided that the proposed deviation will at least be more cost-effective than that specified by City Power. | | |
|---|---|---|
| **Item** | **Sub clause of CP_TSSPEC_214** | **Proposed deviation** |
| | | |

Tender Number: _____

Tenderer's Authorised Signatory: _____

                                   Name in block letters         Signature

Full name of company: _____