2. SCOPE OF WORK:

2.1 This scope of work covers Transnet Ports Terminals specific requirements regarding the protection testing to be performed in the high voltage substations associated with the electrical network in the Port of Durban.

2.1.1 **The following substation equipment falls under the ambit of this scope of work. Relays may be of the static or electronic programmable type: -**

- Voltage transformer
- Over current and earth fault relays
- Differential relays
- Cable differential relays
- Current Transformers (Protection and Metering)
- GE UR35 Multi-feeder Protection Directional relays,
- Frame leakage
- ARC Detection relays ABB, Vamp
- High Differential Bus bar Blocking
- Panel indication meters
- Transformer protection
- Batteries and battery chargers
- Power factor and harmonic filters
- High voltage switchgear panels and circuit breakers (oil, Vacuum and SF6)
- Distribution transformers
- Low voltage switchgear
- Cables (XLPE and Paper insulated)

2.1.2 **The work shall be as per the scope of work. This shall include but not be restricted to: -**

- Calibration and/or programming of protection relays.
- Switchboard commissioning testing and verification of settings programmed into protection relays.
- Substation testing; and functionality testing of substation protection equipment.

3.0 MINIMUM TESTING REQUIREMENTS FOR SUBSTATION EQUIPMENT

3.1 Unless otherwise agreed, the following minimum tests shall be carried out and recorded. If any clarity is required, the relay manufacturers recommended test method shall be implemented. Where possible all current transformer ratio settings and protection settings shall be recorded prior to the actual test.

3.2.1 **Current Transformers (CT's)**

- Polarity check. Ensure that the CT is de-magnetised after test.
- Ratio check
- Magnetisation curve. A minimum of 5 points shall be plotted. The actual values (voltage versus current) as well as a graph clearly indicating the knee point or saturation flux level shall be produced on the report.

3.2.2 **Voltage Transformer Test**

- Polarity check
- Ratio check
- Phasing check

3.2.3 **Overcurrent and Earth Fault Relays**

- All testing shall be carried out with the plug multiple setting (PMS) set on 100% and the time multiple setting (TMS) set on 1.
- All relay alarm messages and/or indications shall be recorded
- Check pickup value
- Check drop-out value
- Check operating time by injecting 2 X threshold value into the relay by using at least 5 different values of current.
- The test sheet shall clearly indicate whether the relay complies with the relevant IEC curve type i.e. it shall indicate the IEC minimum maximum values as well as the actual values obtained.
- Instantaneous over current relays shall be measuring by injecting the minimum current that gives operation at each current setting.

- Sensitive earth fault relays shall be tested by injecting the minimum current that gives operation at each current setting.

3.2.4 **Differential Relays**

- When testing an unbiased differential relay, the secondary current shall be slowly raised until the relay operates. This shall be done at all the current settings and finally at the required setting.
- When testing a biased relay, current shall be injected into one biased coil and out of the operating coil. In addition to this, a check shall be made of at least two points on the bias characteristic.

3.2.5 **Pilot Wire**

- The overall fault-setting of the relay shall be checked by injecting into each phase in turn i.e. Red – Earth; Yellow – Earth; Blue – Earth; Red – Yellow; Blue – Yellow; Red - Blue
- Check system stability on a through fault
- Test Pilot Cable insulation resistance of all cores and to earth
- Test Pilot Cable loop resistance
- If necessary, add pilot loop resistors as per manufacturer's Recommendations.

3.2.6 **Directional Relays**

- Use a phase shifting transformer, which will permit the phase angle of the relay voltage to be varied with respect to the relay current, enabling the directional characteristic and maximum torque angle of the relay to be tested. The relay shall be tested as a standard inverse time relay with directional properties for both current and voltage

3.2.7 **Frame Leakage**

- Test resistance measurement of each protected zone; Zone 1 – Ground; Zone 2 – Ground; Zone 3 – Ground etc.; Zone 1- Zone 2; Zone 2 – Zone 3 etc.; First Zone – last Zone
- Test operation of protection relay by injecting current until it operates at the correct value.
- Ensure correct tripping sequence.

3.2.8 **Restricted Earth Fault**

- The sensitivity of this system shall be checked by injecting current through each of the main current transformers in turn. During this test the voltage across the relay coil and stabilising resistance shall be recorded.
- The stability of the scheme shall be tested by injecting through the neutral current transformer and each phase current transformer in turn.
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3.2.9 **Panel Meters**

- All panel meters shall be calibrated and have indication scales that align with the voltages, current etc. that they are required to display

3.2.10 **Bus bar Protection**

- The sensitivity and stability of the system shall be tested.

3.2.11 **Transformer Protection**

- Operate Bucholz Relay.
- Check alarm and trip circuits
- Operate Temperature Relay.
- Check alarm and trip circuits

3.2.12 **Battery Chargers**

- Carry out a battery load test. The following minimum test results shall be recorded
- The individual cell voltage before the test i.e. on charge
- The individual cell voltage after load test was completed i.e. off charge.
- Discharge voltage.
- A battery discharge curve indicating the battery voltage, load current and the lapsed time.
- Liquid crystal display unit and keypad for settings and local information on the unit.
- The CPU must have an integral surge suppression circuit, and the data transfer must be done via a photo optical communication system internal in the unit.
- The control power supply must be an isolated power supply unit.

4. GENERAL REQUIREMENTS:

4.1 Transnet Port Terminals will not consider any contracts offer that, in sole opinion of Transnet Port Terminals does not have adequate experience and /or adequate equipment to ensure quality in their work.

4.2 The buyer may be contacted should there be a need for other information.

4.3 Deliver certificates and reports within.

4.4 State validity period for all work performed.