



ELECTRICAL ENGINEERING

**SCOPE OF WORK AND SPECIFICATION FOR THE
PROTECTION ENGINEERING, PROTECTION TESTING, COMMISSIONING,
REPAIR AND EMERGENCY BREAKDOWN SERVICES
TO
HIGH VOLTAGE NETWORK PROTECTION AND SUBSTATION EQUIPMENT
AS AND WHEN REQUIRED IN THE PORT OF DURBAN**

SPECIFICATION NO. DHE HT_ST_01 - 06- 2021

THIS SPECIFICATION SUPERSEDES ALL OTHER ISSUES WITH SIMILAR TITLES

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

SECTION	CONTENTS	INDEX	PAGE	No.
1.	BRIEF SCOPE OF WORK		3	
1.1	GENERAL CONDITIONS		3	
2.	APPLICABLE STANDARDS AND SERVICE CONDITIONS		3	
3.	RESPONSIBILITY, CONTROL OF WORK		5	
4.	CONTRACT EXECUTION AND METHOD OF PAYMENT		6	
5.	ADMIN WORK ASSOCIATED WITH ROUTINE SUBSTATION SERVICES		7	
6.	WORKMANSHIP RELATING TO HIGH VOLTAGE SERVICES		7	
7.	GENERAL REQUIREMENTS AND PRECAUTIONS FOR PROVISION OF THE "SERVICES" TO THE "EQUIPMENT"		8	
8.	ACCESS TO SUBSTATIONS		9	
	ANNEXURE "A"; SCHEDULE OF REQUIREMENTS			
	ANNEXURE "B"; ORDER FORM			
	ANNEXURE "C"; SERVICES / WORKS ATTENDANCE REPORT			
	ANNEXURE "D"; SCHEDULE OF WORKS CARRIED OUT			
	ANNEXURE "E"; SCHEDULE OF QUANTITIES & RATES			
	ANNEXURE "F"; SCHEDULE OF RETURNABLE DOCUMENTATION			
	ANNEXURE "G"; TYPICAL COMMISSIONING TEST			
	ANNEXURE "H"; SCHEDULE OF DRAWINGS			
	ANNEXURE "I"; STATEMENT OF COMPLIANCE			
	ANNEXURE "J"; WORK ON TRANSNET NATIONAL PORT AUTHORITY ELECTRICAL EQUIPMENT AND/OR IN SUBSTATIONS			
	ANNEXURE "K"; SUBSTATION TESTING PHILOSOPHY & GUIDELINES			
	ANNEXURE "L"; PRE – QUALIFYING AND TECHNICAL EVALUATION CRITERIA			

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

1.0 BRIEF SCOPE OF WORK

The Port of Durban and the old Durban International airport have a number of HV substations and mini-substations operating on three different voltages these being 33, 11 and 6.6 kV. The following services are required for those substations for a thirty six (36) month period.

Protection engineering, protection testing, commissioning, repair and emergency breakdown services

The old Durban International airport substations are now under the control of the Port of Durban electrical department and are automatically included when the Port of Durban substations are mentioned in this document.

The protection testing of the substations in the Port of Durban and at the old Durban International airport are not carried out on a continuous basis but rather on a scheduled basis over the thirty six (36) month period of the contract.

1.1 GENERAL CONDITIONS

1.1.1 Annexure's "A", "B", "C", "D", "E", "F", "G", "H", "I", "J", "K" and "L" form an integral part of this document. It is essential that all Annexures that are required to be completed and returned as part of this tender are signed. Failure to do so WILL preclude a tender from consideration.

1.1.2 Tenderers must indicate whether their tender complies completely with the requirements of this document, or if not, precisely how it differs. This information must be submitted at the time of tendering on Annexure I; "Statement of Compliance".

1.1.3 All documents forming part of the tender shall be firmly bound. No loose documents will be considered. Failure to comply with the above requirements may preclude a tender from consideration.

1.1.4 The transfer of protection engineering, protection testing and fault analysis skills to Transnet National Ports Authority (TNPA) electrical engineering staff is required during any protection engineering, testing or fault analysis work. The outcome of this skills transfer is that at least three TNPA Electrical Engineering personal will be able to undertake the following at the end of the contract.

- Develop protection schemes and settings for those schemes, for all protection systems used in the Port of Durban.
- Be able to setup and test the various protection relays used in the Port of Durban substations.
- Be able to download and conduct analysis of protection relay fault data.

1.1.5 The Professional Electrical Engineer required for the work to be undertaken as listed in this specification will be on site all times during the protection testing and will sign off all protection engineering, protection testing and fault analysis reports.

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

2.0 APPLICABLE STANDARDS AND SERVICE CONDITIONS

2.1 Standards

2.1.1 The following standards and specifications (the most recent addition) are applicable and may be used as a reference guide in the execution of the SERVICES.

SABS IEC 371; BS 3938	Current Transformers
SABS IEC 185; BS 3941	Voltage Transformers
SABS IEC 5227	Electrical Power Switchgear
SABS IEC 51	Measuring instruments
SABS IEC 255	Electrical Protection Relays
SABS BS 142	Standard voltages, currents
SABS 1019	Insulation levels for electricity supply
SABS 1299	Direct acting indicating electrical measuring instruments and their accessories
IEC PUBLICATION 56	High-voltage alternating current circuit breakers
IEC PUBLICATION 60	High-voltage test techniques
IEC PUBLICATION 129	Alternating current disconnectors (isolators) and earthing switches
IEC PUBLICATION 267	Guide to the testing of circuit breakers with respect to out-of-phase switching.
IEC PUBLICATION 298	HV metal enclosed switchgear and Control gear
BS 37	Electricity meters
BS 142	Electrical Protective relays
SANS 60067 - 1 2011	Power Transformers
SABS 10198 - 1 to 13 2004	Medium voltage cables
SABS 1029 - 2016	Mini-substations

2.1.2 The following Ethernet standard is applicable in the Port of Durban:

- Category 5 cable has been installed in all buildings around the Port.
- The system works with a 100/1000-multi-link switch on the input/output ports.
- The standard protocol is TCP/IP.
- Addresses used by the system are Class "A" or "B".
- All TNPA data communication is via a Giga bit ring using fiber optic cable as the means of data transportation.
- Windows 7 professional or enterprise operating system.
- Standard IP range used by Electrical Engineering are 10.0.4.0 contractor to arrange for IP allocation from TNPA, this will include gateway and domain rights allocation as well.

2.1.3 Where no specific rules, regulations, codes or requirements are contained in this specification nor covered by any of the above standards, the CONTRACTOR shall, in consultation with TNPA, adhere to Internationally accepted best engineering practices or the original manufacturers specification.

2.1.4 The following equipment represents a standardised list of products widely in use on the electrical network infrastructure in the Port of Durban :-

- Energy meters - Landis & Gyr
- Protection relays - GE UR F35 multiple feeder management relay, GE T60, GE L30 and GE G30.
- Differential pilot wire protection - SIEMENS Type 7SD600; only 5amp balancing transformer.

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

- Communication network switches – Ruggedized Cisco 16 way-switch with 100 gigabyte uplink capability
- Power factor protection – Strike Technologies REL 04B protection relay
- Power factor transducers - Various
- Arc detection - ABB and Vamp
- Harmonic 5th current Filters and PF banks manufactured by RWW and ABB
- Schneider M340 PLC

2.1.5 Service Conditions

The following service conditions are applicable in the port:

- | | |
|---------------------------|---|
| (i) Altitude | : Sea level. |
| (ii) Ambient temperature | : - 5 deg.C to + 35deg.C. |
| (iii) Relative humidity | : As high as 90%. |
| (iv) Lightning conditions | : Severe with a maximum ground density of 11 flashes per square kilometre per annum |
| (v) Atmosphere | : Saline, highly corrosive, dust laden; |
| (vi) Electricity supplies | : Single phase; 230 Volt 50 Hz $\pm 5\%$ or;
: From 400 to 6 600, 11 000 or 33 000 Volts 3 phase 50 Hz $\pm 5\%$. |

3.0 RESPONSIBILITY, CONTROL OF WORK

- 3.1 The labour for the repair work, to the EQUIPMENT will be monitored as and when by the TECHNICAL OFFICER from Transnet National Ports Authority (TNPA) or his authorized deputy.
- 3.2 The CONTRACTOR shall permit the TECHNICAL OFFICER to inspect the work being done by the CONTRACTOR at any time.
- 3.3 Neither the system of operation, nor any control circuitry of the EQUIPMENT shall be modified or altered in anyway during the execution of the work covered by this agreement without the consent of TNPA.
- 3.4 The CONTRACTOR shall provide the TECHNICAL OFFICER with new circuit diagrams for approval by the ENGINEER. Final drawings shall be submitted both in hard copy and electronically (AutoCAD format) in the event that changes are approved.
- 3.5 All work completed during the contract, which has not specifically been excluded from the service charge as detailed in Annexure "E", shall be considered to be included in the service charge and the TECHNICAL OFFICER shall not be liable for any extra payments whatsoever.
- 3.6 The CONTRACTOR shall be responsible for carrying out all tasks associated with the provision of the SERVICES. All workmanship, shall be of the highest standard, and carried out to the satisfaction of TNPA. The CONTRACTOR shall be responsible for ensuring that all test and calibration instrumentation and plant used for provision of the SERVICE shall meet national accredited testing standards. The Professional Electrical Engineer will be on site at all times during the protection testing and will sign off all protection engineering, protection testing and fault analysis reports.
- 3.7 TNPA HV personnel will prepare the required test or work permits that the CONTRACTOR

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

- will sign onto or off of, as and when he is required to do so.
- 3.8 The CONTRACTOR will be required to furnish proof of competency in terms of high voltage safety practice to the satisfaction of the TECHNICAL OFFICER. The CONTRACTOR will furthermore need to be familiar with the provisions of the Transnet Electrical Safety Instructions, and all other company safe work procedures and regulations before access to TNPA substations will be granted.
- 3.9 Notwithstanding the above arrangement, the CONTRACTOR will be required to log in by phone to the "Electrical Control Office" each occasion the CONTRACTOR enters or leaves a substation; in addition to signing the substation logbook. Failure to comply with this may lead to the cancellation of this contract.

4.0 CONTRACT EXECUTION AND METHOD OF PAYMENT

- 4.1 For breakdowns, emergency call outs and Ad hoc attendance on site, the CONTRACTOR will be advised by means of a telephone call confirmed by a signed e-mailed order form (Annexure "B") of the work required on each occasion. The required response to the callout could be critical which requires a response within 1 hour, urgent which requires a response within 3 hours and normal which requires a response within 24 hours.
- 4.2 The TECHNICAL OFFICER shall ensure that the any order forms (Annexure "B's") are signed and faxed on the same date to the CONTRACTOR. This date shall be the official date of order.
- 4.3 If any TNPA official is responsible for delaying the CONTRACTOR to complete the required repair due to operational or other reasons, the CONTRACTOR must advise the TECHNICAL OFFICER without delay.
- 4.4 Should the CONTRACTOR fail to comply with any of the provisions of this contract, and not take the necessary steps to correct the matter within 48 hours after being notified by the TECHNICAL OFFICER, the CONTRACTOR will be regarded as having committed a breach of contract and the TECHNICAL OFFICER will lodge a complaint with the Port of Durban Procurement department contracts manager.
- 4.5 If a callout is initiated by TNPA for work listed in section two of annexure "E" the schedule of quantities and rates, then the cost of the callout will be the amount entered into the schedule of quantities and rates for a callout. If the two hours (2) allowed for a callout is exceeded then the contractor will be paid an hourly rate thereafter as per the rate entered into the schedule of quantities.
- 4.6 Payment will only be effected after the TNPA TECHNICAL OFFICER has accepted the repair and the contractors V.A.T. invoice, annexure "C" and test or fault report has been submitted to the TNPA TECHNICAL OFFICER.
- 4.7 The contractor's payment claim for any month will not be processed if clause 4.6 is not strictly adhered to.
- 4.8 No additional charges will be accepted for the provision of SERVICES to the EQUIPMENT in terms of this agreement. If it is evident that additional repairs/fault finding needs to be carried out when attending to a routine service call the TNPA TECHNICAL OFFICER must be advised and his approval given before any work is undertaken.

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

- 4.9 An increase in the labour charge rate is allowed for in the second and third year of the thirty six (36) month period. The percentage labour rate increase must be entered into annexure E, the schedule of quantities and rates for year 2 and 3 of the 3 year (36 month period).

5.0. ADMIN WORK ASSOCIATED WITH ROUTINE SUBSTATION SERVICES

- 5.1 The CONTRACTOR shall prepare one substation test file (including file) with copies of all test reports applicable to the Circuit Breakers / Contactor Breakers on completion of testing in each substation. The substation protection test file must be handed to the TNPA TECHNICAL OFFICER for placing in the substation within three weeks after the testing has been completed. A PDF copy of the test report must be emailed to the Technical officer also within three weeks after the completion of the protection testing for the substation. Once all the applicable substations have been tested (as listed in annexure E) the contractor will be required to provide three CD'S with all the substations protection test reports and the GE relay configuration files for each of the GE relays installed in the substations that were protection tested.
- 5.2 The CONTRACTOR shall issue 3 copies of fault reports as and when completed. One will be placed in the substation desk by the Contractor and two will be handed to the TNPA TECHNICAL OFFICER for filing.

6.0 WORKMANSHIP RELATING TO HIGH VOLTAGE EQUIPMENT SERVICES

- 6.1 The CONTRACTOR shall ensure that the equipment once repaired still complies with the provisions of the OCCUPATIONAL HEALTH AND SAFETY ACT OF 1993 (OHS Act; ACT NO. 85 OF 1993) and all regulations as amended. If in the Contractor's view the EQUIPMENT required to be serviced/repared, does not comply with the provisions of the OHS Act, this shall be brought to the attention of the TECHNICAL OFFICER in writing.
- 6.2 The CONTRACTOR is required to carry out servicing and repairs as per the requirements of this agreement and "Schedule of Requirements"; ANNEXURE "A".
- 6.3 The CONTRACTOR shall be competent to carry out all work required in terms of this contract using only qualified competent personnel, and approved and appropriately certificated equipment/instruments. The attached "Schedule of Previous Works and Service Rates"; Appendix "D" must be fully completed at the time of tendering.
- 6.4 The Schedule requires the following information:-
- Details of experience relating to the variety of the equipment and activities covered by this document, including high voltage accreditation;
 - Organisation for whom such work has previously been done; Contact persons, value and duration of such contracts;
 - Details of the human resources available to the contractor to carry out the activities and repairs in accordance with the provisions of this agreement, including response times to calls;
 - Details of present similar commitments;
 - Availability of approved and calibrated high voltage test equipment to carry out the variety of tasks covered by this agreement;
- 6.5 Failure to supply the information requested under clause 6.4 above at the time of tendering

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

will preclude a tender from being considered.

7.0 GENERAL REQUIREMENTS AND PRECAUTIONS FOR PROVISION OF THE "SERVICES" TO THE "EQUIPMENT"

- 7.1 These requirements cover (amongst others) site electrical pre-operational tests and commissioning tests required for electrical apparatus, wire, cables and other miscellaneous equipment and material as called for in this document, and must be read in conjunction with Annexure A - Schedule of Requirements and Annexure K - Guideline for Routine Testing and Calibration.
- 7.2 Pre-operational tests and acceptance certificates as herein specified are defined as those tests and inspections required by the TECHNICAL OFFICER prior to equipment being energized to determine that the apparatus involved may be safely energized. This includes calibration tests, checks on limit switch settings, interlocking, PLC functioning etc.
- 7.3 This agreement intends that the workmanship methods, inspections and materials used for provision of the SERVICES shall conform to accepted engineering practice, the specifications as prepared by the TECHNICAL OFFICER, manufacturer's instructions and the relevant Standards as referred to in this document.
- 7.4 The CONTRACTOR shall exercise extreme care in performing the tests specified so as not to jeopardize the safety of personnel and to prevent equipment damage during any tests. All exposed live parts subject to testing shall be guarded by barricades, or other practical means to prevent personnel from being injured by coming in contact with exposed "live" parts.
- 7.5 All equipment, exposed "live" parts, etc., shall be completely discharged by grounding or other accepted methods so as to eliminate the possibility of injury to personnel from electrical shock after the tests have been completed.
- 7.6 Following established procedures, equipment will only be energized after certification by the CONTRACTOR that equipment is ready for energizing and with the concurrence of the TECHNICAL OFFICER. All testing shall be scheduled by the CONTRACTOR and cleared through the TECHNICAL OFFICER. No testing shall be scheduled without this clearance.
- 7.7 The CONTRACTOR shall give 48 hours' notice to the TECHNICAL OFFICER of the intention to carry out testing. TNPA will notify all interested parties who shall be responsible for having their representatives present at the designated time and date. Absence of any one representative will not prohibit testing from proceeding on schedule, unless such representative is essential to doing the tests.
- 7.8 The CONTRACTOR will co-ordinate all testing to ensure that all EQUIPMENT is prepared and that the conditions are safe. When new EQUIPMENT to be commissioned, it may be necessary for the manufacturer's representative to be present and possibly perform tests. The request for a manufacturer's representative to be present shall be made sufficiently in advance to the date the tests are scheduled so that satisfactory arrangements can be made.
- 7.9 The CONTRACTOR shall furnish all testing equipment for tests, which are to be performed. Only approved testing equipment that has been calibrated by an approved calibration authority shall be utilised for carrying out testing and calibration of EQUIPMENT. Proof of such compliance shall be furnished if called for by the TECHNICAL OFFICER.

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

- 7.10 Test results shall be entered in test forms provided by the CONTRACTOR, or if such forms are not available, on test forms approved by the TECHNICAL OFFICER. Formal test reports shall be prepared, signed and submitted by the CONTRACTOR to the TECHNICAL OFFICER within 48 hours of completion of the tests.
- 7.11 TNPA's requirements for routine testing and calibration of various types of protection relays; (electronic and electro-mechanical types) as encountered in TNPA substations in the Port of Durban are outlined in the attached Annexure K – Guideline for Testing and Calibration of Substation Equipment that forms an integral part of this document. For reasons of convenience, it is recommended that an approved type single phase injection test set be used.
- 7.12 All instruments used during tests, shall have been calibrated within the last year by a SANAS approved calibration laboratory.
- 7.13 Each test carried out shall be recorded, as should all relay alarm messages and/or indications. If the injection set is of the modern microprocessor type capable of producing a test record then the record generated must conform to the format acceptable to TNPA. All other test records produced shall be of an approved type and in a format acceptable to TNPA.
- 7.14 Unless otherwise agreed all tests shall be conducted once the relevant switchgear has been isolated.
- 7.15 Unless a microprocessor controlled type of test set is used, the injection current shall be controlled by means of tapped reactors in the primary circuit of the injection transformer. The injection transformer shall be provided with secondary tapings chosen to correspond with the current setting of the relay. This ensures that the relay impedance is small when reflected back into the primary circuit of the injection transformer, and reduces the harmonics in the test current that are due to saturation of the magnetic circuit of the relay under test.
- 7.16 The CONTRACTOR must ensure that during all tests, all the trip/closing circuits are energised and the circuit breaker is tripped at least once during a relay test.
- 7.17 Due to the complexity of certain protection schemes e.g. bus bar protection, transformer protection, only the minimum requirements for testing is contained within this document, for a detailed explanation refer to the manufacturer's documentation. This shall be necessary when a protection scheme not generally used in the port is tested.

8.0 ACCESS TO SUBSTATIONS

- 8.1 Access to the Ports substations is restricted to people who are in possession of a "C" green certificate, a "A" Brown certificate or letter of authority as detailed in the Transnet electrical safety instructions. The contractor therefore must be in possession of such authorization or be prepared to undergo the training to obtain such authorization. All costs associated with obtaining the certification will be for the contractors account.
- 8.2 Access to substations is also possible through the Power Supplies and Services depot under the supervision of depot staff in possession of the required certification. In the case of access to substations via the depot, advanced notice must be given to the depot manger or section supervisor when access is required.

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

- 8.3 The contractor will be required to sign an indemnity before access to the substations will be granted. See appendix J for an example of the indemnity that the contractor will be required to sign.
- 8.4 The main substations within the Port of Durban have CO² firefighting systems installed in them. These systems must be set from automatic to manual before entering the substation. The firefighting system must be set to automatic again when the substation is being vacated.

TRANSNET NATIONAL PORTS AUTHORITY
PORT OF DURBAN

ANNEXURE "A"

SCHEDULE OF REQUIREMENTS

1.0 DETAILED SCOPE OF WORK

1.1 This Annexure covers Transnet National Ports Authority of South Africa's (TNPA) specific requirements with regard to the Protection engineering, protection testing, commissioning, repair and emergency breakdown services to be performed in the high voltage substations associated with the electrical network in the Port of Durban. I.E. as defined in Clause 1 of the main body of this agreement as "the SERVICES"; and "the EQUIPMENT".

1.1.1 **The following substation equipment falls under the ambit of this agreement. 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)
- Any other substation equipment not mentioned above that needs to be tested.

1.1.2 **The works shall be as per this agreement and associated Annexures. This shall include; but not be restricted to:-**

- Time gradient studies.
- Calibration and/or programming of protection relays.
- Switchboard commissioning testing and verification of settings programmed into protection relays by "Site Engineers".
- Yearly routine substation testing; and functionality testing of substation equipment.
- Cable tracing and fault finding.
- Provision of cable joints and terminations.
- Cable, switchboard and transformer high potential testing and fault finding
- Power factor and power quality surveys
- ADHoc associated breakdown repairs to the above types of equipment

1.2 The CONTRACTOR is required to carry out routine servicing of the EQUIPMENT as directed by the TECHNICAL OFFICER. Notification to this effect will be by means of "ORDER FORM"; ANNEXURE "B". Routine servicing of the EQUIPMENT and shall include (but not be limited to) the tasks listed below and in ANNEXURES "G" and "K" which form part of this document.

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

- 1.3 Similarly, the CONTRACTOR is required to respond to call-outs from TNPA to faulty EQUIPMENT as directed by the TECHNICAL OFFICER. Notification to this effect will be by means of an "ORDER FORM"; ANNEXURE "B". Hours applicable - Weekdays (Monday 07H00 to Friday 16H00).
- 1.4 The CONTRACTOR is also required to respond to AFTER Hours call-outs from TNPA to faulty EQUIPMENT as directed by the TECHNICAL OFFICER. Notification to this effect will be by means of "ORDER FORM"; ANNEXURE "B". Will be faxed to the contractor the next working day (Monday to Friday 16H01 to 06H59, Saturday and Sunday).
- 1.5 Once the EQUIPMENT repairs have been completed by the CONTRACTOR, ANNEXURE "C" shall be completed and returned to the TECHNICAL OFFICER to enable the repair/workmanship to be inspected timeously.
- 1.6 Alternatively, the Annexure "C" may be faxed to 361-8310 for the attention of the Electrical Projects Department. Any guarantee periods applicable shall start from the date that the work is accepted by the TECHNICAL OFFICER.
- 1.7 The CONTRACTOR is required to provide the SERVICES to the EQUIPMENT as listed in the attached "TYPICAL COMMISSIONING WORK"; ANNEXURE "G". TNPA reserves the right to add additional EQUIPMENT to this list. However, this will be done in consultation with the CONTRACTOR.
- 1.8 The CONTRACTOR shall be a recognized protection testing and calibration specialist with proven ability and accreditation in the electrical engineering industry. One or more members shall be registered with the Engineering Council of South Africa; and preferably also the South African Institute of Electrical Engineers.
- 1.9 The specialist company shall enjoy recognition by organizations such as Eskom (Protection Testing & Measurement Division); the Durban municipal authority (Ethekwini Electricity) as a recognized high voltage protection testing specialist. Documentary evidence of such experience, recognition and ability shall be submitted to TNPA.
- 1.10 The CONTRACTOR shall supply the required complement of competent labour to complete the SERVICES at the specified individual distribution substations within the allocated period/s, as determined by TNPA operational requirements. However, TNPA will not be held liable for any claims arising from delays arising from such operations.
- 1.11 TNPA reserves the right to terminate the contract at any point if it is found that the CONTRACTOR'S performance, supervision, tools, equipment, services, and test instrumentation are found to be substandard.
- 1.12 The CONTRACTOR shall only utilize testing devices and measuring equipment that are certified and which carry a valid calibration certificate as issued by an approved calibration authority. Examples of such certification of the test equipment to be utilized to complete the SERVICES, shall be submitted as part of the tender bid.
- 1.13 The CONTRACTOR shall include copies or examples of the proposed test sheets, reflecting the typical format that will accommodate the various specified relay tests, as part of the tender bid.
- 1.14 No further claims of any nature will be allowed. Any work not complying with specifications as contained herein and elsewhere in the contract document shall be redone at the

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

CONTRACTORS own expense.

- 1.15 The CONTRACTOR shall supply day work rates for the various grade of staff required. These rates will only be applicable where the TECHNICAL OFFICER gives written instruction for additional works and these works have not been priced in the tender document.
- 1.16 The CONTRACTOR shall submit a list of companies for which routine protection testing and calculation of protection relay setting work has been successfully completed by them. The list shall include the value of previous contracts, completion dates and reference telephone numbers.
- 1.17 TNPA reserves the right to free-issue certain items of equipment, hardware or software. Free issuing of these items, once agreed with the CONTRACTOR in no way diminishes the CONTRACTOR'S responsibilities as detailed in this agreement. The CONTRACTOR shall conduct a quality check on such free-issued equipment and indicate acceptance of the equipment.
- 1.18 The CONTRACTOR shall be required to bear all cost which may arise as a result of damage which may have been caused to equipment or services or which may arise as a result of his operation on the respective sites.
- 1.19 Annexure H; Schedule of Drawings provides details of equipment relationships, voltages and interconnections etc. for all substations in the Port of Durban.
- 1.20 The setup of the "GE UR 35" power management multiple feeder relays must be identical for all 6.6, 11 and 33kV substations in the port.

2.0 MINIMUM TESTING REQUIREMENTS FOR SUBSTATION EQUIPMENT

- 2.1 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.

2.2.1 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

2.2.2 Voltage Transformer Test

- Polarity check
- Ratio check
- Phasing check

2.2.3 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

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

- 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.

2.2.4 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.
- Differential pilot wire protection - These relays shall be "SIEMENS Type 7SD600, Firmware version V3.1". Set up of the Siemens 7SD600-4EA00-2DA0/BB-Z,X 01,
- Relays LED'S must be programmed to indicate the following.
 - Led No.1 Differential trip signal.
 - Led No.2 Inter trip received signal.
 - Led No.3 Inter trip Send signal.
 - Led No.4 Pilot Wire Fail signal.

2.2.5 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.

2.2.6 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

2.2.7 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.

2.2.8 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.

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

2.2.9 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

2.2.10 Bus bar Protection

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

2.2.11 Transformer Protection

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

2.2.12 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 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.

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

ANNEXURE "B"

ORDER FORM

TNPA CONTRACT REF NO. _____

TNPA W/O: _____ DATE: _____ TIME: _____

CONTRACTORS REF. NO. _____

ADDRESSED TO: _____ FAX NO: _____

RESPONSE CATEGORY (Tick):

☐ A

☐ B

☐ C

A – Critical (Respond same day within 1 hours)

B – Urgent (Respond same day within 3 hours)

C – Normal (Respond within 24 hours or later)

The following high voltage equipment requires repair/service:-

SUBSTATION: _____ LOCALITY: _____

CONTACT PERSON: _____ TEL NO: _____

DESCRIPTION OF FAULT:

SIGNATURE: _____
Transnet National Ports Authority

FAX NO: 3618310

PHONE NO: 3618675 / 083 708 0813

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

ANNEXURE "C"

HV NETWORK CALL-OUT/SERVICE ATTENDANCE REPORT

CONTRACTORS REF. NO: _____ TNPA REF. NO.: _____

TO: ELECTRICAL PROJECTS DEPT. Fax No: 3618310 Phone: 3618675/0837080813

TIME AND DATE OF CALL-OUT/SERVICE _____

LOCALITY: _____ SUBSTATION: _____

REPAIRS CARRIED OUT:

MATERIAL:

TRANSPORT:

TECHNICIAN: NAME: (print) _____

SIGNATURE: _____

DATE: _____

TIME: _____

PHONE: _____

ANNEXURE "D"

SCHEDULE OF HIGH VOLTAGE WORKS PREVIOUSLY CARRIED OUT

1.0 WORKS PREVIOUSLY CARRIED OUT

- (a) Organisation, contact person, contact number and equipment description for whom similar HV testing, calibration and call-out/breakdown maintenance services and repair work done:

- (b) Duration of contract/s, contract value/s of items in (a) above:-

- (c) Number of similar contracts that the tenderer is currently committed to, the organisation concerned, equipment description, and contact person and contact number.

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

ANNEXURE "E"

SCHEDULE OF QUANTITIES AND RATES					
PORT OF DURBAN SUBSTATION PROTECTION ENGINEERING, PROTECTION TESTING, COMMISSIONING, REPAIR AND EMERGENCY BREAKDOWNS SERVICES					
ITEM NO.	TASK DESCRIPTION	UNIT	QTY	RATE	TOTAL
1	Professional services external				
1.1	Adhoc outsourcing of professional services to various TNPA approved subcontractors	hours	200		
	Total cost for section 1				
2	As and when Protection engineering, commissioning, repair and emergency breakdown services				
2.1	Cost per two hour (2) call out including travel to any area of the Port of Durban including Wentworth substation during normal working hours (07H00 to 16H00)	each	45		
2.2	Hourly labour rate during normal working hours (07H00 to 16H00)	hours	90		
2.3	Cost per two hour (2) call out including travel to any area of the Port of Durban including Wentworth substation after hours (16H01 to 06H59, including weekends and public holidays)	each	18		
2.4	Hourly after hours labour rate (16H01 to 06H59, including weekends and public holidays)	hours	36		
	Total cost for section 2				

3	PROTECTION TESTING OF THE PORT OF DURBAN AND OLD DURBAN INTERNATIONAL SUBSTATIONS AND MINI-SUBSTATIONS						
3.1	POINT AREA	No of panels	Breaker use	Drawing reference	Protection relay	Protection type	Cost per breaker
3.1.1	Stanger street 33 kV substation	5		PEB 33			
	E75		Incomer		L30	OC, EF & CD	
	E74		Transformer		T30	OC, EF, B&T	
	E73		Bus section		F35	bus bar blocking zone 1 & 2	
	E72		Transformer		T30	OC, EF,	

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

						B&T	
		No of panels	Breaker use	Drawing reference	Protection relay	Protection type	Cost per breaker
	E71		Feeder		L30 + 7SD600	OC, EF & CD	
	Substation earth resistance (ER)						
	Battery bank test						
Note	The two power transformers have oil temp alarm and trip, winding temp alarm and trip, bucholz alarm and trip and pressure relief. The bus bar protection system is bus bar blocking. The protection testing must include breaker fail and trip circuit supervision.						
	Total cost for Stanger street 33 kV substation						
3.1.2	Stanger street 6.6 kV substation	17		PEB 29			
	E50		Feeder		F35	OC & EF	
	E51		Feeder		F35 & 7SD600	OC & EF CD	
	E52		Feeder		F35 & 7SD600	OC & EF CD	
	E53		Transformer		F35	OC, EF, B&T	
	E54		PFC bank		F35 & RLC-04	OC & EF	
	E55		Feeder		F35 & 7SD600	OC & EF CD	
	E56		Incomer / feeder		F35 & 7SD600	OC & EF CD	
	E57		Incomer		F35	OC & EF	
	E58		Bus section		F35	High impedance zone 1 & 2	
	E59		Incomer		F35	OC & EF	
	E60		Incomer / feeder		F35 & 7SD600	OC & EF CD	
	E61		Feeder		F35 & 7SD600	OC & EF CD	
	E62		PFC bank		F35 & RLC-04	OC & EF	
	E63		Feeder		F35 & 7SD600	OC & EF CD	
	E64		Feeder		F35 & 7SD600	OC & EF CD	
	E65		Feeder		F35	OC & EF	
	E66		Feeder		F35	OC & EF	

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

		No of panels	Breaker use	Drawing reference	Protection relay	Protection type	Cost per breaker
	Substation earth resistance (ER)						
Note	<p>For the capacitor banks the following protection testing must be carried out on the RLC-04 relay, over Voltage, high set over Voltage, high set overcurrent, earth fault and high set earth fault and high set line unbalance.</p> <p>The power transformer has oil temp alarm and trip and bucholz alarm and trip.</p> <p>The bus bar protection system is high impedance.</p> <p>The protection testing must include breaker fail and trip circuit supervision.</p>						
	Total cost for Stanger street 6.6 kV substation						
3.1.3	Ocean Terminal building 6.6 kV substation	7		PEB 29			
	F03		Transformer		F35	OC, EF, B&T	
	F04		Spare		F35	N/A	
	F05		Incomer		F35 & 7SD600	OC & EF CD	
	F06		Bus section		F35	Frame leakage zone 1,2 & 3	
	F07		Incomer		F35 & 7SD600	OC & EF CD	
	F08		Feeder		F35	OC & EF	
	F09		Transformer		F35	OC, EF, B&T	
	Substation earth resistance (ER)						
	Battery bank test						
Note	<p>The two power transformers have oil temp alarm and trip and bucholz alarm and trip.</p> <p>The bus bar protection system is frame leakage.</p> <p>The protection testing must include breaker fail and trip circuit supervision.</p>						
	Total cost for Ocean Terminal building 6.6 kV substation						
3.1.4	Sand bypass 6.6 kV substation	9		PEB 29			
	F90		Transformer		F35	OC, EF, B&T	
	F91		Transformer		F35	OC, EF, B&T	

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

		No of panels	Breaker use	Drawing reference	Protection relay	Protection type	Cost per breaker
	F92		Incomer		F35 &7SD600	OC & EF CD	
	F93		Incomer		F35 &7SD600	OC & EF CD	
	F94		Bus section		F35	High impedance and arc zone 1 & 2	
	F95		Incomer		F35 &7SD600	OC & EF CD	
	F96		Incomer		F35 &7SD600	OC & EF CD	
	F97		Feeder		F35	OC, EF	
	F98		Feeder		F35	OC, EF	
	Substation earth resistance (ER)						
	Battery bank test						
Note	The power transformers have oil temp alarm and trip and bucholz alarm and trip. The bus bar protection system is high impedance and arc. The protection testing must include breaker fail and trip circuit supervision.						
	Total cost for Sand bypass 6.6 kV substation						
3.2	BAYHEAD AREA						
3.2.1	DHI 33 kV substation	5		PEB 33			
	E25		Incomer		L30	OC & EF CD	
	E24		Transformer		T30	OC, EF, B&T	
	E23		Bus section		F35	bus bar blocking zone 1 & 2	
	E22		Transformer		T30	OC, EF, B&T	
	E21		Feeder		L30 + 7SD600	OC & EF CD	
	Substation earth resistance (ER)						
	Battery bank test						
Note	The power transformers have oil temp alarm and trip, winding temp alarm and trip, bucholz alarm and trip and pressure relief.						

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

	The bus bar protection system is bus bar blocking. The protection testing must include breaker fail and trip circuit supervision.						
	Total cost for DHI 33 kV substation						
		No of panels	Breaker use	Drawing reference	Protection relay	Protection type	Cost per breaker
3.2.2	DHI 6.6 kV substation	21		PEB 29			
	E01		Incomer / feeder		F35 & 7SD600	OC & EF CD	
	E02		Feeder		F35	OC, EF	
	E03		Feeder		F35	OC, EF	
	E04		Feeder		F35	OC, EF	
	E05		Feeder		F35 & 7SD600	OC & EF CD	
	E06		Feeder		F35 & 7SD600	OC & EF CD	
	E07		Transformer		F35	OC, EF, B&T	
	E08		PFC bank		F35 & RLC-04	F35 & RLC-04	
	E09		Spare		F35		
	E10		Incomer		F35	OC, EF	
	E11		Bus section		F35	bus bar blocking zone 1 & 2	
	E12		Incomer		F35	OC, EF	
	E13		Spare		F35		
	E14		PFC bank		F35 & RLC-04	F35 & RLC-04	
	E15		Transformer		F35	OC, EF, B&T	
	E16		Feeder		F35 & 7SD600	OC & EF CD	
	E17		Feeder		F35	OC, EF	
	E18		Feeder		F35 & 7SD600	OC & EF CD	
	E19		Feeder		F35	OC, EF	
	E20		Feeder		F35	OC, EF	
	E21		Incomer / feeder		F35 & 7SD600	OC & EF CD	
	Substation earth resistance (ER)						
Note	For the capacitor banks the following protection testing must be carried out on the RLC-04 relay, over Voltage, high set over Voltage, high set overcurrent, earth fault and high set earth fault and high set line unbalance. The power transformers have oil temp alarm and trip, winding temp alarm and trip, bucholz alarm						

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

	and trip and pressure relief. The bus bar protection system is bus bar blocking. The protection testing must include breaker fail and trip circuit supervision.						
		No of panels	Breaker use	Drawing reference	Protection relay	Protection type	Cost per breaker
	Total cost for DHI 6.6 kV substation						
3.2.3	Shot blast 6.6 kV substation	7		PEB 29			
	F39		Incomer		F35 & 7SD600	OC, EF CD	
	F40		Spare		F35		
	F41		Transformer		F35	OC, EF, B&T	
	F42		Bus section		F35	High impedance and arc zone 1 & 2	
	F43		Transformer		F35	OC, EF, B&T	
	F44		Spare		F35		
	F45		Incomer		F35 & 7SD600	OC, EF CD	
	Substation earth resistance (ER)						
	Battery bank test						
Note	The power transformers have oil temp alarm and trip and bucholz alarm and trip. The bus bar protection system is high impedance and arc. The protection testing must include breaker fail and trip circuit supervision.						
	Total cost for Shot blast 6.6 kV substation						
3.2.4	Graving Dock 6.6 kV substation	9		PEB 29			
	F68		Incomer		MCGG	Solkor OC, EF	
	F69		Feeder		MCGG	OC, EF	
	F70		Feeder		MCGG	OC, EF	
	F71		Transformer		MCGG	OC, EF, B&T	
	F72		Bus section			Frame leakage zone 1,2 & 3	
	F73		Transformer		MCGG	OC, EF, B&T	

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

	F74		Feeder		MCGG	OC, EF	
		No of panels	Breaker use	Drawing reference	Protection relay	Protection type	Cost per breaker
	F75		Spare		MCGG	OC, EF, B&T	
	F76		Incomer		MCGG	Solkor OC, EF	
	Substation earth resistance (ER)						
	Battery bank test						
Note	The power transformers have oil temp alarm and trip, winding temp alarm and trip, bucholz alarm and trip and pressure relief. The bus bar protection system is bus bar blocking. The protection testing must include breaker fail and trip circuit supervision.						
	Total cost for Graving Dock 6.6 kV substation						
3.2.5	Pump House 6.6 kV substation	5		PEB 29			
	F78		Incomer		F35 & 7SD600	OC, EF CD	
	F79		Motor		Vamp 40	OC, EF	
	F80		Motor		Vamp 40	OC, EF	
	F81		Motor		Vamp 40	OC, EF	
	F82		Incomer		F35 & 7SD600	OC, EF	
	Zone 1 bus bar protection high impedance						
	Zone 2 bus bar protection high impedance						
	Zone 1 arc detection						
	Zone 2 arc detection						
	Substation earth resistance (ER)						
	Battery bank test						
Note	Protection testing for the motors must be overcurrent and earth fault according to tripping curve and instantaneous, phase unbalance, stall and thermal. The bus bar protection system is high impedance and arc. The protection testing must include breaker fail and trip circuit supervision.						
	Total cost for Pump House 6.6 kV substation						

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

3.2.6	Floating dock 6.6 kV substation	5		PEB 29			
		No of panels	Breaker use	Drawing reference	Protection relay	Protection type	Cost per breaker
	F83		Incomer		F35 & 7SD600	OC, EF CD	
	F84		Transformer		F35	OC, EF	
	F85		Bus section		F35	High impedance and arc zone 1 & 2	
	F86		Feeder		F35	OC, EF	
	F87		Incomer		F35 & 7SD600	OC, EF CD	
	Substation earth resistance (ER)						
	Battery bank test						
Note	The power transformers have oil temp alarm and trip and bucholz alarm and trip. The bus bar protection system is high impedance and arc. The protection testing must include breaker fail and trip circuit supervision.						
	Total cost for Floating dock 6.6 kV substation						
3.2.7	Repair Quay 6.6 kV substation	7		PEB 29			
	F58		Spare		F35		
	F59		Transformer		F35	OC, EF, B&T	
	F60		Incomer		F35 & 7SD600	OC, EF CD	
	F61		Bus section		F35	Frame leakage zone 1,2 & 3	
	F62		Incomer		F35 & 7SD600	OC, EF CD	
	F63		Transformer		F35	OC, EF, B&T	
	F64		Spare		F35		
	Substation earth resistance (ER)						
	Battery bank test						
Note	The power transformers have oil temp alarm and trip and bucholz alarm and trip. The bus bar protection system frame leakage. The protection testing must include breaker fail and trip circuit supervision.						
	Total cost for Repair Quay 6.6 kV substation						

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

		No of panels	Breaker use	Drawing reference	Protection relay	Protection type	Cost per breaker
3.2.8	Ambrose Park 11 kV substation	3		PEB 24			
	F10		Incomer		F35	OC, EF	
	F11		Feeder		F35	OC, EF	
	F12		Feeder		F35	OC, EF	
	Substation earth resistance (ER)						
	Battery bank test						
	Total cost for Ambrose Park 11 kV substation						
3.3	FYNNLAND AREA						
3.3.1	Allan Dalton 33 kV substation	18		PEB 33			
	E80 33 kV side		Transformer		T60	OC, EF, B&T	
	E80 11 kV side		Transformer			OC, EF	
	E81		Feeder		L30	OC, EF CD	
	E82 33 kV side		Transformer		T60	OC, EF, B&T	
	E82 6.6 kV side		Transformer			OC, EF	
	E83		Incomer		L30	OC, EF CD	
	E84		Spare			OC, EF	
	E85		Spare			OC, EF	
	E86		Bus section			High impedance and arc zone 1 & 2	
	E87		Spare			OC, EF	
	E88		Gen NEC/R			OC, EF	
	E89		Spare			OC, EF	
	E90		Incomer		L30	OC, EF CD	
	E91 33 kV side		Transformer		T60	OC, EF, B&T	
	E91 6.6 kV side		Transformer			OC, EF	

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

	E92		Feeder		L30	OC, EF CD	
	E93 33 kV side		Transformer		T60	OC, EF, B&T	
		No of panels	Breaker use	Drawing reference	Protection relay	Protection type	Cost per breaker
	E93 11 kV side		Transformer			OC, EF	
	Substation earth resistance (ER)						
	Battery bank test						
Note	The power transformers have oil temp alarm and trip, winding temp alarm and trip, bucholz alarm and trip and pressure relief. The bus bar protection system is bus bar blocking. The protection testing must include breaker fail and trip circuit supervision.						
	Total cost for Allan Dalton 33 kV substation						
3.3.2	Allan Dalton generator 11 kV substation	11		PEB 33			
	E40		Gen 1			OC, EF	
	E41		Gen 2			OC, EF	
	E42		PFC bank		F35 & RLC-04	OC, EF, Cap bank protection	
	E43		Feeder			OC, EF CD	
	E44		Incomer			OC, EF	
	E45		Bus section			High impedance zone 1 & 2	
	E46		Incomer			OC, EF	
	E47		Feeder			OC, EF CD	
	E48		PFC bank		F35 & RLC-04	OC, EF, Cap bank protection	
	E49		Gen 3			OC, EF	
	E50		Gen 4			OC, EF	
	Substation earth resistance (ER)						
	Battery bank test						
Note	For the Port of Durban standby generators the following protection testing is also required, under and over frequency, under and over Voltage and differential protection. For the capacitor banks the following protection testing must be carried out on the RLC-04 relay, over Voltage, high set over Voltage, high set overcurrent, earth fault and high set earth fault and high set line unbalance. The power transformers have oil temp alarm and trip and bucholz alarm and trip. The bus bar protection system is high impedance and arc.						

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

	The protection testing must include breaker fail and trip circuit supervision.						
	Total cost for Allan Dalton generator 11 kV substation						
		No of panels	Breaker use	Drawing reference	Protection relay	Protection type	Cost per breaker
3.3.3	Allan Dalton 6.6 kV substation	17		PEB 29			
	E01		Spare		F35	OC, EF	
	E02		Spare		F35	OC, EF	
	E03		Feeder		F35	OC, EF	
	E04		Transformer		F35	OC, EF	
	E05		Feeder		F35	OC, EF	
	E06		Feeder		F35 & 7SD600	OC, EF CD	
	E07		PFC bank		F35 & RLC-04	OC, EF, cap bank protection	
	E08		Incomer		F35	OC, EF	
	E09		Bus section		F35	High impedance and arc zone 1 & 2	
	E10		Incomer		F35	OC, EF	
	E11		PFC bank		F35 & RLC-04	OC, EF, cap bank protection	
	E12		Feeder		F35 & 7SD600	OC, EF CD	
	E13		Feeder		F35	OC, EF	
	E14		Transformer		F35	OC, EF	
	E15		Feeder		F35	OC, EF	
	E16		Spare		F35	OC, EF	
	E17		Feeder		F35	OC, EF	
	Substation earth resistance (ER)						
	Battery bank test						
Note	<p>For the capacitor banks the following protection testing must be carried out on the RLC-04 relay, over Voltage, high set over Voltage, high set overcurrent, earth fault and high set earth fault and high set line unbalance.</p> <p>The power transformers have oil temp alarm and trip and bucholz alarm and trip.</p> <p>The bus bar protection system is high impedance and arc.</p> <p>The protection testing must include breaker fail and trip circuit supervision.</p>						
	Total cost for Allan Dalton 6.6 kV substation						
3.3.4	Fynnlands 6.6 kV	9		PEB 29			

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

	substation						
	E70		Spare		ABB REF 615	OC, EF	
		No of panels	Breaker use	Drawing reference	Protection relay	Protection type	Cost per breaker
	E71		Incomer / feeder		ABB REF 615 & 7SD600	OC, EF	
	E72		Feeder		ABB	CD	
						OC, EF	
	E74		Bus section			High impedance and arc zone 1 & 2	
	E75		Feeder		ABB REF 615	OC, EF	
	E76		Feeder		ABB REF 615	OC, EF	
	E77		Incomer / feeder		ABB REF 615 & 7SD600	OC, EF	
						CD	
	E78		Spare		ABB REF 615	OC, EF	
	Substation earth resistance (ER)						
	Battery bank test						
Note	The bus bar protection system is high impedance and arc. The protection testing must include breaker fail and trip circuit supervision.						
	Total cost for Fynnlands 6.6 kV substation						
	CFI 6.6 kV substation	5		PEB 29		OC, EF	
						OC, EF	
			Motor 1		Vamp 40	OC, EF	
			Motor 2		Vamp 40	OC, EF	
			Motor 3		Vamp 40		
			Motor 4		Vamp 40		
	Substation earth resistance (ER)						
Note	Protection testing for the motors must be overcurrent and earth fault according to tripping curve and instantaneous, phase unbalance, stall and thermal.						

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

	Total cost for CFI 6.6 kV substation						
		No of panels	Breaker use	Drawing reference	Protection relay	Protection type	Cost per breaker
3.4	PIER 2 CONTAINER TERMINAL						
3.4.1	Pier 2 33 kV substation	5		PEB 33		OC, EF	
						CD	
	E41		Incomer		F35	OC, EF, B&T	
	E42		Transformer		T60	High impedance and arc zone 1 & 2	
	E43		Bus section		F35	OC, EF, B&T	
	E44		Transformer		T60	OC, EF	
	E45		Incomer		F35	CD	
	Substation earth resistance (ER)						
	Battery bank test						
Note	The power transformers have oil temp alarm and trip, winding temp alarm and trip, bucholz alarm and trip and pressure relief. The bus bar protection system is bus bar blocking. The protection testing must include breaker fail and trip circuit supervision.						
	Total cost for Pier 2 33 kV substation						
3.4.2	Pier 2 11 kV substation	20		PEB 30			
	E01		PFC bank		F35 & RLC-04	CD	
	E02		Feeder		F35 & 7SD600	OC, EF	
	E03		Feeder		F35 & 7SD600	CD	
	E04		Spare		F35	OC, EF	
	E05		Feeder		F35 & 7SD600	OC, EF	

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

	E06		Incomer		F35	OC, EF	
	E07		Feeder		F35	OC, EF	
	E08		Feeder		F35	OC, EF	
	E09		Feeder		F35	High impedance and arc zone 1 & 2	
		No of panels	Breaker use	Drawing reference	Protection relay	Protection type	Cost per breaker
	E10		Feeder		F35	OC, EF	
	E11		Bus section		F35	OC, EF	
	E12		Feeder		F35	OC, EF	
	E13		Feeder		F35	CD	
	E14		Feeder		F35 &7SD600	OC, EF	
	E15		Feeder		F35	OC, EF	
	E16		Incomer		F35	CD	
	E17		Feeder		F35 &7SD600	OC, EF	
	E18		Spare		F35	CD	
	E19		Feeder		F35 &7SD600	OC, EF	
	E20		Feeder		F35 &7SD600	CD	
	E21		PFC bank		F35 & RLC-04	OC, EF	
	Substation earth resistance (ER)						
	Battery bank test						
Note	The power transformers have oil temp alarm and trip, winding temp alarm and trip, bucholz alarm and trip and pressure relief. The bus bar protection system is bus bar blocking. The protection testing must include breaker fail and trip circuit supervision.						
Total cost for Pier 2 11 kV substation							
Total cost for all Port of Durban substations							
	PORT OF DURBAN MINI-SUBSTATIONS			Drawing reference	Protection relay	Protection type	Cost per mini-substation
3.5	POINT AREA	6		PEB 29			
3.5.1	B berth mini				VIP 35	OC, EF, ER	

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

3.5.2	M berth mini				VIP 35	OC, EF, ER	
3.5.3	R berth mini				VIP 45	OC, EF, ER	
3.5.4	Q berth mini				FUSED	ER	
3.5.5	Gantry mini					OC, EF, ER	
3.5.6	Station yard mini				FUSED	ER	
3.6	BAYHEAD AREA	7		PEB 29			
				Drawing reference	Protection relay	Protection type	Cost per mini-substation
3.6.1	Congella no.1 mini				VIP 35	OC, EF, ER	
3.6.2	Congella no.2 mini				VIP 35	OC, EF, ER	
3.6.3	Congella no.3 mini				VIP 35	OC, EF, ER	
3.6.4	Capstan mini				VIP 12R	OC, EF, ER	
3.6.5	Converter mini				VIP 12R	OC, EF, ER	
3.6.6	Inner caisson mini				VIP 35	OC, EF, ER	
3.6.7	Crane supply mini				VIP 12R	OC, EF, ER	
3.6.8	Outer caisson mini				VIP 12R	OC, EF, ER	
3.7	FYNNLAND AREA	5		PEB 29			
3.7.1	Fynnland mini				VIP 45	OC, EF, ER	
3.7.2	Fynnland RMU				VIP 35	OC, EF, ER	
3.7.3	Electrical depot mini				VIP 35	OC, EF, ER	
3.7.4	Pollution control mini				VIP 35	OC, EF, ER	
3.7.5	Tank washout mini				VIP 45	OC, EF, ER	
3.7.6	IVS Berth 8 mini				VIP 35	OC, EF, ER	

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

3.7.7	CFI mini				VIP 35	OC, EF, ER	
3.8	ALLAN DALTON	4		PEB 29			
				Drawing reference	Protection relay	Protection type	Cost per mini-substation
3.8.1	Bayhead rd. mini				VIP 35	OC, EF, ER	
3.8.2	Kingsrest mini 1				VIP 35	OC, EF, ER	
3.8.3	Kingsrest mini 2				VIP 35	OC, EF, ER	
3.8.4	NMPP mini				VIP 35	OC, EF, ER	
3.8.5	Berth 9 mini				VIP 35	OC, EF, ER	
3.8.6	Berth 100 mini				VIP 35	OC, EF, ER	
	Total cost for all Port of Durban mini-substations						
3.9	OLD DURBAN INTERNATIONAL AIRPORT SUBSTATIONS						
		No of panels	Breaker use	Drawing reference	Protection relay	Protection type	Cost per breaker
3.9.1	OPS 11 kV substation	9		PEB 25			
	A01		Feeder		DCC	OC, EF	
	A02		Feeder		DCC	OC, EF	
	A03		Feeder		DCC	N/A	
	A04		Incomer		DCC	OC, EF	
	A05		Bus section		DCC	OC, EF	
	A06		Incomer		DCC	OC, EF	
	A07		Feeder		DCC	OC, EF	
	A08		Feeder		DCC	OC, EF	
	A09		Feeder		DCC	OC, EF	
	Substation earth resistance (ER)						
	Total cost for OPS 11 kV substation						
3.9.2	GEN 1 11 kV SUBSTATION	3		PEB 25			

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

	A21		Transformer		CDG	OC, EF	
	A22		Spare		CDG	OC, EF	
	A23		Transformer		CDG	OC, EF	
	Substation earth resistance (ER)						
		No of panels	Breaker use	Drawing reference	Protection relay	Protection type	Cost per breaker
	Total for GEN 1 11 kV substation						
3.9.3	GEN 2 11 kV SUBSTATION	3		PEB 25			
	A15		Transformer		CDG	OC, EF	
	A16		Incomer		CDG	OC, EF	
	A18		Transformer		CDG	OC, EF	
	Substation earth resistance (ER)						
	Total cost for GEN 2 11 kV substation						
3.9.4	P&L 11 kV SUBSTATION	5		PEB 25			
	A38		Feeder		DCC	OC, EF	
	A39		Incomer		CDG - LV side	OC, EF	
	A40		Bus section			N/A	
	A41		Incomer		CDG - LV side	OC, EF	
	A42		Feeder		DCC	OC, EF	
	Substation earth resistance (ER)						
	Total cost for P&L 11 kV substation						
3.9.5	24 SUBSTATION	5		PEB 25			
	A59		Incomer		DCC	OC, EF	
	A60		Incomer		DCC	OC, EF	
	A61		Transformer		DCC	OC, EF	
	A62		Transformer		DCC	OC, EF	
	A63		Spare		DCC	OC, EF	
	Substation earth resistance (ER)						

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

	Total cost for 24 substation						
3.9.6	6 SUBSTATION	5		PEB 25			
	A53		Spare		DCC	OC, EF	
	A54		Transformer		DCC	OC, EF	
	A55		Transformer		DCC	OC, EF	
	A56		Incomer		DCC	OC, EF	
	A57		Incomer		DCC	OC, EF	
	Substation earth resistance (ER)						
	Total for 6 substations						
	Total cost for all old Durban International airport substations						
				Drawing reference	Protection relay	Protection type	Cost per mini-substation
3.10	OLD DURBAN INTERNATIONAL AIRPORT MINI-SUBSTATIONS	4		PEB 25			
3.10.1	A mini					ER	
3.10.2	B mini					ER	
3.10.3	C mini					ER	
3.10.4	D mini					ER	
	Total cost for all old Durban International airport mini-substations						
	Total cost for the protection testing of the Port of Durban and old Durban International airport substations and mini-substations						
4	Summary of schedule of quantities and rates					Totals	
4.1	Section 1 - Professional services external						
4.2	Section 2 - As and when Protection engineering, commissioning, repair and emergency breakdown services						
4.3	Section 3 - Protection testing of the Port of Durban and old						

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

	Durban International airport substations and mini-substations	
4.4	Provide the total cost for all work which is the sum of section 1 + section 2 + section 3 as shown in line items 4.1, 4.2 and 4.3 above.	

5	Total cost for labour year 1 is calculated by dividing the total cost for the schedule of quantities and rates as shown in line 4.4 above (summary section), by 3.	
----------	---	--

ALLOWING FOR INFLATION OF LABOUR COSTS DURING YEARS 2 AND 3 OF THE 36 MONTHS

				Percentage increase applied to labour costs	Totals
6	Cost for labour year 2 = (Year 1 labour cost as shown in line item 5 above + percentage increase for labour costs if necessary)				
7	Cost for labour year 3 = (Year 2 labour cost as calculated in line item 6 above + percentage increase for labour costs if necessary)				
8	Health and safety file	each	1	N/A	
9	Total cost for labour for 36 months including percentage increase in labour costs for years 2 and 3 = Year 1 labour cost (line item 5) + Year 2 labour cost (line item 6)+ Year 3 labour cost (line item 7)+ cost for Health and safety file (line item 8)				

SIGNATURE OF TENDERER _____ DATE _____

TRANSNET NATIONAL PORTS AUTHORITY
PORT OF DURBAN

ANNEXURE "F"

SCHEDULE OF RETURNABLE DOCUMENTATION

- Registration with the Engineering council of South Africa as a Professional Engineer for Power Engineering specifically Protection engineering and testing (certified proof to be supplied)
- Annexure "D"
- Annexure "E"
- Annexure "I"

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

ANNEXURE "G" Page 1 of 2

Typical Commissioning Tests

Commissioning Tests for Transformers	Yes	No	Details	Comments
1. Ratio Test on all Taps				
2. % Impedance Test				
3. Vector Group Test				
4. Phase Resistance Test				
5. Insulation test (Megger Test)				
6. Pressure Relief test				
7. Oil Temperature relay (Alarm and trip)				
8. Winding Temp.relay (Alarm and trip)				
9. CT ratio and magnetizing saturation test				
10. Secondary Injection Tests on relays magnetizing saturation test				

Commissioning Tests H.V. Circuit Breaker	Yes	No	Details	Comments
1. Manual Controls: Trip & Close Test				
2. Remote Controls: Trip & Close Test (if applicable)				
3. Change of state indication verification Remote Change of state indication verification (if applicable)				
4. Open/Close status verification Remote Change Open/Close status verification (if applicable)				
5. Earth state verification Remote Earth state verification (if applicable)				
6. Trip circuit healthy Test Remote trip Circuit state verification (if applicable)				
7. Solkor Relay secondary injection Solkor Relay indication on primary protection meter (if applicable)				
8. Overcurrent and Earth fault secondary injection indication on primary protection meter (if applicable)				
9. Primary injection tests				
10. CT ratio tests, polarity, Magnetizing and saturation test				
11. Auto-reclose (where applicable)				
12.Remote alarms/indications verify (if applicable)				

Solkor Relay Tests	Yes	No	Details	Comments
1. Check connections				
2. Secondary wiring insulation resistance test				

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

3. CT ratio and polarity test				
4. Pilot cable insulation & continuity tests				
5. Overall fault setting (primary injection)				
6. Circuit breaker tripping tests				
7. Stability tests				

Other Metering checks	Yes	No	Details	Comments
1. kWh meter connections/polarity				
2. C.T.ratio				
3. Panel Volt meters; scale, operation				
4. Panel Ammeters; ratios, scale, and operation				
5. Kilowatt-hour meter accuracy				

General Commissioning Checks	Yes	No	Details	Comments
1. Calibrate/test protection systems (complete)				
2. CB mech. aspects (rack in/out, operation)				
3. Switchboard CB numbering and labeling correct (truck, panel, rear) a; Rear cable entry cover plate. (No. only) b: Rear top section of the panel situated above the level of the VT'S (No. Only) c: Front of the switchboard above the level of the removable trolley (No. and designation) d: Front of each removable trolley. (No. and designation)				
4. Substation earthing system checked/tested				
5. Bonding to substation main earth bar				
6. Cable termination earthing (feed/supply arrangement)				
7. High potential testing of cables (new cable)				
8. High potential testing (existing cable)				
9. Lockout of spouts checked				
10. Cable and busbar earthing systems checked				
11. Earthing equipment, CB operating tools, safety signs				
12 Correct switching diagrams provided;				
13. Energizing notice prepared				
14. Solkor electronic relay calibrated set points:- a. Alarm; b. Trip; c. Intertrip (send and receive)				
15. Diagram provided re operation of Zone or busbar protection.				
16. As Built wiring diags. provided for sw/board				
17. Phase rotation OCB to OCB for Entire Distribution board continues and correct vector phasing from VT'S				

ANNEXURE "H"

SCHEDULE OF DRAWINGS

This appendix lists NPA drawings, which shall be read in conjunction with this specification.

- | | |
|-------------------|---|
| 1. PEB 033-030-00 | 33 kV DISTRIBUTION AND GENERATION HV SWITCHING DIAGRAM. (PORT OF DURBAN) |
| 2. PEB 030-97-00 | 11 kV RETICULATION SWITCHING DIAGRAM AND EMERGENCY CONTROL. (PIER 2 CONTAINER TERMINAL) |
| 3. PEB 029-132-00 | 6.6 kV RETICULATION SWITCHING DIAGRAM AND EMERGENCY CONTROL. (PORT OF DURBAN) |
| 4. PEB 025-008-00 | EMERGENCY CONTROL HV & LV SWITCHING DIAGRAM (OLD DURBAN INTERNATIONAL AIRPORT) |

STATEMENT OF COMPLIANCE

This tender complies with all the requirements of this agreement in all respects.

SIGNATURE:DATE:

This tender complies generally with clauses of this agreement but differs from it on the following points.

SIGNATURE: _____ **DATE:** _____

TNPA
PORT OF DURBAN

<i>WORK ON TRANSNET NATIONAL PORT AUTHORITY ELECTRICAL EQUIPMENT AND/OR IN SUBSTATIONS</i>

WHEREAS **TRANSNET NATIONAL PORTS AUTHORITY OF SOUTH AFRICA (TNPA)** has
acceded to a request for access to **TNPA** property and/or equipment by
..... (Hereafter referred to as the
CONTRACTOR), to carry out work in/on
Situating at

NOW THEREFORE the **CONTRACTOR** hereby indemnifies and holds **TNPA** harmless against any
damage of whatever nature suffered by the **CONTRACTOR**, (or any other party) against any claims
arising from such request for access to **TNPA** property; as also against any liability in respect of
death or injury to any person in the employ of the **CONTRACTOR** and resulting from the granting
of such access. This includes all claims for legal or other expenses reasonably incurred in connection
therewith, insofar as any such loss, damage, injury or death is in any way attributable to the
rendering by **TNPA** of the said assistance to the **CONTRACTOR**, or any act or omission in
connection with the rendering of such assistance.

The **CONTRACTOR** furthermore accepts that entry is granted entirely at his own risk. **TNPA** shall
provide full supervision during the period for which access has been granted to **TNPA** property.
(See Note 4 of General Conditions).

The **CONTRACTOR** agrees to abide by and observe all restrictions, and/or any other
precautions/procedures laid down by **TNPA** personnel to be observed during the period for which
access has been granted to **TNPA** property.

The **CONTRACTOR** hereby confirms his competency (and all personnel employed by him) to carry
out the work on **TNPA** property for which this access permit is being granted. The **CONTRACTOR**
furthermore agrees to carry out all work in strict compliance with the provisions of the *Occupational
Health and Safety Act of 1993; Act No.85 of 1993 (OHSAct)*, and to appoint a safety officer to
ensure continued adherence to the provisions of the above OHSAct .

THUS DONE AND SIGNED ATON THISDAY OF20...

CONTRACTOR: _____ **WITNESS:** _____

<i>General Conditions</i>

1. The **CONTRACTOR** must familiarize himself with TNPA High Voltage Electrical regulations
a copy to be supplied to the **CONTRACTOR** By **TNPA**
2. The **CONTRACTOR** must sign the Substation Log Book every time they enter or leave the
Substation building for the day.
3. The **CONTRACTOR** must ensure that the CO2 Equipment is isolated and turned to manual
during working in the substation and returned to Automatic once leaving the substation.

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

4. The **CONTRACTOR** will be issued with a TNPA HT Key that must be returned to TNPA on termination of Contract. The HT key will only be issued to persons that have High Voltage accreditation with either Durban Metro or ESCOM. Accredited personnel must at all times supervise the execution of work in substations as TNPA personnel will not be able to be present for the full duration of work in substations.
5. TNPA Contact personnel to be contacted in the event of Accidental Tripping of Circuit Breakers to do switching:-
W Buys: 083 414 1018
Mohamed Sheik: 083 446 1567

SUBSTATION TESTING PHILOSOPHY AND GUIDELINES.

The testing of protection equipment on protection schemes presents a number of problems. This is because the main function of protection equipment is solely concerned with operation under system fault conditions, and cannot readily be tested under normal system operating conditions. This situation is aggravated by the increasing complexity of protection schemes and use of relays containing various suppliers' software. The testing of protection equipment is divided into two stages and these are discussed below under:-

- Commissioning tests
- Periodic/routine maintenance tests

1.0 COMMISSIONING TESTS

1.1 Commissioning tests are done at energizing of new equipment onto the electrical reticulation network to prove that a particular protection scheme has been installed correctly prior to switching on the power. All aspects of the scheme are thoroughly checked, from installation of the correct equipment through wiring checks and operation checks of the individual items of equipment, finishing with testing of the complete scheme. The impact of such errors may range from simply being a nuisance (tripping occurs repeatedly on energizing, requiring investigation to locate and correct the error/s) through to failure to trip under fault conditions, leading to major equipment damage, disruption to supplies and potential hazards to personnel.

1.2 The aim of commissioning tests are:-

- To ensure that the equipment has not been damaged during transit or installation especially Vacuum bottles.
- To ensure that the installation work has been carried out correctly
- The tests actually conducted are determined at the time of commissioning by mutual agreement between the TNPA's representative and the commissioning engineer.

1.3 Tests commonly carried out during commissioning include but are not limited to:-

- Wiring diagram check, using circuit diagrams showing all the reference numbers of the interconnecting wiring.
- General inspection of the equipment, checking all connections, wires on relays terminals, labels on terminal boards, etc
- Insulation resistance measurement of all circuits
- Perform relay self-test procedure and external communications checks on digital/numerical relays
- Test main current transformers
- Test main voltage transformers
- Check that protection relay alarm/trip settings have been entered correctly
- Tripping and alarm circuit checks to prove correct functioning In addition, the following checks must be carried out, to prove the Data mapping to I/O list was done correctly for SCADA implementation if required for that particular substation.
- Secondary injection test on each relay to prove operation at one or more setting values.

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

- Primary injection tests on each relay to prove stability for external faults and to determine the effective current setting for internal faults (essential for some types of electromechanical relays)
- Testing of protection scheme logic programmed into protection meter
- Termination check -Ensure that all terminations on Protection relays, Supervisory relays, Aux. protection relays, trip coils and trip circuits are tight and secure. Ensure 100% functionality of closing, trip and supervisory circuits.
- Amp and Voltmeter test -Ensure functionality and basic accuracy of Metering/Indication volt and amp meters by means of secondary injection testing.

Note: this procedure shall be conducted across the 3 individual phases. The results shall be recorded in terms of injection current, instrument indication and % error.

- Earth Fault check -Test and confirm that no DC positive earth fault exist on the entire Protection scheme.
- Trip Coil test -Breaker trip coils to be tested for operation at 80% trip voltage. Trip coil resistance and minimum tripping voltage to be recorded.

1.4 Insulation Tests should include :-

- All the deliberate earth connections on the wiring to be tested should first be removed, for example earthing links on current transformers, voltage transformers and D.C. supplies.
- Some insulation testers generate impulses with peak voltages exceeding 5kV. In these instances any electronic equipment should be disconnected while the external wiring insulation is checked.
- The insulation resistance should be measured to earth and between electrically separate circuits. The readings are recorded and compared with subsequent routine tests to check for any deterioration of the insulation.
- The insulation resistance measured depends on the amount of wiring involved, its grade, and the site humidity. Generally, if the test is restricted to one cubicle, a reading of several hundred mega-ohms should be obtained. If long lengths of site wiring are involved, the reading could be only a few mega-ohms.
- Megger test - All applicable H. V. cables and busbar sections shall be meggered as to confirm standard insulation levels. Megger tests are to be utilized as to ensure the earthing integrity on all C.T.'S and V.T.'S

1.5 Digital and numerical relays usually have a self-test procedure that is detailed in the operation manual. These tests should be followed to determine if the relay is operating correctly. This will normally involve checking of the relay "watchdog" circuit, exercising all digital inputs and outputs and checking that the relay analogue inputs are within calibration by applying a test current or voltage. For these tests, the relay outputs are normally connected to prove correct relay operation.

1.5.1 Unit protection schemes involve relays that need to communicate with each other. This leads to additional testing requirements. The communications path between the relays is tested using suitable equipment to ensure that the path is complete and that the received signal strength is within specification.

1.5.2 After completion of these tests, it is usual to enter the relay settings required. This can be done manually via the relay front panel controls, or using a portable PC and suitable software.

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

1.5.3 Whichever method is used, a check by a TNPA appointed commissioning Technical Officer must verify that the correct settings have been used, and the settings recorded.

1.5.4 Current transformer tests are normally carried out prior to energizing of the main circuits. The CONTRACTOR shall perform the following tests on each CT. in the Protection scheme; including :-

- Ratio Test -The ratio of each CT tap to be confirmed by means of primary injection testing. Ratios to be compared with CT. nameplate data and applicable electrical schematic diagram.
- Polarity Test -_Each current transformer should be individually tested by means of the DC flick test to verify that the primary and secondary polarity markings are correct.
- Magnetisation Curve - The magnetising curve shall be plotted with a minimum of 8 voltage levels by means of injecting the appropriate voltages on the secondary winding and measuring the secondary current with the primary winding open circuited. This test/plotted graph shall clearly indicate the linear path, knee-point and saturation area. Several points should be checked on each current transformer magnetisation curve. This must be done by energizing the secondary winding from the local mains supply through a variable auto-transformer while the primary circuit remains open. The characteristic is measured at suitable intervals of applied voltage, until the magnetising current is seen to rise very rapidly for a small increase in voltage. This indicates the approximate knee-point or saturation flux level of the current transformer. The magnetising current should then be recorded at similar voltage intervals as it is reduced to zero.
- The short-time current rating must be in excess of the CT secondary current rating, to allow for the measurement of the saturation current. This will be in excess of the CT secondary current rating. As the magnetizing current will not be sinusoidal, a moving iron or dynamometer type ammeter should be used.
- It is often found that current transformers with secondary ratings of 1A or less have a knee-point voltage higher than the local mains supply. In these cases, a step-up interposing transformer must be used to obtain the necessary voltage to check the magnetisation curve.

1.6 Voltage transformer tests require testing for polarity and phasing.

- Polarity check - The voltage transformer polarity can be checked using the method for CT polarity tests care must be taken to connect the battery supply to the primary winding, with the polarity ammeter connected to the secondary winding. If the voltage transformer is of the capacitor type, then the polarity of the transformer at the bottom of the capacitor stack should be checked.
- Ratio check - This check can be carried out when the main circuit is first made live. The voltage transformer secondary voltage is compared with the secondary voltage shown on the nameplate.

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

- Phasing check - Correct phasing should be when carrying out 'on load' tests across a normally open Buscoupler where supply from a proven system potential is tested against the equipment been commissioned for the first time.
- 1.7 At some point during commissioning, the alarm and trip settings of the Protection Relay elements involved will require to be entered and/or checked. The method of entering settings varies according to the relay technology used. It is usual to use appropriate software, supplied by the manufacturer, for this purpose. Once the data has been entered, it should be checked for compliance with the recommended settings as calculated from the protection setting study. The recorded settings form an essential part of the commissioning documentation provided to the client.
- 1.8 Secondary Injection tests must always be done prior to primary injection tests. The purpose of secondary injection testing is to prove the correct operation of the protection scheme that is downstream from the inputs to the protection relay(s). Secondary injection tests are always done prior to primary injection tests. This is because the risks during initial testing to the LV side of the equipment under test are minimized. The primary (HV) side if the equipment is disconnected, so that no damage can occur.
- 1.8.1 Secondary Injection test sets are often computer based. They comprise a PC (usually a standard laptop PC with suitable software) and a power amplifier that takes the low-level outputs from the PC and amplifies them into voltage and current signals suitable for application to the VT and CT inputs of the relay. The phase angle between voltage and current outputs will be adjustable, as also will the phase angles between the individual voltages or currents making up a 3-phase output set.
- 1.8.2 Much greater precision in the setting of the magnitudes and phase angles is possible, compared to traditional test sets. Digital signals to exercise the internal logic elements of the relays may also be provided. The alarm and trip outputs of the relay are connected to digital inputs on the PC so that correct operation of the relay, including accuracy of the relay tripping characteristic can be monitored and displayed on-screen, saved for inclusion in reports generated later, and printed for an immediate record.
- 1.8.3 Test Blocks/Plugs for Secondary Injection Equipment - To avoid open-circuiting CT secondary terminals, it is essential that CT shorting jumper links are fitted across all appropriate 'live side' terminals of the test plug BEFORE it is inserted. With the test plug inserted in position, all the test circuitry can now be connected to the isolated 'relay side' test plug terminals.
- 1.8.4 Withdrawing the test plug immediately restores the connections to the main current transformers and voltage transformers and removes the test connections.
- 1.8.5 Replacement of the test block cover then removes the short circuits that had been applied to the main CT secondary circuits. Where several relays are used in a protection scheme, one or more test blocks may be fitted on the relay panel enabling the whole scheme to be tested, rather than just one relay at a time.
- 1.8.6 Digital or Numerical Relay technology is becoming more commonplace. Some manufacturers recommend that if a digital or numerical relay passes its' self test, it can be relied upon to operate at the settings used and that testing can therefore be confined to those parts of the scheme external to the relay. It is required that one

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

element of each relay (usually the simplest) is exercised, using a secondary injection test set, to check that relay operation occurs at the conditions expected, based on the setting of the relay element concerned. Another alternative is for the complete functionality of each relay to be exercised.

- 1.8.7 Curve Test relays -The functionality of each relay must be tested by means of secondary injection at 6 points (1.5 x, 2 x, 4 x, 6 x, 8 x and 10 x) on the applicable IEG 255 I BS 142 time characteristics curve. The mentioned 6-point curve test shall be conducted only on the set settings in terms of plug and time multiplier. The results at each of the curve point's trips to be recorded in terms of phase, current and time. **Note:** this procedure shall be conducted across the 3 individual phases.
- 1.8.8 Thermal Overcurrent Test -The functionality of the O/C element will be tested by means of secondary injection at a value = to full load + 20% overload. Contractor to record O/C current, trip time and relay trip display indication. At the point of injecting only full load current the contractor to record the current value and relay display value for that particular phase. **Note:** this procedure shall be conducted across the 3 individual phases.
- 1.8.9 Phase Unbalance Test -The functionality of the phase unbalance element will be tested by means of 3 phase secondary injection at a value = to full load current - decrease the red phase value by 20% - record trip time and relay trip display indication. This process shall be repeated to the point of injecting 3 phase full load current - decrease the blue phase value by 20% -record trip time and relay trip display indication.
- 1.8.10 Instantaneous Overcurrent Test -The functionality of the instantaneous O/C element will be tested by means of secondary injection at a value = to the highest (1») value as set on the relay -record trip time and relay trip display indication. Note: this procedure shall be conducted across the 3 individual phases.
- 1.9 Earth fault test -The functionality of the earth fault element will be tested by means of secondary injection to the relay and primary injection through the core balance C. T. The contractor to record primary I secondary injection current values, trip times and relay trip display indication.
- 1.10 Undercurrent test -The functionality of the undercurrent element will be tested by means of 3 phase secondary injection at a value = to full load current -decrease the 3 phases values by 50 % -record trip time and relay trip display indication.
- 1.11 Trip circuit test -Functionality testing of the complete trip circuit, physical tripping of applicable --VCB, shall be conducted by means of secondary injection at 1 curve point.
- 1.12 Low-set, High-set and Earth fault test -The functionality"of the Low-set O/C, High-set O/C and Earth fault groups to be tested by means of secondary injection to the set current value as registered with each individual group. The results shall be recorded in terms of trip current value, time in mil. Sec and relay trip display indication. Note: this procedure shall be conducted across the 3 individual phases. If applicable -In addition, the Earth Fault element shall be tested by means of primary injection through the core balance C.
- 1.13 Trip circuit test -Functionality testing of the complete trip circuit, physical tripping of applicable circuit breaker, shall be conducted by means of secondary injection at 1 curve point.

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

1.15 Tripping and Alarm Annunciation Tests - It is essential that all of the tripping and alarm circuits are checked. This is done by closing the protection relay contacts manually and checking that:-

- The correct circuit breakers are tripped
- The alarm circuits are energized
- The correct flag indications are given
- There is no maloperation of other apparatus that may be connected to the same master trip relay or circuit breaker.

a. Many designs of withdrawable circuit breakers can be operated while in the maintenance position, so that substation operation can continue unaffected except for the circuit controlled by the circuit breaker involved. In other cases, isolators can be used to avoid the need for busbar de-energizing if the circuit involved is not ready for energizing.

b. Busbar blocking - High impedance differential bus-bar protection shall be provided for protection of the busbars and any leakage current for the following 3 conditions:-

- Earth faults.
- Phase to Phase faults.
- Three Phase faults.

Note: The switchgear protection "Zones" must be split over two sections; with one current transformer located on each side of the busbar compartment. A separate CT core must be provided for on each side of the busbar chamber

2.0 PERIODIC MAINTENANCE CHECKS (ROUTINE PROTECTION TESTING)

2.1 The Contractor shall perform the specified routine testing works on all the mentioned Circuit Breaker panels, Motor Contactor panels, Main / Aux. Distribution Transformers, Primary / Secondary Circuit Breakers, Current Transformers, Aux. Voltage Transformers and N.E.R. cabinets.

- The Contractor shall record all values, calculations and results of each specified routine test performed as to comply with this specification.
- The Contractor shall compare all recorded curve and time characteristic values of each relay tested with the original manufacturers technical design specification.
- The Contractor shall compile a task list of all major non-compliance defects recorded; smaller defects shall be repaired as to ensure 100% functionality of the protection schema. All repair works shall be conducted according to the guidelines specifications contained in this agreement.

2.4.1 These are required to identify equipment failures and degradation in service, so that corrective action can be taken. Because a protection scheme only operates under fault conditions, defects may not be revealed for a significant period of time, until a fault occurs.

2.5 Regular testing assists in detecting faults that would otherwise remain undetected until a fault occurs.

2.6 Periodic testing is necessary to ensure that a protection scheme continues to provide satisfactory performance for many years after installation. All equipment is subject to gradual

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

degradation with time, and regular testing is intended to identify the equipment concerned so that remedial action can be taken before scheme maloperation occurs. However, due care should be taken in this task, otherwise faults may be introduced as a direct result of the remedial work.

- 2.7 The clearance of a fault on the system is correct only if the number of circuit breakers opened is the minimum necessary to remove the fault. A small proportion of faults are incorrectly cleared, the main reasons being:
- limitations in protection scheme design
 - faulty relays
 - defects in the secondary wiring
 - incorrect connections
 - incorrect settings
 - known application shortcomings accepted as improbable occurrences
 - pilot wire faults due to previous unrevealed damage to a pilot cable
 - various other causes, such as switching errors, testing errors, and relay operation due to mechanical shock.
- 2.8 Frequency of Inspection and Testing - Although protection equipment should be in sound condition when first put into service, problems can develop unchecked and unrevealed because of its infrequent operation.
- 2.9 With digital and numerical relays, the in-built self-testing routines can be expected to reveal and annunciate most faults, but this does not cover any other components that, together, comprise the protection scheme.
- 2.10 Regular inspection and testing of a protection scheme is therefore required. In practice, the frequency of testing may be limited by lack of staff or by the operating conditions on the power system.
- 2.11 Maintenance tests may sometimes have to be made when the protected circuit is on load. The particular equipment to be tested should be taken out of commission and adequate back-up protection provided for the duration of the tests. Such back-up protection may not be fully discriminative, but should be sufficient to clear any fault on the apparatus whose main protection is temporarily out of service.
- 2.12 Maintenance Tests - Primary injection tests are normally only conducted out during initial commissioning. If scheme mal-operation has occurred and the protection relays involved are suspect, or alterations have been made involving the wiring to the relays from the VT's/CT's, the primary injection tests may have to be repeated.
- 2.13 Secondary injection tests may be carried out at suitable intervals to check relay performance, and, if possible, the relay should be allowed to trip the circuit breakers involved. The interval between tests will depend upon the criticality of the circuit involved, the availability of the circuit for testing and the technology of the relays used. Secondary injection testing is only necessary on the selected relay setting and the results should be checked against those obtained during the initial commissioning of the equipment.
- 2.14 It is better not to interfere with relay contacts at all unless they are obviously corroded. The performance of the contacts is fully checked when the relay is actuated.

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

- 2.15 Insulation tests should also be carried out on the relay wiring to earth and between circuits, using a 1000V tester. These tests are necessary to detect any deterioration in the insulation resistance.
- 2.16 Protection Scheme Design For Maintenance - If the following principles are adhered to as far as possible, the danger of back-feeds is lessened and fault investigation is made easier:-
- Test blocks should be used, to enable a test plug to be used, and a defective unit to be replaced quickly without interrupting service.
 - Circuits should be kept as electrically separate as possible, and the use of common wires should be avoided, except where these are essential to the correct functioning of the circuits
 - Each group of circuits which is electrically separate from other circuits should be earthed through an independent earth link
 - Where a common voltage transformer or D.C. supply is used for feeding several circuits, each circuit should be fed through separate links or fuses. Withdrawal of these should completely isolate the circuit concerned
 - Power supplies to protection schemes should be segregated from those supplying other equipment and provided with fully discriminative circuit protection
 - A single auxiliary switch should not be used for interrupting or closing more than one circuit
 - Terminations in relay panels require good access, as these may have to be altered if extensions are made. Modern panels are provided with special test facilities, so that no connections need be disturbed during routine testing junction boxes should be of adequate size and, if outdoors, must be made waterproof
 - All wiring should be ferruled for identification and phase-coloured
 - Electromechanical relays should have high operating and restraint torques and high contact pressures; jewel bearings should be shrouded to exclude dust and the use of very thin wire for coils and connections should be voided. Dust-tight cases with an efficient breather are essential on these types of electromechanical element.
 - Static, digital and numerical relays should have test facilities accessible from the front to assist in fault finding. The relay manual should clearly detail the expected results at each test point when healthy
- 2.17 Schemes using single function electromechanical relay tests – E.G. Type CDG & CAG or similar static relay technology will usually require each relay to be exercised. Thus a scheme with distance and back-up over current elements will require a test on each of these functions, thereby taking up more time than if a digital or numerical relay is used. Similarly, it may be important to check the relay characteristic over a range of input currents to confirm parameters for an over current relay such as:-
- The minimum current that gives operation at each current setting
 - The maximum current at which resetting takes place

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

- The operating time at suitable values of current
 - The time/current curve at 2 or 3 points with the time multiplier setting at 1
 - The resetting time at zero current with the TMS at 1 similar considerations apply to distance and unit protection relays of these technologies.
 - Curve Test on a typical COG type / rotating disc relay -The functionality of each relay will be tested by means of secondary injection at 6 points (1.5 x, 2 x, 4 x, 6 x, 8 x and 10 x) on the applicable IEC 255 / BS 142 time characteristics curve.
 - This mentioned 6-point curve test shall be conducted only on the set settings in terms of plug and time multiplier. Where a relay is equipped with more than 1 plug setting, each plug shall be tested for functionality only on the 4 x point.
 - The-results at each of the curve point's trips to be recorded in terms of phase, current and time. Note: this procedure shall be conducted across the 3 individual phases.
 - High set -If the protection relay is equipped with a High Set element, the functionality will be tested by means of secondary injection. The results to be recorded in terms of phase current and time. Note: this procedure shall be conducted across the applicable phases.
 - Injection test on a typical CDG type relay -The functionality of each relay will be tested by means of secondary injection on the set plug setting. The results shall be recorded in terms of trip current value and time in mil-sec.
 - Trip circuit test -Functionality testing of the complete trip circuit, physical tripping of applicable circuit breaker, shall be conducted by means of secondary injection at 1 curve point.
 - Electromechanical Relay Tests -Type P & B Gold (Motor protection)
 - Thermal Test - The functionality of each relay will be tested by means of connecting the 3 current element in series followed by the specified secondary injection. From cold start, inject $2 \times I_r \times \% \text{ tap I } 100$ -record thermal time to trip. Reduce current to $1 \times I_r \times \% \text{ tap } 1100$ -record time taken for $\%$ Running load to return to 100% (I_r = Ratio between motor full load current and C.T. ratio)
 - Functionality testing of the complete trip circuit, physical tripping of applicable AC8 I VC8, shall be conducted by means of secondary injection at 2 X Full Load Current.
- 2.18 Main and Aux. Distribution Transformer tests - The contractor shall perform the following tests on each Distribution Transformer in the Protection schema. The results shall be recorded in terms of relay operation / indication.
- 2.19 Trip test -Bucholz and Temperature Transformer protection to be trip tested from the Transformer.
- 2.20 Bucholz test -Bucholts relay to be tested by means of injecting approx. 350cc of air into the relay with a Bucholz relay pump. Ensure functionality and circuit integrity of the alarm and trip level floats / contacts.
- 2.21 Temperature relay test -Ensure functionality and accuracy of the temperature relay by means of removing the transducer from the transformer, placing the transducer in a

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

separate heated oil bath and comparing the temperature readings from the relay with a separate calibrated thermometer. Ensure functionality and circuit integrity of the alarm and trip level contacts.

- 2.22 Frame Leakage protection -With reference to Annexure "An -Ensure circuit integrity and functionality of the frame leakage protection schema, by means of primary injection through the C.T. on the transformer core earth. Note: The specified C.T. test will be applicable to this frame leakage C. T. + the specified routine Protection Relay testing.
- 2.23 Neutral Earth Resistance (N.E.R.) tests - The contractor shall perform the following test on each N.E.R. in the Protection schema.
- 2.23.1 N.E.R. test; Sensitive Earth Fault and Balanced Earth Fault protection schemas, ensure circuit integrity and functionality by means of primary injection through the C. T. on the resistor / neutral core earth. **Note:** The specified C. T. test will be applicable to the N.E.R. C. T.'s & the specified routine Protection Relay testing. The resistance of the complete resistor shall be measured and recorded.
- 2.24 Bus-coupler test - The contractor shall perform the following test on each Bus-coupler in the Protection schema. Bus-coupler test -With reference to Annexure "A" -Bus-coupler panel, ensure circuit integrity and functionality by means of testing and recording "Zone Reach", "Zone Resistance Measurements" and "Zone Tripping Sequence" in terms of the 3 Zone functional design. Note: The specified C.T. test will be applicable to the Zone C.T.'s & the specified routine Protection Relay testing.
- 2.25 The Contractor shall perform the following Earthing test on each applicable Substation and Manifold earth bar.
- 2.25.1 Earthing test -The test shall be conducted by means of the 2 earth spike / bridge megger method to determine the earth resistance measurement from the main substation earth-bar, in each of the applicable substations in the distribution schema and from the depot manifold main earth-bar. Measurements to be recorded.
- 2.26 The Contractor shall perform the following Battery test on each protection battery bank in the Protection schema.
- 2.26.1 Battery test -The test shall be conducted by means a variable load resistor connected to the complete battery bank, loading the battery bank to a approx. value of 30% above the nominal current value measured at that particular substation (minimum of 20 A).
- 2.26.2 The contractor to measure the change in voltage for a period of time. Measurements to be recorded in terms of current and voltage curve.
- 2.26.3 The contractor to express an opinion on the general state of the protection battery bank and identify problematic cells.

3.0 CABLES AND TERMINATIONS

- Medium voltage stress cone type terminations or potheads shall remain intact but testing shall not include any bus work beyond the pothead or stress termination.

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

- Cable continuity and phase identification shall be checked.
- In setting up the test set special safety precautions should be taken regarding grounding of the test equipment. The test set, its voltmeter and the cable shield should be grounded at the same ground.
- All four core cables shall be tested between one conductor and ground with the other conductors and the metallic shield, metallic sheath or armour grounded to the same ground. Each conductor to be tested in this manner.
- All single conductor cables shall also be tested between one conductor and ground with the other conductor in the same conduit grounded.
- Each cable is to be given a full dielectric absorption test as herein specified with a suitable motor driven or electronic megger. The readings taken shall be recorded in the test record.
- The dielectrical absorption megger test shall be applied for a long enough duration to fully charge the cable. Megger readings shall be taken every fifteen (15) seconds during the first three (3) minutes and at one (1) minute intervals thereafter. The test shall continue until three (3) equal readings one (1) minute apart are obtained. The cable may then be considered to be fully charged.
- All cables should have approximately the same megaohm reading. In the event that a cable shows an appreciably lower resistance value than the others in the same conduit or cable run, this condition shall be discussed with the Technical Officer prior to the application of the high potential test.
- After an acceptable megger test, the Contractor shall give the cables a direct current (DC) high potential test. The test potential shall be 80% of the factory test voltage for 15 minutes. The test voltages shall be applied gradually during the first minutes in five equal steps. Leakage current readings shall be taken at each voltage increment, and at one (1) minute intervals after full test voltage has been applied for the remainder of the test. After completion of the test, cables shall be discharged slowly. No test will be accepted where there is an appreciable increase in leakage current throughout the test.
- Cables shall not be subjected to more than one (1) high potential test without approval of the Technical Officer. During these tests, a man shall be stationed at each point where the cable has exposed connections.
- Acceptance:
The cable must withstand the specified high voltage without an appreciable increase in leakage current.
- Final acceptance will also depend on satisfactory results of the two megger tests. The results of the final megger test should reasonably parallel those of the first megger test and should show no evidence of permanent injury to the cable caused by the high voltage test.
- Complete and accurate records of all megger and accompanying high potential tests shall be made. The records shall include the following:-

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

- (a) Complete identification of the cable including its approximate length;
- (b) Megger readings vs time data;
- (c) High potential and leakage current readings vs time data;
- (d) The approximate average cable temperature.

- No cable shall be energized until the Technical Officer approves the master copy of its test record.

MEDIUM VOLTAGE SWITCHGEAR AND CIRCUIT BREAKERS

- 3.1 All switchgear shall be given operational tests. This shall include mechanical operation, as well as operation by control circuits, relays and tripping devices.
- 3.2 All breakers and busbars shall be pressure tested between each phase separately and ground with other phases tied to ground. All breakers shall be racked-out.
- 3.3 In addition, each breaker shall be tested in the racked-out and closed position. Tests shall be applied between each phase to ground and to each other phase.
- 3.4 All circuit breakers shall be operated through at least three (3) open-close-open cycles in both the rack-in and test positions by manual operation and by control circuits from each control point. All indication lights, annunciators, alarms and targets shall be observed to determine correct operation and breaker mechanism shall be observed for correct alignment, freedom of binding and good contact. All breakers shall be checked for ease of rack-in and rack-out and checked to determine that the breaker cannot be moved out of operation position while the breaker is closed.
- 3.5 The interchange ability of the circuit breakers shall be demonstrated.
- 3.6 PT and CT data shall be recorded and PT and CT circuits shall be checked for continuity, insulation resistance and polarity.
- 3.7 Protective relays shall be adjusted and calibrated with an injection type test arrangement (multi-amp or equal). Results shall be recorded and the co-ordination of the protective relaying shall be proved.
- 3.8 After initial energization, switchgear shall be checked for correct phase sequence.

4.0 POWER TRANSFORMERS

- 4.1 Before testing, all transformers shall be inspected for cleanliness, damage, moisture (blue coloured silica gel), oil leaks and phase identification. Each transformer winding shall be individually tested. Oil filled transformers shall have the oil tested for dielectric strength. Accessories and auxiliary circuits to switchgear and alarm panels shall also be checked.
- 4.2 Transformer windings shall be tested with cables disconnected.
- 4.3 The 400 volt connection to the switchgear does not have to be opened, but the secondary isolator shall be racked out.
- 4.4 The transformer neutral has to be disconnected from ground.

Transnet National Port Authority
Electrical Engineering SPECIFICATION NO. DHE. HT_ST_01 - 06- 2021

- 4.5 When meggering the primary side, the secondary winding has to be grounded and vice versa.
- 4.6 The minimum values of the specified megger tests shall be as specified in the standard specification.
- 4.7 All 2500 V megger tests shall be held at least five (5) minutes and until three (3) consecutive equal readings one (1) minute apart are obtained. Readings shall be taken every thirty (30) seconds during the first two (2) minutes and every minute thereafter. 1000 V Megger readings must be held until the reading reaches a constant value and until three (3) consecutive equal readings one (1) minute apart are obtained.
- 4.8 The oil samples for the dielectric strength test shall be taken from the bottom of the transformer tank and tested in accordance with SABS Specifications.
- 4.9 Oil temperature indicator, level gauge and pressure relief devices must be manually actuated to check operation of auxiliary circuits.
- 4.10 To check the Bucholz relay, air shall be injected at the test connection.