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TITLE	STANDARD FOR POWER TRANSFORMER REFURBISHMENT AND REPAIRS ONSITE AND OFFSITE	REFERENCE	REV
		CP_TSSTAN_063	1
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**STANDARD FOR POWER TRANSFORMER
REFURBISHMENT AND REPAIRS ONSITE
AND OFFSITE**

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FOREWORD

Recommendations for corrections, additions or deletions should be addressed to the:

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2016

INTRODUCTION

This standard applies to all transformers that are currently in use in the City Power Transmission Network that have been earmarked for repairs/refurbishment for re-use in Transmission and Substations.

The standard provides guidelines to the *Contractors* and *City Power employees* or any other representatives in determining the degree of repairs and refurbishment and also assists in outlining their responsibilities for power transformers ranging from 5MVA to 315MVA for indoor and outdoor use.

This standard shall be read and implemented in conjunction with CP_TSCHECK_069.

1 SCOPE

This standard covers the general requirements for the repairs and refurbishment of power transformers ranging from 5MVA to 315MVA for both indoor and outdoor use.

2 NORMATIVE REFERENCES

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

CP_TSSPEC_037: Specification for Power Transformers rated at 40MVA 88/11kV, 45MVA 88/11kV and 45 MVA 132/11kV

CP_TSSPEC_097: Specification for Power Transformers rated at 10MVA and 20MVA

CP_TSSPEC_147: Specification for Power Transformers rated at 315MVA

CP_TSSPEC_163: Specification for Power Transformers rated at 250 MVA

CP_TSSPEC_001, Specification for 11 kV and 22 kV Paper and XLPE cables

CP_TSSPEC_002, Specification for low voltage insulated wire, power and multi-core control cables

CP_TSSPEC_030, Specification for metal cable glands

CP_TSSPEC_016, Specification for contactors

CP_TSSPEC_017, Specification for miniature circuit breakers

CP_TSSPEC_117, Specification for station class, metal-oxide surge arrestors without spark-gaps

CP_TSSPEC_119, Specification for HV current transformers

CP_TSSPEC_116, Specification for new and regenerated mineral insulating oil

CP_TSSPEC_132, Specification for silica gel

CP_TSSPEC_179, Specification for on-line dissolved gas analyser

CP_TSDRAW_050, Wiring of the marshalling kiosks

South African Occupational health and safety act (as amended), Act no. 85 of 1993

NRS 029, Current transformers for rated a.c. voltages from 36 kV up to and including 420 kV (Maximum voltage for equipment)

NRS 054, Power Transformers

NRS 079: Mineral insulating oils (uninhibited and inhibited)

SANS 555: Unused and reclaimed mineral insulating oil for transformers and switchgear

SANS 60076-1: *Power Transformers – Part 1: General*

SANS 60076-2: *Power Transformers– Part 2: Temperature rise*

SANS 60076-3: *Power Transformers– Part 3: Insulation level and dielectric tests*

SANS 60076-4: *Power Transformers– Part 4: Guide to lightning impulse and switching impulse test Power transformers and reactors*

SANS 60076-5: *Power Transformers– Part 5: Ability to withstand short circuit*

SANS 60076-10: Power Transformers– Part 10: Determination of sound levels

SANS 60076-7: Power Transformers– Part 7: Loading guide for oil immersed power transformers

SANS 60137, Insulated Bushings for alternating voltages above 1000V

SANS 1400: Environmental systems – *Requirements with guidance for use*

City Power has a preference to standardise on some of the equipment. Where applicable, the equipment has been specified as such within those specifications. Wherever the term standard is used in this specification, this shall mean the latest City Power/ international / national standard in the following order of priority:

Wherever the term goods, material and/or equipment is used it shall mean new, unused and of the most recent or current models, incorporating all recent improvements in design and materials, tested in accordance with the required standard.

3 DEFINITIONS AND ABBREVIATIONS

The following definitions and abbreviations in the above documents shall apply to this standard.

- 3.1 City Power CP_TSSPEC_037.
- 3.2 NRS (National Rationalisation of Specifications).
- 3.3 SANS (South African National Standards).
- 3.4 IEC (International Electrotechnical Commission).
- 3.5 IEEE (Institute of Electrical and Electronic Engineers Inc.).
- 3.6 BS (British Standard).
- 3.7 PCB (Polychlorinated biphenyl's)
- 3.8 DGA (dissolved gas analysis)
- 3.9 FAT (factory acceptance testing)
- 3.10 SAT (site acceptance testing)

4 REQUIREMENTS

4.1 General

Nothing in this standard shall lessen the obligation of the supplier/contractor. The supplier/contractor shall be fully responsible for the testing, repairs and refurbishment and maintenance of the power transformer and its satisfactory performance in service. Approval by City Power shall not relieve the supplier/contractor of the responsibility for the adequacy of the repairs and refurbishment.

The contractor shall comply fully with as much detail as possible Annexure C.3 (ON SITE MAINTANACE) of the Transformer Refurbishment Checklist and submit the report with the lead times and expected completion time of the refurbishment prior to any work commencing.

4.2 Service conditions

The requirements in this specification apply to transformers for use under the following general conditions described in Table 1.

Environment	Limits
Application	Outdoors or indoors
Altitude	The design shall be based on an altitude of 1800 m a.m.s.l
Maximum ambient air temperature	Hottest any time 40 °C Hottest monthly average 30 °C
Yearly average ambient air temperature	20 °C
Minimum ambient air temperature	Coldest any time -10 °C
Variation in humidity	10% to 90%

Table 1: Atmospheric conditions

4.3 Insulation

The winding insulation shall be of a uniform nature, i.e. non-graded. The copper conductors shall be covered by thermally upgraded paper. The rating of the winding insulation shall be as described in Table 2 below.

Nominal Voltage (kV) Un	Highest Voltage (kV) Um	Rated short duration power-frequency voltage (kV) at 50 Hz	Rated peak lightning impulse withstand voltage (kV)
275	300	395	950
132	145	275	650
88	100	185	450
33	36	88	200
22	24	50	125
11	12	28	95
6.6	7.2	28	95

Table 2 – Winding insulation (based on SANS 60076-3)

4.4 Windings

4.4.1 All and any winding replacements shall be replaced with electrical grade copper with a purity of 99.9% or better in accordance with CP_TSSPEC_037 in clause 7.5 a.

4.4.2 The winding conductor shall be wound in a dust free environment where the atmospheric conditions (temperature and humidity) are controlled better in accordance with CP_TSSPEC_037 in clause 7.5 b.

4.4.3 No resin shall be used on the windings.

4.4.4 Insulated sample conductors (same insulation material used during manufacturing) shall be made and placed inside the tank during the processing and drying of the transformer. These samples may only be removed after FAT is complete, prior before the tank overpressure test is done, after the electrical part of the FAT. The paper strength shall exceed a degree of polymerisation (DP) of 1100 as per IEC 60450.

4.5 Oil

- 4.5.1 The *Contractor* shall drain oil from the existing transformer and where required provide new virgin oil for the refurbished/ repaired transformer. The supplied oil shall comply fully with the requirements of CP_TSSPEC_116.
- 4.5.2 The drained oil shall be delivered to City Power, if not exchanged, including oil from scrapped transformers.
- 4.5.3 Contractor shall ensure that adequate oil storage capacity is available on site during the repair of transformers, in cases where oil will not be replaced or exchanged, thus be re used upon completion of refurbishment.
- 4.5.4 The contractor shall provide a SANS 555 report and full DGA and moisture analysis of the bulk stored oil which will be supplied with the refurbished transformer.
- 4.5.5 The contractor shall provide a SANS 555 report and full DGA and moisture analysis of the oil filled into the refurbished transformer.
- 4.5.6 The contractor shall attach the certificate for establishment of PCB level for oils returned to City Power.

4.6 Bushing insulators

- 4.6.1 Bushing insulators shall comply with the requirements of SANS 60137. Old bushings shall be tested to ensure their compliance to the standard.
- 4.6.2 Every bushing shall be supplied complete with an air-side bushing terminal that shall be suitable for connecting the stem to an aluminium conductor (UPAS) of diameter 26 mm.
- 4.6.3 The design of insulators for 33 kV and above shall be such as to minimize corona discharge and radio interference and shall have test tapings.
- 4.6.4 Connections from main windings to bushing insulators shall be flexible.
- 4.6.5 High and low voltage bushings shall be supplied with external connectors.
- 4.6.6 Clamps and fittings shall be made of steel or malleable iron and shall be galvanized.
- 4.6.7 Bushings shall be stored in accordance with manufacturer's instructions.

4.7 On site transformer maintenance and service

4.7.1 Site establishment

This shall include staff induction, processing equipment, establishment of adequate electricity supplies, etc.

The site established shall be a clean and dry environment with temporary or permanent structures as required, a detachable roof is recommended. A positive pressure and climate conditions is a must for a clean and workable environment.

The contractor shall bring his own transformer drying equipment and heavy lifting machinery that is capable of lifting transformers sized from 5 to 315 MVA respectively.

City Power shall ensure an area 4-6 times the transformer footprint area for site establishment; the contractor shall be responsible for the soil preparation and rehabilitation of the soil and site area.

The contractor shall ensure the site is safe and necessary barricading installed when working in a live yard, ensuring both safe working conditions for the contractor and the team members while also ensuring that normal City Power operations can continue.

The contractor must have a suitable site manager with ORHVS certification on site at all times during work operations on site.

City Power responsible person shall provide ablution facilities and 400 V supply point for welding and testing purposes.

4.7.2 Transformer repairs

The Contractor shall be responsible to supply, deliver and install all equipment and material required to execute the work, even though not specifically referred to in this specification and shall ensure that all the necessary field test facilities and equipment required for the successful execution of onsite repairs are available and in working condition at all times. Only after electrical tests and oil analysis have been conducted and test certificate issued can the transformer be handed over to City Power.

The allowable work to be done on site shall include:

1. Re-gasketing,
2. Tap changer repairs,
3. Gasket leaks sealing, Sealing of leaking gaskets
4. Oil purification [regeneration],
5. Oil replacement,
6. Oil drainage and top up and
7. Dehydrating Breather Maintenance/Service
8. Changing of Silica Gel Desiccant
9. Fans and fan motors service/maintenance and replacement
10. Oil circulation pumps and motors service/maintenance and replacement
11. Conservator inspection and Service
12. Bucholtz Inspection and Service
13. Winding Temperature Indicator Test and Service
14. Oil Temperature Indicator Test and Service
15. Maintenance, servicing and filter replacement of the mobile online moisture removal unit
16. Maintenance, servicing and calibration of the online gas monitoring unit.

All electrical testing shall be carried out in the presence of the “City Power’s” Authorised representatives. All testing shall be in accordance to the IEC/SANS standards and Tests will be conducted with fully assembled Transformer with its own spares and equipment.

The electrical tests shall include, but not limited to the following: Winding resistance test

1. Ratio test
2. Phase displacement
3. Insulation resistance
4. Polarity index (PI)
5. No load test (eddy current loss +hysteresis loss) +load losses and impedance
6. Zero Sequence Impedance (Only in YY windings)
7. Induced over voltage with partial discharged (PD) (running concurrently)
8. Capacitance and Tan delta
9. SFRA
10. Separate-source voltage Withstand test
11. Oil testing, Short temp rise at rated I (amp) (4 Hours)
12. DGA
 - a. Water
 - b. Dielectric strength
 - c. Acidity
 - d. Colour
13. Noise level test (Acoustic)
14. Bushing tests
 - a. Tan Delta
 - b. PD tests
15. Build in CT's
 - a. Polarity
 - b. Ratio
 - c. Knee Point
 - d. Position where installed in winding
16. Over Pressure Test

City Power responsible person shall also carry out their own quality control tests and inspections checks and any defects noted shall be rectified by the Contractor within the agreed time frame.

4.7.3 Warranties

The contractor shall give City Power a one (1) year warrantee from date of commissioning/energizing. The commissioning date to be submitted to Planned Maintenance department for monitoring.

4.7.4 Access to sites

The Contractor shall ensure that all necessary road clearance permits and approvals are received and that access routes to and from the site are at all times kept serviceable.

4.7.5 Transportation requirements

In the event where the transformer is to be moved from site [substation] to a recognised offsite maintenance facility, the Contractor shall ensure that impact recorders are installed on the unit. The impact recordings shall be logged at the commencement of the journey and at the end of the journey. These results shall accompany the transformer to its' final destination and be included in the transformer test and certification documentation package that shall be submitted by the Contractor and received by City Power responsible person at the hand-over of the unit.

The Contractor shall ensure that standard roads and transportation regulations of sensitive consignment are considered and adhered to and that the vehicle and rigging capabilities shall be of the stipulated power transformer loads (5MVA-315MVA).

4.7.6 Security

All equipment shall be safely stored and protected against possible theft or damage. All equipment shall be the Contractor's responsibility for the duration of the project.

4.7.7 Site rehabilitation

After completion of project the Contractor shall ensure that the site is clean and returned to its original state, any building damage shall be repaired. All surplus and dismantled equipment and materials shall remain the property of City Power and shall be transported to City Power designated site.

If there is oil spillage it shall be reported to City Power and a detailed report on how the spillage occurred and the procedure of the removal of the oil from the soil shall be given to City Power. The oil spill will be managed by a specialist contractor and on completion of the process to rehabilitate, the clearance certification will be submitted to City Power for safekeeping.

4.7.8 Fans, Fan motors and pumps

All transformer cooling fans and fan motors and circulation pumps shall be properly checked for wear and tear, moisture ingress and correct rotation.

All fan motors and pumps that cannot be repaired on site shall be transported City Power. The integrity of all fan guards and blade screening shall be checked and secured.

4.8 Off-site [workshop] refurbishment / repairs

4.8.1 Transformer inspection and tests

The contractor shall perform a visual inspection; perform electrical tests and analysis of oil samples to prove the severity of the transformer performance. The contractor shall write a report to City Power explaining the state of the transformer, the conclusion and recommendations

City Power shall at any time carry out progress inspections to ensure that proper quality control measures are followed.

4.8.2 Dismantling, removal and transportation

City Power shall isolate, disconnect and earth the transformer and handover to the contractor. City Power shall ensure that all protection and control circuitry has been made safe and electrically disconnected, to be proved to "dead" in the presence of the appointed contractor.

The Contractor shall dismantle and remove all transformer loose parts, neatly pack on site in order to prepare the transformer for rigging out of the transformer bay (on site).

All rigging work shall only be undertaken by a qualified [trade tested and certified] rigger as per SAQA regulations.

All rigging equipment, mobile as well as workshops, shall be load tested and certified. The certificates shall be available at all times.

The Contractor shall rig and remove the transformer from the transformer bay (on site) onto a suitable vehicle, prepare the transformer and all removable and non-removable accessories for transport to City Power via the rotatable process.

4.8.3 Workshop and testing facilities

The Contractor's repair and testing facility shall be fully equipped to repair/ refurbish transformers ranging from 5MVA to 315 MVA and have test bay facilities capable of performing all tests in accordance to the applicable IEC/SANS 60073 standards.

Workshop shall be equipped with an overhead crane with minimum lifting capacity of 100 Tons, and shall also be equipped with vapour drying out equipment which can cater for drying out of transformer ranging from 5MVA to 315MVA Transformers.

4.8.4 Storage

Storage of up to a maximum of 3-6 months after hand over shall be provided by the Contractor at his premises where after normal storage rates shall apply.

The appointed contractor shall ensure that the necessary long term storage specifications and standards are met.

City Power reserves the right to perform in location inspections from time to time of the in storage units.

4.8.5 Transportation to the designated site

The Contractor shall ensure that the transformer is delivered to City Power's designated site and all accessories shall be stored in crates, clearly marked and the description of each item well defined. All transformer oil openings to be tightly sealed off with 6mm [minimum] thick steel blanking plates and gaskets, Suitable sleepers (wood) shall be supplied to place the transformer onto where transformer plinth is not available.

The Contractor should also ensure that all accessories accompany the transformer to its destination, and a clearly documented audit trail provided.

Electronic Impact Recorders shall be installed when transporting the transformer from the workshop to a specified site. Pre transport sampling shall be recorded and again once offloaded at the designated site. These records are to form part of the official hand over and commissioning documentation at the end of the project.

4.8.6 Factory Acceptance Test

A full factory acceptance test shall be performed and shall include full oil analysis tests, SANS 555, DP paper report and transformer electrical [listed below] test and mechanical tests. The transformer shall comply fully with City Power checklist [CP_TSCHEK_069].

Factory Acceptance Tests shall be witnessed by City Power's nominated representative. The Contractor shall inform City Power of any upcoming factory acceptance tests, in writing, two weeks prior to the proposed test dates.

Tests will be conducted with fully assembled Transformers with its own spares and equipment

The electrical tests shall include, but not limited to the following: **Winding resistance test**

1. Ratio test
2. Phase displacement
3. Insulation resistance
4. Polarity index (PI)
5. No load test (eddy current loss +hysteresis loss) + (Load losses and Impedance)
6. Zero Sequence Impedance (Only in YY windings)
7. Induced over voltage with partial discharged (PD) (running concurrently)
8. Capacitance and Tan delta
9. SFRA (swept frequency response analysis)
10. Separate-source voltage Withstand test
11. Lightning impulse withstand Full and Chopped wave
12. Temp rise at rated I (Amp) (4 hours)
13. DGA
 - a. Water
 - b. Dielectric strength
 - c. Acidity
 - d. Paper insulation test report to be included if rewound was part of the scope (DP and Moisture-paper)
 - e. SANS 555 test to be connected for the bulk oil to be used and report submitted (IEC limits accepted)
14. Noise measurement test (acoustic)
15. Bushing tests
 - a. Tan Delta
 - b. PD Test
 - c. Lightning Impulse Withstand
16. Build in CT's
 - a. Polarity
 - b. Ratio
 - c. Knee Point
 - d. Position where installed in winding
17. Over Pressure Test

4.8.7 Site Acceptance Test

- i. A full site acceptance test shall be performed to include full oil analysis tests and full transformer electrical and mechanical tests. The transformer shall comply with City Power checklist.
- ii. Site acceptance test shall be witnessed by City Power's nominated representatives.

4.8.8 Handing over

Only after electrical, mechanical tests and full oil analysis, SANS 555 and paper DP results have been conducted and test reports issued can the transformer be handed over to City Power. It shall be however noted that before final hand over City Power might also carry out their own quality control tests and inspections checks and any concerns and issues shall be reverted back to the Contractor for rectification.

4.9 Transformer handling

4.9.1 Storage

The transformers shall be restored and stored according to the Original Equipment Manufacturers (OEM) manuals.

The transformer shall be stored fully assembled and filled with oil and no gas top up shall be allowed.

The Contractor/City Power shall ensure that maintenance is done periodically, on stored transformers, according to the OEM's maintenance manual. Oil sampling and analysis shall also be performed periodically on the stored transformer to ensure there is no moisture ingress in the transformer.

4.9.2 General handling

The transformer shall only be loaded and/or off-loaded by qualified and certified riggers. The contractor shall produce proof of such qualification to City Power prior to any transformer loading and/or off-loading.

The contractor shall ensure to follow the OEM's manuals on transformer handling.

4.9.3 Environmental impact

The contractor shall perform an environmental impact assessment in the event of an oil spillage. The contractor shall provide a method statement on how the spillage shall be contained and soil/ground contamination eliminated. The contractor shall also provide a method statement on environmental rehabilitation.

The environment shall be rehabilitated and reinstated to its original state/condition subsequent to any work performed on site.

4.10 Transformer colours

The refurbished transformer colour shall comply fully with CP_TSSPEC_037.

Bushing turrets shall be painted according to phase colour marking and shall be clear and unobscured.

4.11 Conditions of maximum rating, temperature rises and sustained overloads

Continuous maximum rating, temperature rise and overload shall comply with SANS 60076-2 requirements and the SANS Loading Guide when operating with natural or forced cooling.

4.12 Duty under fault conditions

Transformers shall be capable of withstanding short circuits for the periods of time as specified in SANS 60076-5 when operating on any tap position, including that corresponding to minimum effective impedance.

4.13 Efficiency and losses

4.13.1 The efficiency and losses of each transformer shall be specified in Annex C of CP_TSSPEC_037

4.13.2 The capitalized value of each transformer's losses shall be specified in Annex C of CP_TSSPEC_037.

4.14 Regulation and impedance

The voltage regulation from no load to continuous rated output at unity power factor and at 0, 8 lagging power factor with constant voltage across the high voltage windings shall be as specified in Annex C of CP_TSSPEC_037

The impedance voltage between HV and LV windings at normal ratio of transformation and continuous maximum ratings shall be as specified in Annex C of CP_TSSPEC_037.

4.15 Vibration and Noise

The vibration and average noise level shall be as specified in Table 1 below:

Equivalent two winding transformer rating [MVA]	Average Sound level, (dBA)	
	ONAN	ONAF
10	70	71
20	73	74
40	76	77
45	76	77
250	85	86
315	85	86
Notes: For ONAF ratings, the sound levels are with the auxiliary equipment in operation		

Table 3 – Audible sound levels for oil immersed power transformers

4.16 Voltage control

4.16.1 Tap changing gear shall comply with NRS 054.

4.16.2 Transformation shall be carried out without changing phase displacement throughout the complete range of tapings.

4.16.3 The on load tap changing gear shall be provided with local hand operating gear and arranged for remote control.

4.17 Indicating devices and alarms

Temperature Indicating Devices and Alarms

4.17.1 Oil and winding temperature indicating devices shall be as specified in NRS 054. The winding temperature indicating devices shall be so designed that it shall be possible to move the pointers by hand for the purpose of checking the operation of the contacts and associated equipment.

4.17.2 The auxiliary supply shall be rated as specified in Annex C of CP_TSSPEC_037.

4.17.3 Gas and Oil Actuated Relays shall be as specified in NRS 054.

4.18 Marshaling kiosk, control and instrument wiring

4.18.1 These shall comply fully with clause 4.20 of CP_TSSPEC_037.

4.19 Current transformers

4.19.1 The current transformers shall comply fully with clause 4.21 of CP_TSS_037.

4.20 Surge arrestors for HV and MV

4.20.1 The surge arrestors shall comply fully with CP_TSSPEC_037.

4.21 Multicore cables and terminal cables

4.21.1 These shall comply fully with CP_TSSPEC_037.

5 RISK ASSESSMENT AND ENVIRONMENTAL CONDITIONS

- 5.1. The Contractor shall be responsible for adhering and maintaining safe, acceptable environmental management conditions on site and shall in conjunction with City Power ensure that proper oil drainage regimes are followed from date of commencement of work until work is completed and handed back over to City Power
- 5.2. The Contractor shall also complete a risk assessment to ensure secure and safe working conditions and submit the full SHERQ file to City Power responsible personnel.
- 5.3. The appointed contractor shall ensure that their responsible personnel have the necessary valid ORHVS certification for onsite works and be qualified to safely access electrical plant and equipment

6 WORKSHOP AND TESTING FACILITIES

6.1 Workshop Facilities

The workshop area shall be clean and dry. It shall have vertical winding lathes and an overhead crane with a loading of not less than 100 tons. The rewind and tanking area shall be dust free and under positive pressure. Vapour phase process capabilities are essential.

6.2 Testing Facilities

The workshop testing facilities shall be accredited by SANAS or equivalent body. The facility shall be ISO 9001 and 14001 accredited.

7 TESTS

The following tests shall be performed on refurbished transformers

- 7.1. Winding resistance test
- 7.2. Ratio test
- 7.3. Phase displacement
- 7.4. Insulation resistance
- 7.5. Polarity index (PI)
- 7.6. No load tests (eddy current loss and hysteresis loss)
- 7.7. Zero phase impedance
- 7.8. Induced over voltage
- 7.9. Capacitance and tan delta
- 7.10. Swept frequency response analysis (SFRA)
- 7.11. Separate-source voltage withstand test
- 7.12. Lightning Impulse
- 7.13. Noise level measurement (acoustic)
- 7.14. Full DGA and moisture test

8 TRANSFORMER CHECKLIST

Once a decision to repair/refurbish has been taken, City Power in conjunction with the Contractor shall verify the transformer parts and their condition before any refurbishment/repair is undertaken using a form in Annexure C1. This form shall then be given to the Contractor and copies shall be given to the following departments:

1. Planning
2. Asset Management
3. Engineering Workshop (transformer bay)
4. Field Services Primary Plant and
5. Field Services Secondary Plant

- 6. Technology Services (Primary Plant)
- 7. Planned Maintenance.

All the transformer parts shall accompany the transformer to its designated site and shall be the Contractor's responsibility for the duration of the project.

9 DOCUMENTATION

- 9.1. A copy of all Factory Acceptance Test reports shall be provided.
- 9.2. A copy of all Site Acceptance Test reports shall be provided.
- 9.3. A copy of the warrantee period and agreement
- 9.4. Impact recordings.
- 9.5. Dry-keep and DGA service and calibration certificates.

10 WARRANTEE PERIOD

A written one year warrantee based from time of energising for all refurbished transformers shall be provided.

11 HANDING OVER

Refurbished transformer shall only be accepted by City Power after the site acceptance test proves it complies with City Power specification and checklists.

12 QUALITY ASSURANCE

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

13 ENVIRONMENTAL MANAGEMENT

An environmental management system shall be set up in order to assure the environmental compliance of the power transformers throughout its entire life cycle (i.e. during design, development, production, installation, operation and maintenance, decommissioning and disposal phases). Guidance on the requirements for an environmental management system may be found in SANS 14001 and City Power Policy. The details shall be subject to agreement between the purchaser and supplier.

14 HEALTH AND SAFETY

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

ANNEXURE A - Bibliography

None

ANNEXURE B: Revision Information

DATE	REV. NO.	NOTES
June 2014	0	First issue Combined existing checklist into standard
Jan 2019	1	Changed the document heading Added the Sub-Station group committee members Revision of Annexure C (Entire annexure was changed) Included Annexure D

ANNEXURE C: COMPLIANCE CHECKLIST

C.1: TRANSFORMER ASSESSMENT

Item	Description of the job	Yes/No	Comments
1.	Site Establishment		
1.1	Establish site according to sub – clause 4.7.1 of this document		
2.	Transport and Rigging		
2.1	Hydraulic crane truck hire 0 – 100 tons		
2.2	Hydraulic crane truck 50 – 300 tons with boom height of 50m		
2.3	Transformer rigging using jacking system (0 – 100tons)		
2.4	Transformer rigging using a crane (0 – 100tons)		
2.5	Remove existing unit from site 0 – 100 tons		
2.6	Remove existing unit from site 20 – 40 tons		
2.7	Remove existing unit from site 40 – 60 tons		
2.8	Remove existing unit from site 60 – 80 tons		
2.9	Remove existing unit from site 80 – 100 tons		
2.10	Transport of transformer to workshop (per km)		
2.11	Offload transformer at workshop facilities		
3.	Inspections and Analysis - Active Part		
3.1	Untank active parts and assess		
3.2	Conduct preliminary test on transformer active parts		
3.3	Conduct Full oil analysis (DGA; Water, kV and acidity)		
3.4	Conduct DP analysis on the paper		
4.	Inspections and Analysis - Tank		
4.1	Inspect tank		
4.2	Inspect all motors and coolers		
4.3	Inspect all pressure relief devices		
4.4	Inspect conservator		
4.5	Inspect all valves and piping		
5.	Bushings		
5.1	Conduct preliminary tests on all bushings. For condenser type bushings, Tan Delta/Partial Discharge test are required (issue test certificate)		
5.2	Take oil samples from bushings and have them analysed (with supervision from City Power)		
5.3	Drain oil, dismantle and inspect all the bushings		
6.	On-load tap changer (Box-type)		
6.1	Open front cover and inspect the defects		
6.2	Remove all contact epoxy boards and inspect for cracks or any other defects		
6.3	Remove barrier boards and inspects for cracks and effects		

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Item	Description of the job	Yes/No	Comments
6.4	Inspect pressure relays for defects and check settings		
6.5	Inspect mechanical drive mechanism for defects		
6.6	Record transitional resistor value and compare with the name plate information where applicable		
6.7	Inspect all contacts and shafts for wear and defects		
7.	On-load tap changer (Cylinder-type)		
7.1	Open and drain oil from the diverter switch		
7.2	Dismantle and untank the diverter switch		
7.3	Inspect, test and overhaul diverter switch		
7.4	Replace all faulty parts		
7.5	Test the diverter tube for leaks		
8.	Reporting		
8.1	Supply full detailed report and recommendations		
8.2	Scrap copper price must be provided and indicated as a savings		

Tender Number: _____

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

Full name of company:

C.1: ADDITIONAL ACTIVITIES

Any additional activities offered to the above checklist shall be listed below with reasons for addition.			
Item	Description of the job	Yes/No	Comments

Tender Number: _____

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

Full name of company:

C.2: FACTORY REPAIRS / REFURBISHMENT

Item	Description of the job	Yes/No	Comments
1.	Site Establishment		
1.1	Establish site according to sub – clause 4.7.1 of this document.		
2.	Active parts		
2.1	Untank active parts and assess		
2.2	Conduct preliminary test on transformer active parts		
2.3	Dismantle yoke and remove faulty windings		
2.4	Check , clean and overhaul core		
2.5	Renew core bolt and clamp insulation as required		
2.6	Strip and rewind all coils using new bright annealed high conductivity copper covered with Kraft paper. (Provide DP results for the paper – certificate) before and after processing		
2.7	Conduct preliminary test on new coils		
2.8	Pre-press winding(s) to specification		
2.9	Reassemble and dry core and windings		
2.10	Conduct pre-test to ensure correct ratios and resistances		
2.11	Fit and tape harnessing for final dry-out		
3.	Tank and parts		
3.1	Drain oil from tank and clean and inspect tank.		
3.2	Overhaul and re-gasket tank and parts (valves, pumps, inspection plate, coolers etc.)		
3.3	Overhaul and pressure test all coolers (issue test certificate)		
3.4	Overhaul cooling motors and fans (issue test certificate)		
3.5	Overhaul, test and fit Buchholz relay (issue test certificate)		
3.6	Service all pressure devices, supply and fit new micro switches to all of them (issue test certificate)		
3.7	Inspect, clean and test all associated cable work		
3.8	Overhaul, re-gasket and replace all seals on conservator gauges and conservator tank		
3.9	Check and service conservator bag		

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Item	Description of the job	Yes/No	Comments
4.	Bushings		
4.1	Conduct preliminary tests on all bushings. For condenser type bushings, Tan Delta/Partial Discharge test are required (issue test certificate)		
4.2	Take oil samples from bushings and have them analysed (with supervision from City Power)		
4.3	Drain oil, dismantle and inspect all the bushings		
4.4	Replace seals and gaskets		
4.5	Assemble and fill with oil (SANS 555 Certificate for the oil used must be issued)		
4.6	Final test of bushings (issue test certificates)		
5.	On-load tap changer (Box-type)		
5.1	Open front cover and inspect the defects		
5.2	Remove all contact epoxy boards and inspect for cracks or any other defects		
5.3	Remove barrier boards and inspects for cracks and effects		
5.4	Inspect pressure relays for defects and check settings		
5.5	Inspect mechanical drive mechanism for defects		
5.6	Record transitional resistor value and compare with the name plate information where applicable		
5.7	Inspect all contacts and shafts for wear and defects		
6.	On-load tap changer (Cylinder-type)		
6.1	Open and drain oil from the diverter switch		
6.2	Dismantle and untank the diverter switch		
6.3	Inspect, test and overhaul diverter switch		
6.4	Replace all faulty parts		
6.5	Test the diverter tube for leaks		
6.6	On-load tap changer (Box-type)		
7.	Open front cover and inspect the defects		
7.1	Remove all contact epoxy boards and inspect for cracks or any other defects		
7.2	Remove barrier boards and inspects for cracks and effects		
7.3	Inspect pressure relays for defects and check settings		

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Item	Description of the job	Yes/No	Comments
7.4	Inspect mechanical drive mechanism for defects		
8.	Final Assembly		
8.1	Check and tighten all parts of the active parts and final tank		
8.2	Draw vacuum		
8.3	Break the vacuum and test fit all parts {bushings. tap changer (box type)		
8.4	and ancillary parts}		
8.5	Draw vacuum and fill transformer with oil		
9.	Test transformer as per SANS 60076 (part 1,2,3,4,5 and 10) included tests are as follows:		
9.1	Induced over voltage		
	a) Separate source over potential		
	b) No-load		
	c) Load losses and impedance voltage		
	d) No load loss [Copper and Iron losses]		
	e) Cellulose moisture content		
	f) Insulation resistance		
	g) Winding resistance		
	h) Voltage/Turns ratio and Phase displacement		
	i) Zero phase Impedance		
	j) Transformer Tan Delta and Capacitance		
	k) Magnetising current		
	l) Core ground insulation		
9.2	Drain oil and prepare auxiliary parts for spray painting with original paint		
9.3	Wait to dry and load transformer and parts for transport to site		
10.	Transport and Rigging		
10.1	Install unit at selected site: 0 – 20 tons		
10.2	Install unit at selected site: 20 – 40 tons		

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Item	Description of the job	Yes/No	Comments
10.3	Install unit at selected site: 40 – 60 tons		
10.4	Install unit at selected site: 60 – 80 tons		
10.5	Install unit at selected site: 80 – 100 tons		
10.6	Transport of transformer to site (per km)		
10.7	Offload transformer at site		
11.	On – site activities		
11.1	Draw a vacuum for 48 hours		
11.2	Supply virgin oil (per litre) (SANS 555 oil certificate)		
11.3	Fill oil under vacuum		

Tender Number: _____

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

Full name of company:

C.2: ADDITIONAL ACTIVITIES

Any additional activities offered to the above checklist shall be listed below with reasons for addition.			
Item	Description of the job	Yes/No	Comments

Tender Number: _____

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

Full name of company:

C.3: ONSITE MAINTENANCE

Item	Description of the job	Yes/No	Comments
1.	Onsite risk and condition assessment		
2.	High pressure wash the transformer to remove all oil and dirt from the transformer as well as the plinth		
3.	Re-gasketing of main tank		
4.	Re-gasketing of bushings		
5.	Remove and Install new bushings where required		
6.	Re-gasketing of tap changer chamber		
7.	Tap changer service/maintenance		
8.	Oil purification [regeneration],		
9.	Oil drainage and top up		
10.	Radiator fins inspection and maintenance		
11.	Dehydrating Breather Maintenance/Service		
12.	Changing of Silica Gel Desiccant		
13.	Fans and fan motors service/maintenance and ensure correct rotation		
14.	Remove old and install new fans where required		
15.	Remove old and install new fan motors where required		
16.	Oil circulation pumps and motors service/maintenance		
17.	Remove old and install new oil circulation pumps where required		
18.	Conservator inspection and Service		
19.	Buchollz Inspection and Service		
20.	Winding Temperature Indicator Service and test		
21.	Test, calibrate and adjust the indicators		
22.	Oil Temperature Indicator Test and Service		
23.	Spray paint the whole transformer		
24.	Paint the bushings to match the phases		
25.	Installation of drain valves where required		
26.	Service, test and calibrate the thermometers		
27.	Service, test and calibrate winding temperature indicators		
28.	Remove old OTI and replace with new OTI where required		
29.	Remove old WTI and replace with new WTI where required		
30.	Remove old buchollz and replace with new buchollz where required		

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Item	Description of the job	Yes/No	Comments
31.	Test Internal neutral CT where applicable		
32.	Service and test magnetic type oil level gauge		
33.	Remove old and replace with new magnetic type oil gauge where required		
34.	Supply and install new HV surge arrestor brackets where required		
35.	Supply and install new MV surge arrestor brackets where required		
36.	Supply and Install new HV surge arrestors		
37.	Supply and install new MV surge arrestors		
38.	Maintain, service and replace filter of the mobile online moisture removal where required		
39.	Maintain, service and calibrate online gas monitoring unit where required		
40.	Remove contaminated crusher stones and replace with new where required		
41.	Maintenance of the aux/NEC/NEC transformer		
42.	Remove faulty (old) NEC/NER and install and commission new NEC/NER		
43.	Winding Resistance Test		
44.	Transformer Turns Ratio Test		
45.	Phase Displacement		
46.	Insulation Resistance Test		
47.	Polarity Index (PI)		
48.	No load losses test		
49.	Full load losses		
50.	Zero sequence impedance		
51.	Induced overvoltage with partial discharge		
52.	Tan Delta Test		
53.	Transformer Oil Break Down Test		
54.	Magnetic Balance Test		
55.	Draw routine oil sample		
56.	Dissolve Gas Analysis (DGA)		

Tender Number: _____

Tenderer's Authorised Signatory: _____
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Full name of company: _____

C.4: WORKSHOP TRANSFORMER REPAIRS/REFURBISHMENT

Item	Description of the job	Yes/ No	Comments
1	Site Establishment		
1.1	Allow for complying with all General and Special Conditions of Contract, labour requirements, site establishment , water and sanitary facilities, first aid services, electrical services		
1.2	Allow for the storage and safe keeping of all materials and equipment including the provision of insurances as stipulated in the Conditions of Contract. Allow for 24 hour security for the duration of the contract.		
1.3	Allow for marking-up a full set of drawings to show the exact positions of cables, transformer earthing etc. These "As Built" drawings must be handed to the engineer at commissioning of the equipment. Also all maintenance manuals, including all technical literature, test certificates and wiring diagrams as per specification.		
1.4	Allow for marking-up a full set of drawings to show the exact positions of cables, transformer earthing etc. These "As Built" drawings must be handed to the engineer at commissioning of the equipment. Also all maintenance manuals, including all technical literature, test certificates and wiring diagrams as per specification.		
1.5	Allow for training for City Power staff during installation and commissioning of complete installation.		
1.6	Any additional item(s), not shown in the schedules that the tenderer consider essential and wish to detail and price. (Provide full details)		
2	Onsite maintenance Complete as per ANNEXURE C3		
3	Final assembly Complete as per ANNEXURE C2: part 2,3,4,5,6,7,8		
4	Transformer tests Complete as per ANNEXURE C2: 9		
4.1 DP_ paper test	Remove paper sample and test for DP		
4.2 SANS_555report	Draw oil for SANS 555 report from bulk		
4.3 Oil sample report	Draw oil sample for full DGA, moisture and kV report		

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Item	Description of the job	Yes/ No	Comments
5	Transport to site and offload		
5.1	Transport of transformer to site (per km)		
5.2	Offload transformer at site		
6	Rigging and installation		
6.1	Provide malthoid on plinth where required		
6.2	Install unit at selected site: 0 – 40 tons		
6.3	Install unit at selected site: 41 – 80 tons		
6.4	Install unit at selected site: 81 – 100 tons		
7	Tank and parts Complete as per ANNEXURE C2: part 3		
8.	Auxillaries		
8.1	Supply new silica gel breather where applicable		
8.2	Check and replace pressure relief devices		
8.3	Check and service Dry-Keep unit where required		
8.4	Check and test transformer protection indicators		
9.	On site activities		
9.1	Drain oil and prepare auxiliary parts for spray painting with original paint		
9.2	Wait to dry and load transformer and parts for transport to site		
9.3	Draw a vacuum for 48 hours		
9.4	Supply virgin oil (per litre) where applicable		
9.5	Fill oil under vacuum		
9.6	Connect the HV and MV bushings		
9.7	HV Busbar/Conductor Clamps		
9.8	HV Conductor (Centipede) where required		
9.9	HV Conductor (Hare) to Surge Arrestors		
9.10	Solid Copper Busbar 160mm x 12mm between MV TX bushing and cable termination		
9.11	Flexible clamp for Solid Copper Busbar 160mm x 12mm onto MV bushing		
9.12	Provide MV Busbar/Conductor Clamps where required		
9.13	Tubular Aluminium busbar clamps (inclusive of end cap on one side)		

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Item	Description of the job	Yes/ No	Comments
9.14	MV Conductor (Bull)		
9.15	Supply, Install surge arrestors brackets where required		
9.16	Connect the auxilliary wiring to the marshalling kiosk		
9.17	Connect the NECR/Aux transformer and transformer earth lead		
9.18	Remove existing plinth		
9.19	Install new concrete plinth (25MPA)		
9.20	Remove existing marshalling kiosk		
9.21	Remove existing termination structure		
9.22	Supply & install complete cable support structure for cable terminations & cable supports. Required foundations, bolts, nuts, indication signage and earthing to be included		
9.23	Corrosion protection paint to steel		
9.24	Supply and install galvanized holding down bolts for steel structures		
9.25	Install new removable barrier welded mesh fence with frame		
9.26	70mm ² CCS conductor and connect onto main earth grid using exothermic welding only		
9.27	Test and verify earthmat integrity		
9.28	Control and Low Voltage cables where required		
10	Adhoc purchases		
10.1	7 Core - 2.5mm ²		
10.2	12 Core - 2.5mm ²		
10.3	4 Core - 2.5mm ²		
10.4	4 Core - 16mm ²		
10.5	4 Core - 4mm ²		
10.6	19 Core - 2.5mm ²		
10.7	4 Core - 1.5mm ² (screened)		
10.8	Cable racking - 300mm wide		
10.9	7 Core - 2.5mm ² termination		
10.10	12 Core - 2.5mm ² termination		
10.11	4 Core - 2.5mm ² termination		
10.12	4 Core - 16mm ² termination		

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Item	Description of the job	Yes/ No	Comments
10.13	4 Core - 4mm ² termination		
10.14	19 Core - 2.5mm ² termination		
10.15	4 Core - 1.5mm ² termination		
10.16	Verification of all control and protection circuits and as the supply of as-built drawings		
10.17	Terminate 630 mm ² x 1c Cu Cable (4 x phase)		
10.18	Joint 630mm ² x 1c Cu Cable		
10.19	Terminate 1000mm ² x 1c Alu Cable (4 x phase)		
10.20	Joint 1000mm ² x 1c Alu Cable		
10.21	Terminate 300mm ² x 3c Alu Cable		
11	On site Testing Electrical Test to be performed		
11.1	a) Induced over voltage		
	b) Separate source over potential		
	c) No-load		
	d) Load losses and impedance voltage		
	e) No load loss [Copper and Iron losses]		
	f) Cellulose moisture content		
	g) Insulation resistance		
	h) Winding resistance		
	i) Voltage/Turns ratio and Phase displacement		
	j) Zero phase Impedance		
	k) Transformer Tan Delta and Capacitance		
	l) Magnetising current		
	m) Noise level test		
	n) Core ground insulation		
11.2	Draw oil sample for DGA report		
12	Liven up and Handover to City Power		

C.4: ADDITIONAL ACTIVITIES

Any additional activities offered to the above checklist shall be listed below with reasons for addition.			
Item	Description of the job	Yes/No	Comments

Tender Number: _____

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

Full name of company: _____

ANNEXURE D: RATES PER WORK D

PHASE 1 : Workshop Transformer Assessment								
Item	Short Description	Long Description	Unit	Qty	Supply Rate	Labour Rate	Supply Amount	Total item cost
1		Site Establishment						
1.1.1	Total Site Establishment	Establish site according to sub – clause 4.7.1 as per CP_TSSTAN_063	sum					
1.1.2	Rent 44ft container_ Site Est	Rent 44 ft container Establish site						
1.1.3	Port 20sm office	Portable Office 4m x5m Establish site						
1.1.4	Port Toilet	Portable flushable toilet						
2		Transport and Rigging						
2.1.1	Hydraulic_crn_0-40T	Hydraulic crane hire 0-40 tons	each					
2.1.2	Hydraulic_crn_41-60T	Hydraulic crane hire 41-60 tons	each					
2.1.3	Hydraulic_crn_61-80T	Hydraulic crane hire 61-80 tons	each					
2.1.4	Hydraulic_crn_81-100T	Hydraulic crane hire 81-100 tons	each					
2.1.5	Hydraulic_crn_50T_boom_40m	Hydraulic crane truck 50 ton with boom reaching 40 metres.	each					
2.1.6	Hydraulic_crn_100-160T_boom_50m	Hydraulic crane truck 100-160 ton with boom reaching 50 metres.	each					
2.1.7	Hydraulic_crn_161-300T_boom_50m	Hydraulic crane truck 160-300 ton with boom reaching 50 metres.	each					

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PHASE 1 : Workshop Transformer Assessment

Item	Short Description	Long Description	Unit		Supply Rate		Amount (R)	Amount (R)
2		Transport and Rigging						
2.2.1	Rig_0-40T_crane	Rigging of transformer on and Off the Low-bed 0-40 tons using a crane	each					
2.2.2	Rig_0-40T_jack	Rigging of transformer on and Off the Low-bed 0-40 tons using jacking system	each					
2.2.3	Rig_41-60T_crane	Rigging of transformer on and Off the Low-bed 41-60 tons using a crane	each					
2.2.4	Rig_41-60T_jack	Rigging of transformer on and Off the Low-bed 41-60 tons using jacking system	each					
2.2.5	Rig_61-80T_crane	Rigging of transformer on and Off the Low-bed 61-80 tons using a crane	each					
2.2.6	Rig_61-80T_jack	Rigging of transformer on and Off the Low-bed 61-80 tons using jacking system	each					
2.2.7	Rig_81-100T_crane	Rigging of transformer on and Off the Low-bed 81-100 tons using a crane	each					
2.2.8	Rem_80 – 100T_jack	Rigging of transformer on and Off the Low-bed 81-100 tons using jacking system	each					
2.3.1	Transp_TFR_(per KM)	Transport of transformer to workshop (per km)	km					

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PHASE 1 : Workshop Transformer Assessment

Item	Short Description	Long Description	Unit	Qty	Supply Rate		Amount (R)	Amount (R)
3		Inspections and Analysis - Active Part						
3.1.1	Unt_act_parts_assess	Untank active parts and assess	each					
3.1.2	Cond_prelim test_act_part	Conduct preliminary test on transformer active parts	each					
3.1.3	Cond_oil&DGA	Conduct oil and gas analysis	each					
3.1.4	Cond_fur_ana	Conduct furanic analysis	each					
3.1.5	Cond_paper_ana	Conduct physical paper analysis	each					
3		Inspections and Analysis - Tank						
3.2.1	Insp_tank	Inspect tank	each					
3.2.2	Insp_mot&cooler	Inspect all motors and coolers	each					
3.2.3	Insp_pres_relief_dev	Inspect all pressure relief devices	each					
3.2.4	Insp_conserv	Inspect conservator	each					
3.2.5	Inspec_valv&pipe	Inspect all valves and piping	each					
3.2.6	Inspec_rad_fins	Inspect all radiator fins	each					

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PHASE 1 : Workshop Transformer Assessment

Item	Short Description	Long Description	Unit	Qty	Supply Rate		Amount (R)	Amount (R)
3		Inspections and Analysis - Active Part						
3.1.1	Unt_act_parts_assess	Untank active parts and assess	each					
3.1.2	Cond_prelim test_act_part	Conduct preliminary test on transformer active parts	each					
3.1.3	Cond_oil&DGA	Conduct oil and gas analysis	each					
3.1.4	Cond_fur_ana	Conduct furanic analysis	each					
3.1.5	Cond_paper_ana	Conduct physical paper analysis	each					
3.2.0		Inspections and Analysis - Tank						
3.2.1	Insp_tank	Inspect tank	each					
3.2.2	Insp_mot&cooler	Inspect all motors and coolers	each					
3.2.3	Insp_pres_relief_dev	Inspect all pressure relief devices	each					
3.2.4	Insp_conserv	Inspect conservator	each					
3.2.5	Inspec_valv&pipe	Inspect all valves and piping	each					

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PHASE 1 : Workshop Transformer Assessment								
Item	Short Description	Long Description	Unit	Qty	Supply Rate		Amount (R)	Amount (R)
4		Bushings						
4.1	Prelim_test_bush	Conduct preliminary tests on all bushings. For condenser type bushings, Tan Delta/Partial Discharge test are required (issue test certificate)	each					
4.2	oil &DGA_bush	Take oil samples from bushings and have them analysed (with supervision from City Power)	each					
4.3	Inspec_bush	Drain oil, dismantle and inspect all the bushings	each					
5		On-load tap changer (Box-type)						
5.1	Ope_fro cov_insp	Open front cover and inspect the defects	each					
5.2	Rem_epo_board_insp_defec	Remove all contact epoxy boards and inspect for cracks or any other defects	each					
5.3	Rem_bar_board_insp_defec	Remove barrier boards and inspects for cracks and effects	each					
5.4	Insp_relay_defec	Inspect pressure relays for defects and check settings	each					
5.5	Insp_mechdriv_defec	Inspect mechanical drive mechanism for defects	each					
5.6	Rec_res_val	Record transitional resistor value and compare with the name plate information where applicable	each					
5.7	Insp_cont_defec	Inspect all contacts and shafts for wear and defects	each					

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PHASE 1 : Workshop Transformer Assessment								
Item	Short Description	Long Description	Unit	Qty	Supply Rate		Amount (R)	Amount (R)
6.0		On-load tap changer (Cylinder-type)						
6.1	Ope_divert_switc	Open and drain oil from the diverter switch	each					
6.2	Dism_untank_switc	Dismantle and untank the diverter switch	each					
6.3	Insp_test_divert_switc	Inspect and test diverter switch	each					
6.4	Test_divert_leaks	Test the diverter tube for leaks	each					
7		Reporting						
7.1	Supp_report_	Supply full detailed report and recommendations	each					
7.2	Scrap_Cu_saving	Scrap copper price must be provided and indicated as a savings on all quotations	each					
		TOTAL						

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PHASE 2: Workshop Transformer Repairs/Refurbishment

Item	Short Description	Long Description	Unit	Qty	Supply Rate	Labour Rate	Supply Amount	Total Item Cost
1.0		Site Establishment						
1.1.1	Specification requirements	Allow for complying with all General and Special Conditions of Contract, labour requirements, site establishment , water and sanitary facilities, first aid services, electrical services						
1.1.2	Security	Allow for the storage and safe keeping of all materials and equipment including the provision of insurances as stipulated in the Conditions of Contract. Allow for 24 hour security for the duration of the contract.						
1.1.3	As built drawings and manuals	Allow for marking-up a full set of drawings to show the exact positions of cables, transformer earthing etc. These "As Built" drawings must be handed to the engineer at commissioning of the equipment. Also all maintenance manuals, including all technical literature, test certificates and wiring diagrams as per specification.						
1.1.4	Training	Allow for training for City Power staff during installation and commissioning of complete installation.						
1.2	Additional Items	Any additional item(s), not shown in the schedules that the tenderer consider essential and wish to detail and price. (Provide full details)						
1.3	Additional Item a							
1.4	Additional Item b							

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Item	Short Description	Long Description	Unit	Qty	Supply Rate	Labour Rate	Supply Amount	total item cost
2.1	Onsite maintenance/service/repairs (work to be done)							
2.1.1	Onsite_Risk_assessment	Onsite risk and condition assessment	Each					
2.1.2	Hi_pressure_wash	High pressure wash the transformer to remove all oil and dirt from the transformer as well as the plinth	Each					
2.1.3	Regasket_main_tank	Re-gasketing of main tank	Each					
2.1.4	Regasket_bushings	Re-gasketing of bushings	Each					
2.1.5	Remove_install_new_bushings	Remove and Install new bushings where required	Each					
2.1.6	Regasket_tapchanger_chamber	Re-gasketing of tap changer chamber	Each					
2.1.7	Serve_tapchanger	Tap changer service/maintenance	Each					
2.1.8	oil_purification	Oil purification [regeneration],	Each					
2.1.9	Oil_top_up	Oil drainage and top up	Each					
2.1.10	Inspect_service_radiator_fins	Radiator fins inspection and maintenance	Each					
2.1.11	Inspect_service_breather	Dehydrating Breather Maintenance/Service	Each					
2.1.12	Change_silica_gel	Changing of Silica Gel Dessicant	Each					

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Item	Short Description	Long Description	Unit	Qty	Supply Rate	Labour Rate	Supply Amount	Total Item Cost
2,00	Active parts							
2,10	Dismantle_yoke_remove_windings	Dismantle yoke and remove faulty windings	Each					
2,20	check_clean_core	Check , clean and overhaul core	Each					
2,30	Renew_core_bolt_clamp_inspect	Renew core bolt and clamp insulation as required	Each					
2,40	Strip_rewind_coils_copper_purity99.9%	Strip and rewind coils using copper with a purity of 99.9% or better	Each					
2,50	Conduct_prelim_test	Conduct preliminary test on new coils	Each					
2,60	Pre_press_windings	Pre-press winding(s) to specification	Each					
2,70	Reassemble_drycore_windings	Reassemble and dry core and windings	Each					
2,80	Conduct_ratio_test_resistance	Conduct pre-test to ensure correct ratios and resistances	Each					
2,90	Fit_tape_harness_dryout	Fit and tape harnessing for final dry-out	Each					

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Item	Short Description	Long Description	Unit	Qty	Material	Labour	Total	Total
3,00	Tank and parts							
3,10	Drain_oil_inspec_tank	Drain oil from tank and clean and inspect tank.	Each					
3,20	Overhaul_regasket_tank_parts	Overhaul and re-gasket tank and parts (valves, pumps, inspection plate, coolers etc.)	Each					
3,30	Overhaul_pressure_test_coolers	Overhaul and pressure test all coolers (issue test certificate)	Each					
3,40	Overhaul_cooling_motor_fans	Overhaul cooling motors and fans (issue test certificate)	Each					
3,50	Overhaul_test_fit_bucholz	Overhaul, test and fit Buchholz relay (issue test certificate)	Each					
3,60	Service_pressure_relief_device	Service all pressure devices, supply and fit new micro switches to all of them (issue test certificate)	Each					
3,70	Inspect_clean_associated_cables	Inspect, clean and test all associated cable work	Each					
3,80	Overhaul_regasket_replace_seals_conservator	Overhaul, re-gasket and replace all seals on conservator gauges and conservator tank	Each					
3,90	chec_serv_conserv_bag	Check and service conservator bag	Each					

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Item	Short Description	Long Description	Unit	Qty	Material	Labour	Total	Total
4,00	Bushings							
4,10	Conduct_prelim_test_bushings_certificate	Conduct preliminary tests on all bushings. For condenser type bushings, Tan Delta/Partial Discharge test are required (issue test certificate)	Each					
4,20	Draw_oil_sample_analyse	Draw oil samples from bushings and have them analysed (with supervision from City Power)	Each					
4,30	Replace_seals_gaskets_clean_porcelain	Replace seals and gaskets and clean porcelain shells	Each					
4,40	assemble_fill_oil	Assemble and fill with oil where applicable	Each					
4,50	Final_test_bushings_certificate	Final test the bushings (issue test certificate)	Each					
5,00	On-load tap changer (Box-type)							
5,10	Open_front_cover_inspect	Open front cover and inspect the defects	Each					
5,20	Remove_boards_inspect	Remove all contact epoxy boards and inspect for cracks or any other defects	Each					
5,30	Remove_barrier_inspect	Remove barrier boards and inspects for cracks and effects	Each					
5,40	Inspect_relays_settings	Inspect pressure relays for defects and check settings	Each					
5,50	Inspect_mech_drive shaft	Inspect mechanical drive mechanism for defects	Each					
5,60	Record_resistor_values_compare	Record transitional resistor value and compare with the name plate information where applicable	Each					
5,70	Inspect_contacts_defects	Inspect all contacts and shafts for wear and defects	Each					
5,80	Repair_replace_tap changer	Repair/replace tap changer contacts where necessary						

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Item	Short Description	Long Description	Unit	Qty	Material	Labour	Total	Total
6,00	On-load tap changer (Cylinder-type)							
6,10	Open_drain_divert_switch	Open and drain oil from the diverter switch	Each					
6,20	Dismante_Detank_divert_switch	Dismantle and Detank the diverter switch	Each					
6,30	Inspect_test_overhaul_divert_switch	Inspect, test and overhaul diverter switch	Each					
6,40	Replace_faulty_parts	Replace all faulty parts	Each					
6,50	Test_divert_tubes_leaks	Test the diverter tube for leaks	Each					
6,70	Asse_and_the_part	Assemble and re-tank diverter switch for final reconnection to the active parts	Each					
7,00	Auxiliaries							
7,10	Supply_new_silica_gel_breather	Supply new silica gel breather where applicable	Each					
7,20	Check_replace_pressure_relief_device	Check and replace pressure relief devices	Each					
7,30	Check_Service_DryKeep	Check and service Dry-Keep unit where required	Each					
7,40	Check_Test_protection_indicators	Check and test transformer protection indicators	Each					

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Item	Short Description	Long Description	Unit	Qty	Material	Labour	Total	Total
8,00	Final Assembly							
8,10	Check_tighten_active parts	Check and tighten all parts of the active parts and final tank	Each					
8,20	Draw_vacuum	Draw vacuum	Each					
8,30	Break_vacuum_test	Break the vacuum and test fit all parts {bushings. tap changer (box type) and ancilliary parts}	Each					
8,40	Draw_vacuum_fill_oil	Draw vacuum and fill transformer with oil	Each					
9,00	Test transformer as per SANS 60076 (part 1,2,3,4,5 and 10) included tests are as follows:							
9,10	elec_tests_performed	Electrical Tests to be performed	Each					
	a) Ind_over_volt	a) Induced over voltage	Each					
	b) Separate_potential	b) Separate source over potential	Each					
	c) No-load	c) No-load	Each					
	d) Loadloss_impedance voltage	d) Load losses and impedance voltage	Each					
	e) Noload_loss	e) No load loss [Copper and Iron losses]	Each					
	f) Cellulose_moisture_content	f) Cellulose moisture content	Each					
	g) Insulation_resistance	g) Insulation resistance	Each					
	h) Winding_resistance	h) Winding resistance	Each					

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9,00	Test transformer as per SANS 60076 (part 1,2,3,4,5 and 10) included tests are as follows:							
Item	Short Description	Long Description	Unit	Qty	Material	Labour	Total	Total
9,10	elec_tests_performed	Electrical Tests to be performed						
	i) Turns_ratio_phase_displacement	i) Voltage/Turns ratio and Phase displacement	Each					
	j) Zero_Impedance	j) Zero phase Impedance	Each					
	k) Tan_Delta_capacitance	k) Transformer Tan Delta and Capacitance	Each					
	l) Magnetising_current	l) Magnetising current	Each					
	m) Core_ground_insulation	m) Core ground insulation	Each					
9,20	DP_paper_test	Remove paper sample and test for DP	Each					
9,30	SANS_555_report	Draw oil sample for SANS 555 report from bulk oil	Each					
9,40	Oil_sample_report	Draw oil sample for full DGA, moisture and KV report	Each					
10,00	Transport to site and offload							
10.1.1	Transport_site_km	Transport of transformer to site (per km)	Each					
10.1.2	Offload_site_km	Offload transformer at site	Each					

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Item	Short Description	Long Description	Unit	Qty	Material	Labour	Total	Total
10.2.0	Rigging and Installation							
10.2.1	Prov_malth_plinth	Provide malthoid on plinth where required	Each					
10.2.2	Inst_0-40_tons	Install unit at selected site: 0 – 40 tons	Each					
10.2.3	Inst_41-80_tons	Install unit at selected site: 41 – 80 tons	Each					
10.2.4	Inst_81-100_tons	Install unit at selected site: 81 – 100 tons	Each					

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Item	Short Description	Long Description	Unit	Qty	Material	Labour	Total	Total
11,00	On – site activities							
11,10	Drain_oil_prep_aux_parts_paint	Drain oil and prepare auxiliary parts for spray painting with original paint	Each					
11,20	Load_tranformer_transport	Wait to dry and load transformer and parts for transport to site	Each					
11,30	Draw_vacuum_48hrs	Draw a vacuum for 48 hours	Each					
11,40	Supply_virgin_oil	Supply virgin oil (per litre) where applicable	Each					
11.4.1	Fill_oil_under_vacuum	Fill oil under vacuum	Each					
11.4.2	Connect_bushings	Connect the HV and MV bushings						
11.4.3	Connect_HV_bushing_clamps	HV Busbar/Conductor Clamps	each					
11.4.4	Connect_HV_conductor	HV Conductor (Centipede) where required	m					
11.4.5	Connect_HV_conductor_surge arrestors	HV Conductor (Hare) to Surge Arrestors	m					
11.4.6	Connect_solid_copper_MV_busbars	Solid Copper Busbar 160mm x 12mm between MV TX bushing and cable termination	m					
11.4.7	Connect_flexible_clamp_copper_MV_busbars	Flexible clamp for Solid Copper Busbar 160mm x 12mm onto MV bushing	each					
11.4.8	Provide_MV_busbars_clamps	Provide MV Busbar/Conductor Clamps wher required	each					
11.4.9	Provide _Tube_clamps	Tubular Aluminium busbar clamps (inclusive of end cap on one side)	each					
11,50	Connect_MV_conductor (bull)	MV Conductor (Bull)	m					

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Item	Short Description	Long Description	Unit	Qty	Material	Labour	Total	Total
11,00	On – site activities							
11,90	Supply_install_surge arrestor_brackets	Supply, Install surge arrestors brackets where required	Each					
11,10	Conn_aux_wiring_kiosk	Connect the auxilliary wiring to the marshalling kiosk	Each					
11,11	Conn_NECR_earthcond	Connect the NECR/Aux transformer and transformer earth lead	Each					
11,12	Remove_plinth	Remove existing plinth	Each					
11,13	Install_new plinth_25MPA	Install new concrete plinth (25MPA)	Each					
11,13	Remove_existing_kiosk	Remove existing marshalling kiosk	Each					
11,14	Remove_existing_structure	Remove existing termination structure	Each					
11,15	Supply_install_cable_term_ structure	Supply & install complete cable support structure for cable terminations & cable supports. Required foundations, bolts, nuts, indication signage and earthing to be included	Each					
11,16	Corrosion_protection _steel	Corrosion protection paint to steel	litre					
11,17	Supply_install_ galvanized_holddown_bolts	Supply and install galvanized holding down bolts for steel structures	each					
11,18	Install_new barrier_ fence_frame	Install new removable barrier welded mesh fence with frame	m2					
11,19	Provide_earthing_70mm²_ exothermic_weld	70mm² CCS conductor and connect onto main earth grid using exothermic welding only	m					
11,20	Test_verify_earthmat_ integrity	Test and verify earthmat integrity	Each					
11,21	Supply_install_LV cables	Control and Low Voltage cables where required						

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Item	Short Description	Long Description	Unit	Qty	Material	Labour	Total	Total
	Adhoc purchases	Adhoc purchases						
11,20	7_core_2.5mm ²	7 Core - 2.5mm ²	m					
11,21	12_core_2.5mm ²	12 Core - 2.5mm ²	m					
11,22	4_core_2.5mm ²	4 Core - 2.5mm ²	m					
11,23	4_core_16mm ²	4 Core - 16mm ²	m					
11,24	4_core_4mm ²	4 Core - 4mm ²	m					
11,25	19_core_2.5mm ²	19 Core - 2.5mm ²	m					
11,26	4_core_1.5mm ² _screened	4 Core - 1.5mm ² (screened)	m					
11,27	Cable_rack_300mm_wide	Cable racking - 300mm wide	m					
11,28	7_core_2.5mm ² _termination	7 Core - 2.5mm ² termination	Each					
11,29	12_core_2.5mm ² _termination	12 Core - 2.5mm ² termination	Each					

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Item	Short Description	Long Description	Unit	Qty	Material	Labour	Total	Total
	Adhoc purchases	Adhoc purchases						
11,30	4_core_2.5mm ² _termination	4 Core - 2.5mm ² termination	Each					
11,31	4_core_16mm ² _termination	4 Core - 16mm ² termination	Each					
11,32	4_core_4mm ² _termination	4 Core - 4mm ² termination	Each					
11,33	4_core_2.5mm ² _termination	19 Core - 2.5mm ² termination	Each					
11,34	4_core_1.5mm ² _termination	4 Core - 1.5mm ² termination	m					
11,35	Verify_control_cct_as_built_drawings	Verification of all control and protection circuits and as the supply of as-built drawings	sum					
11,36	Terminate_630mm ² _cu_cable (4 x phase)	Terminate 630 mm ² x 1c Cu Cable (4 x phase)	Each					
11,37	Joint_630mm ² _cables	Joint 630mm ² x 1c Cu Cable	Each					
11,38	Terminate_1000mm ² _al_cable (4 x phase)	Terminate 1000mm ² x 1c Alu Cable (4 x phase)	Each					
11,39	Joint_1000mm ² _cables	Joint 1000mm ² x 1c Alu Cable	Each					
11,40	Terminate_300mm ² _3c_al_cable	Terminate 300mm ² x 3c Alu Cable	Each					

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Item	Short Description	Long Description	Unit	Qty	Material	Labour	Total	Total
12,00	On site Testing							
12,1	electrical_test_performed	Electrical Test to be performed	Each					
12.1.a	a) Ind_over_volt	a) Induced over voltage	Each					
12.1.b	b) Separate_potential	b) Separate source over potential	Each					
12.1.c	c) No-load test	c) No-load	Each					
12.1.d	d) Load loss_ZV	d) Load losses and impedance voltage	Each					
12.1.e	e) No load _loss	e) No load loss [Copper and Iron losses]	Each					
12.1.f	f) Cell_moist_cont	f) Cellulose moisture content	Each					
12.1.g	g) Ins_resis	g) Insulation resistance	Each					
12.1.h	h) Wind_resis	h) Winding resistance	Each					
12.1.i	i) Rat_phase_displ	i) Voltage/Turns ratio and Phase displacement	Each					
12.1.j	j) Zero_Phase_Imped	j) Zero phase Impedance	Each					
12.1.k	k) Trans_tan_delta & Cap	k) Transformer Tan Delta and Capacitance	Each					
12.1.l	l) Mag_curr	l) Magnetising current	Each					
12.1.m	m) Noise_level_test	m) Noise level test	each					
12.1.n	n) Core_ground_resis	n) Core ground insulation	Each					
12,20	Oil_sample_report	Draw oil sample for DGA report	Each					
13,00		Liven up and Handover to City Power	Each					

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Item	Short Description	Long Description	Unit	Qty	Supply Rate	Labour Rate	Supply Amount	total item cost
1.0		Site Establishment						
1.1.1	total Site Establishment	Establish site according to sub – clause 4.7.1	sum					
1.1.2	Rent 44ft container _Site Est	Rent 44 ft container Establish site						
1.1.3	Port 20sm office Site Est	portable Office 4m x5m Establish site						
1.1.4	Port Toilete _ site est	Portable flushable toilet						
1.2	Specification requirements	Allow for complying with all General and Special Conditions of Contract, labour requirements, site establishment , water and sanitary facilities, first aid services, electrical services	month					
1.3	Security	Allow for the storage and safe keeping of all materials and equipment including the provision of insurances as stipulated in the Conditions of Contract. Allow for 24 hour security for the duration of the contract.	month					
1.4	As built drawings and manuals	Allow for marking-up a full set of drawings to show the exact positions of cables, transformer earthing etc. These "As Built" drawings must be handed to the engineer at commissioning of the equipment. Also all maintenance manuals, including all technical literature, test certificates and wiring diagrams as per specification.	sum					
1.5	Training	Allow for training for City Power staff during installation and commissioning of complete installation.	no of ppl					
1.6	Additional Items	Any additional item(s), not shown in the schedules that the tenderer consider essential and wish to detail and price. (Provide full details)						
1.7	Additional Item a							

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Item	Short Description	Long Description	Unit	Qty	Supply Rate	Labour Rate	Supply Amount	total item cost
1.0		Site Establishment						
1.8	Additional Item b							
1.9	Additional Item c							
1.10	Additional Item d							
2.1		Onsite maintenance/service/repairs (work to be done)						
2.1.1	Onsite_Risk_assessment	Onsite risk and condition assessment	Each					
2.1.2	Hi_pressure_wash	High pressure wash the transformer to emove all oil and dirt from the transformer as well as the plinth	Each					
2.1.3	Regasket_main_tank	Re-gasketing of main tank	Each					
2.1.4	Regasket_bushings	Re-gasketing of bushings	Each					
2.1.5	Remove_install_new_bushings	Remove and Install new bushings where required	Each					
2.1.6	Regasket_tapchanger_chamber	Re-gasketing of tap changer chamber	Each					
2.1.7	Serve_tapchanger	Tap changer service/maintenance	Each					
2.1.8	oil_purification	Oil purification [regeneration],	Each					
2.1.9	Oil_top_up	Oil drainage and top up	Each					
2.1.10	Inspect_service_radiator_fins	Radiator fins inspection and maintenance	Each					
2.1.11	Inspect_service_breather	Dehydrating Breather Maintenance/Service	Each					
2.1.12	Change_silica_gel	Changing of Silica Gel Dessicant	Each					

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Item	Short Description	Long Description	Unit	Qty	Supply Rate	Labour Rate	Supply Amount	total item cost
2.1		Onsite maintenance/service/repairs (work to be done)						
2.1.13	Service_fans_motors_correct_ratation	Fans and fan motors service/ maintenance and ensure correct rotation	Each					
2.1.14	Remove_install_new_fans	Remove old and install new fans where required	Each					
2.1.15	Remove_install_new_motors	Remove old and install new fan motors where required	Each					
2.1.16	Service_oil_circulation_pumps	Oil circulation pumps and motors service/maintenance	Each					
2.1.17	Remove_install_new_oil_pumps	Remove old and install new oil circulation pumps where required	Each					
2.1.18	Inpect_service_conservator	Conservator inspection and Service	Each					
2.1.19	Inpect_service_buchollz	Buchollz Inspection and Service	Each					
2.1.20	Service_test_calibrate_WTI	Winding Temperature Indicator Service and test	Each					
2.1.21	Test_calibrate_adjust_indicators	Test, calibrate and adjust the indicators	Each					
2.1.22	Service_test_calibrate_OTI	Oil Temperature Indicator Test and Service	Each					
2.1.23	Spray_paint_transformer	Spray paint the whole transformer	Each					
2.1.24	Paint_bushing_phases	Paint the bushings to match the phases	Each					

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2,00		Onsite maintenance/service/repairs (work to be done)						
2.25	Install_drain_valves	Installation of drain valves where required	Each					
2.26	Service_test_carlibrate_thermometers	Service, test and calibrate the thermometers	Each					
2.27	Service_test_carlibrate_thermometers	Service, test and calibrate winding temperature indicators	Each					
2.28	Remove_Replace_OTI	Remove old OTI and replace with new OTI where required	Each					
2.29	Remove_Replace_WTI	Remove old WTI and replace with new WTI where required	Each					
2.30	Remove_Replace_bucholz	Remove old bucholz and replace with new bucholz where required	Each					
2.31	Test_internal_neutral_CT	Test Internal neutral CT where applicable	Each					
2.32	Service_test_oil_level_gauge	Service and test magnetic type oil level gauge	Each					
2.33	Remove_replace_oil_level_gauge	Remove old and replace with new magnetic type oil gauge where required	Each					
2.34	Supply_install_HV_arrestor_bracket	Supply and install new HV surge arrestor brackets where required	Each					
2.35	Supply_install_MV_arrestor_bracket	Supply and install new MV surge arrestor brackets where required	Each					
2.36	HV_surge_arrestor	Supply and Install new HV surge arrestors	Each					

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PHASE 3 : Transformer Service/Maintenance								
Item	Short Description	Long Description	Unit	Qty	Supply Rate	Labour Rate	Supply Amount	total item cost
2.00		Onsite maintenance/service/repairs (work to be done)						
2.37	MV _surge _arrestor	Supply and install new MV surge arrestors	Each					
2.38	Maintain,_Replace, filter_mobile_moisture	Maintain, service and replace filter of the mobile online moisture removal where required	Each					
2.39	Maintain_carlibrate_online_DGA	Maintain, service and calibrate online gas monitoring unit where required	Each					
2.40	Remove,_contam_crusher & _replace	Remove contaminated crusher stones and replace with new where required	Each					
2.41	Maintain_NEC/R/aux	Maintenance of the aux/NEC/NEC transformer	Each					

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PHASE 3 : Transformer Service/Maintenance								
Item	Short Description	Long Description	Unit	Qty	Supply Rate	Labour Rate	Supply Amount (R)	total item cost
3.0		On Site tests						
3,1.1	Wnd Res _On Site test	Winding Resistance Test	Each					
3,1.2	Tx Turns.Ratio _On Site test	Transformer Turns Ratio Test	Each					
3,1.3	Phse Displ _On Site test	Phase Displacement	Each					
3,1.4	Insul Res _On Site test	Insulation Resistance Test	Each					
3,1.5	Porol Indx _On Site test	Porality Index (PI)	Each					
3,1.6	No Load Loose _On Site test	No load losses test	Each					
3,1.7	Full Load Lse _On Site test	Full load losses	Each					
3,1.8	Z Seq Imp _On Site test	Zero sequence impedance	Each					
3,1.9	Ind OvrVtge inc Part dis _On Site test	Induced overvoltage with partial discharge	Each					
3,1.10	Tan Delta _On Site test	Tan Delta Test	Each					
3,1.11	Tx Oil Brk dwn _On Site test	Transformer Oil Break Down Test	Each					
3,1.12	Mag Balnce _On Site test	Magnetic Balance Test	Each					
3,1.13	Routin Oil Smple _On Site test	Draw routine oil sample	Each					
3,1.14	DGA _Disslved Gas _On Site test	Dissolve Gas Analysis (DGA)	Each					
3,1.15	full set of tests _on Site	full set of the above tests 3.1.1 to 3.1.14	set					

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Tender Number: _____

Tenderer's Authorised Signatory: _____

Name in block letters Signature

Full name of company: _____