# TERMS OF REFERENCE

PROVISION OF MAINTENANCE, REPAIR AND SERVICING OF GENERATORS COUNTRY WIDE FOR THE ZAMBIA NATIONAL COMMERCIAL BANK

## 1.0 GENERAL INTRODUCTION

The Zambia National Commercial Bank Plc (Zanaco) is in the process of engaging a contractor to provide Maintenance, Repair and Servicing of Generators country wide. Maintenance of gensets is part of ZANCO's assets management strategies that aims at providing efficient and reliable support services to all branch operations country wide. Around 60 + standby power generators with capacities ranging from 10 to 550 KVA are installed country wide. These power generators are required to operate efficiently with the highest level of reliability owing to the sensitive nature of operations for the bank.

## 2.0 DELIVERABLES

The contractor will be required to provide standard power generators maintenance services as guided in the scope of work below and as per original equipment manufactures' recommendations. The maintenance scope will include Preventive (Routine service), Predictive (Planned maintenance) and Reactive (Break down) maintenance.

### 2.1 Preventive Maintenance

Preventive maintenance will be scheduled to mainly check and replace consumables such as lubricants, fluids and filters and will be done periodically as per service schedule indicated in Table 1 below.

### 2.2 Predictive Maintenance

Predictive maintenance will be done by way of checking equipment maintenance history to aid with tracking critical spares that may fall due for replacement. Physical inspections during routine maintenance should also be done to pinpoint other maintenance requirements that may have arisen during operation. Condition monitoring techniques will be employed for critical and high capacity generator sets to predict maintenance requirements.

### 2.3 Reactive Maintenance (Emergency Repairs)

Reactive maintenance (Emergency Repairs) will be done on a very minimal basis as need arises. However, the contractor is required to be proactive with regards to predictive maintenance during routine service and advise the bank accordingly of any foreseeable major maintenance requirements in view of preventing foreseeable breakdowns that might lead to prolonged down times.

## 3.0 SCOPE OF WORK

The genset maintenance services to be provided will be conducted at period intervals whose frequency of service will depend on the genset capacity, load demand and the criticality of facilities to be serviced. The maintenance program outlined in Table 1.0 below is a typical diesel generator set maintenance schedule that is subject to run time hours of the generator set.

### 3.1 Maintenance Program

The contractor will be required to carry out the following preventive maintenance tasks:

- General Inspection
- Lubrication Service
- Cooling System Service
- Fuel System Service
- Servicing and Testing starting batteries
- Electrical System Service
- Power Unit Service
- Regular Engine Exercise

**Table 1.0 Typical Diesel Genset Maintenance schedule**

| **Maintenance Item** | | **Service Frequency** | | |
|---|---|---|---|---|
| | Monthly | Quarterly | 6 months | Annually |
| General Inspection | | X | | |
| Check coolant heater | | X | | |
| Check coolant level | | X | | |
| Check oil level | | X | | |
| Check fuel level | | X | | |
| Check charge-air piping | | X | | |

| Maintenance Item | Monthly | Quarterly | 6 months | Annually |
|---|---|---|---|---|
| Check/clean air cleaner | | X | | |
| Check battery charger | | X | | |
| Drain fuel filter | | X | | |
| Drain water from fuel tank | | X | | |
| Check coolant concentration | | X | | |
| Check drive belt tension | | X | | |
| Drain exhaust condensate | | X | | |
| Check starting batteries | | X | | |
| Change oil and filter | | X | | |
| Change coolant filter | | X | | |
| Clean crankcase breather | | X | | |
| Change air cleaner element | | X | | |
| Check radiator hoses | | X | | |
| Change fuel filters | | X | | |
| Clean cooling system | | | | X |

### 3.1.1 General Inspection

When the generator set is running, particular attention must be paid to mechanical problems that could create unsafe or hazardous conditions. The following are several areas that should be inspected frequently to maintain safe and reliable operation.

i. **Exhaust System:** With the generator set operating, inspect the entire exhaust system including the exhaust manifold, muffler and exhaust pipe. Check for leaks at all connections, welds, gaskets and joints, and make sure that the exhaust pipes are not heating surrounding areas excessively. Repair any leaks immediately.

ii. **Fuel System:** With the generator set operating, inspect the fuel supply lines, return lines, filters and fittings for cracks or abrasions. Make sure the lines are not rubbing against anything that could cause an eventual breakage. Repair any leaks or alter line routing to eliminate wear immediately.

iii. **DC Electrical System:** Check the terminals on the starting batteries for clean and tight connections. Loose or corroded connections create resistance which can hinder starting.

iv. **AC Electrical System:** Check **A.**C. wiring, Battery charger, Control panel/switchgear, A.C. generator voltage regulator, electrical system accessories & components.

v. **Power Unit:** Check Generator structure, Clutch assembly (power take off) and Coupling(s).

vi. **Engine:** Monitor fluid levels, oil pressure and coolant temperatures frequently. Look and listen for changes in engine performance, sound, or appearance that will indicate that service or repair is needed. Be alert for misfires, vibration, excessive exhaust smoke, loss of power or increases in oil or fuel consumption.

### 3.1.2 Lubrication Service

- Check the engine oil level when the engine is shut down at the interval specified in Table 1. above
- For accurate readings on the engine's dipstick, shut off the engine and wait approximately 10 minutes to allow the oil in the upper portions of the engine to drain back into the crankcase.
- Follow the engine manufacturer's recommendations for API oil classification and oil viscosity.
- Keep the oil level as near as possible to the "full" mark on the dipstick by adding the same quality and brand of oil.
- Change the oil and filter at the intervals recommended in Table 1. Above.
- Used oil and filters must be disposed of properly to avoid environmental damage or liability.

### 3.1.3 Cooling System Service

- Check the coolant level during shutdown periods at the interval specified in Table 1.
- Remove the radiator cap after allowing the engine to cool and, if necessary, add coolant until the level is about 3/4-inch below the radiator cap lower sealing surface.
- Use a coolant solution as recommended by the engine manufacturer to fill up the radiator.
- Inspect the exterior of the radiator for obstructions and remove all dirt or foreign material with a soft brush or cloth.
- Use low pressure compressed air if available or a stream of water in the opposite direction of normal air flow to clean the radiator.
- Check the operation of the coolant heater by verifying that hot coolant is being discharged from the outlet hose.
- Check Fan belt condition and tension. Correct if necessary and if worn out replace where necessary.

### 3.1.4 Fuel System Service

- In additional to other fuel system service recommended by the engine manufacturer, drain the fuel at the interval indicated in Table 1. above
- Water vapor accumulates and condenses in the fuel tank and must also be periodically drained from the tank along with any sediment present.
- The charge-air piping and hoses should be inspected for leaks, holes, cracks or loose connections.
- Inspect the charge-air cooler for dirt and debris that may be blocking the fins.
- Check engine air intake components at the interval indicated in Table 1.

- Air cleaners typically contain a paper cartridge filter element which can be cleaned and reused if not damaged.
- Check and ensure that the fuel level sensors/gauges are functional and read fuel correctly and displaying the correct volume on the controller display.

### 3.1.5 Starting Batteries Service

- Check the output voltage of the batteries to ensure the battery is delivering adequate starting power.
- Check output of battery Alternator/charger for the required charging voltage. If the alternator is not working, repair or replace the alternator.
- Keep the batteries clean by wiping them with a damp cloth whenever dirt appears excessive.
- If corrosion is present around the terminals, remove the battery cables and wash the terminals with an appropriate solution.
- After replacing the connections, coat the terminals with a light application of petroleum jelly.
- Use a battery hydrometer to check the specific gravity of the electrolyte in each battery cell and if specific gravity is below the required level, charge the battery to full capacity.
- Check the level of the electrolyte in the batteries at least every 200 hours of operation. If low, fill the battery cells to the bottom of the filler neck with distilled water.

### 3.1.6 AC and DC Electrical System Service

- Check AC and DC wiring including condition of panel fuses, indicator lamps, meters, contactors and other switches.
- Check the AVR for Voltage regulation of the A.C. generator and frequency
- Check that the control panel/switchgear is functional and coordinating the system as required.
- Check that the Motorized Switch (ATS) is able to switch accordingly when commanded by the controller.

### 3.1.7 Power Unit Service

- Check the generator structure for possible damaged and repair if necessary
- Check and ensure that the engine mountings are in good condition and replace were necessary.
- Check and grease the Alternator/Generator bearings were necessary.

### 3.1.8 Generator Set Exercise

- Periodically exercise the generator set during and after service for a minimum of 30 minutes loaded to no less than one-third of the nameplate rating.
- Periods of no-load operation should be held to a minimum, because unburned fuel tends to accumulate in the exhaust system.
- If connecting to the normal load is not convenient for test purposes, connect to a load bank to be set to at least one-third the nameplate rating if available.

## 4.0 KEY PERSONNEL AND EQUIPMENT

The Contractor must ensure that the required, technical and administrative personnel, including tools and equipment required to deliver on the project are considered for costing and made available to the project as necessary. The Contractor shall determine any other resources, work plans and methods required to deliver on the project which must all translate into the Technical and Financial submissions made by the Contractor.

The contractor shall provide sufficient evidence and detail of qualifications, certification, experience and availability for and of personnel which must be available for the required time frame of the project.

The Consultant shall provide evidence satisfactory to ZANACO and as outlined in the Bidding document to indicate the following:

- Qualifications of the personnel
- Certifications of the personnel
- CV of the personnel
- Professional registrations
- Evidence of executing similar works
- List of Mechanical Tools required to execute the works
- List of Electrical Tools required to execute the works
- List of motor vehicles as required by the bidding document

## APPENDIX 1

### PREVENTIVE MAINTENANCE INSPECTION CHECKLIST
### STANDBY GENERATORS / SWITCHES / CONTROLS

Contractor Representative: _____ _____
(Print Name) (Signature)

Location: _____ Time: _____ Date: _____

Hour Meter: _____

Unit Mfg. _____ Model:_____ S/N:_____

Engine Mfg: _____ Model: _____ S/N:_____

Gen. Mfg. _____ Model:_____ S/N:_____

| **SECTION A – COOLING SYSTEM** | **SAT.** (check one) | **UNSAT.** (check one) |
|---|---|---|
| 1. Engine coolant level | ☐ | ☐ |
| 2. Radiator core/heat exchanger | ☐ | ☐ |
| 3. Coolant lines/connections/hoses & connections | ☐ | ☐ |
| 4. Water jacket heater(s) | ☐ | ☐ |

Note: Contractor is responsible for replenishing of necessary fluids where there is an unsatisfactory rating.

| **SECTION B – D.C. ELECTRICAL SYSTEM** | **SAT.** (check one) | **UNSAT.** (check one) |
|---|---|---|
| 1. Battery(s) electrolyte level/specific gravity | ☐ | ☐ |
| 2. Battery compartment/heater cooperation | ☐ | ☐ |
| 3. Battery connections/cables/casing | ☐ | ☐ |
| 4. Shutdown mechanisms | ☐ | ☐ |
| 5. Electrical starter/alternator generator | ☐ | ☐ |
| 6. Electrical system, accessories & components | ☐ | ☐ |

Note: Contractor is responsible for indicator lights, indicator lamps, gauges, switches, relays, contactors, solenoids, coils, voltage regulators, sensors, fuses, pressure sensing switches, transformers, power supplies, battery cables and connections.

| **SECTION C – A.C. ELECTRICAL SYSTEM** | **SAT.** (check one) | **UNSAT.** (check one) |
|---|---|---|
| 1. A.C. wiring | ☐ | ☐ |
| 2. Battery charger | ☐ | ☐ |
| 3. Control panel/switchgear | ☐ | ☐ |
| 4. A.C. generator voltage regulator | ☐ | ☐ |
| 5. Electrical system accessories & components | ☐ | ☐ |

Note: Contractor is responsible for the same components listed under Section B-D.C. Electrical System.

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**PREVENTIVE MAINTENANCE INSPECTION CHECKLIST**
**STANDBY GENERATORS / SWITCHES / CONTROLS**

| **SECTION D – AIR INDUCTION & EXHAUST SYSTEM** | **SAT.** (check one) | **UNSAT.** (check one) |
|---|---|---|
| 1. Air cleaner units/oil bath and dry type | ☐ | ☐ |
| 2. Air induction piping and connections | ☐ | ☐ |
| 3. Turbocharger/blower | ☐ | ☐ |
| 4. Exhaust manifold/piping/connections | ☐ | ☐ |

Note: Contractor is responsible for replacing air cleaners, all types.

| **SECTION E – POWER UNIT** | **SAT.** (check one) | **UNSAT.** (check one) |
|---|---|---|
| 1. Generator structure | ☐ | ☐ |
| 2. Clutch assembly (power take off) | ☐ | ☐ |
| 3. Coupling(s) | ☐ | ☐ |

| **SECTION F – LUBRICATION SYSTEM** | **SAT.** (check one) | **UNSAT.** (check one) |
|---|---|---|
| 1. Engine oil level | ☐ | ☐ |
| 2. Engine oil change | ☐ | ☐ |
| 3. Engine oil filter change | ☐ | ☐ |
| 4. Engine oil sample for analysis | ☐ | ☐ |
| 5. Crankcase pressure | ☐ | ☐ |
| 6. Crankcase breather | ☐ | ☐ |
| 7. Oil leaks (hoses, connectors) | ☐ | ☐ |
| 8. Engine governor oil level/linkage (UG8) | ☐ | ☐ |
| 9. Fan drive bearings | ☐ | ☐ |
| 10. Generator bearings | ☐ | ☐ |
| 11. Engine starter oiler (air type only) | ☐ | ☐ |
| 12. Gauges and safety mechanism | ☐ | ☐ |
| 13. Accessory drives | ☐ | ☐ |

Note: Contractor is responsible for replacing any and all engine oil, lubricant, filters and/or belts.

| **SECTION G – FUEL SYSTEM** | **SAT.** (check one) | **UNSAT.** (check one) |
|---|---|---|
| 1. Fuel tank/day tank | ☐ | ☐ |
| 2. Fuel filters-primary/secondary | ☐ | ☐ |
| 3. Fuel system components/hoses/piping | ☐ | ☐ |
| 4. Gauges and Safety mechanism | ☐ | ☐ |
| 5. Condensation/water in fuel | ☐ | ☐ |

Note: Contractor is responsible for replacing all fuel filters (primary and secondary)

**REMARKS:**

**Checked By:** _____