

{g) General approach and methodology

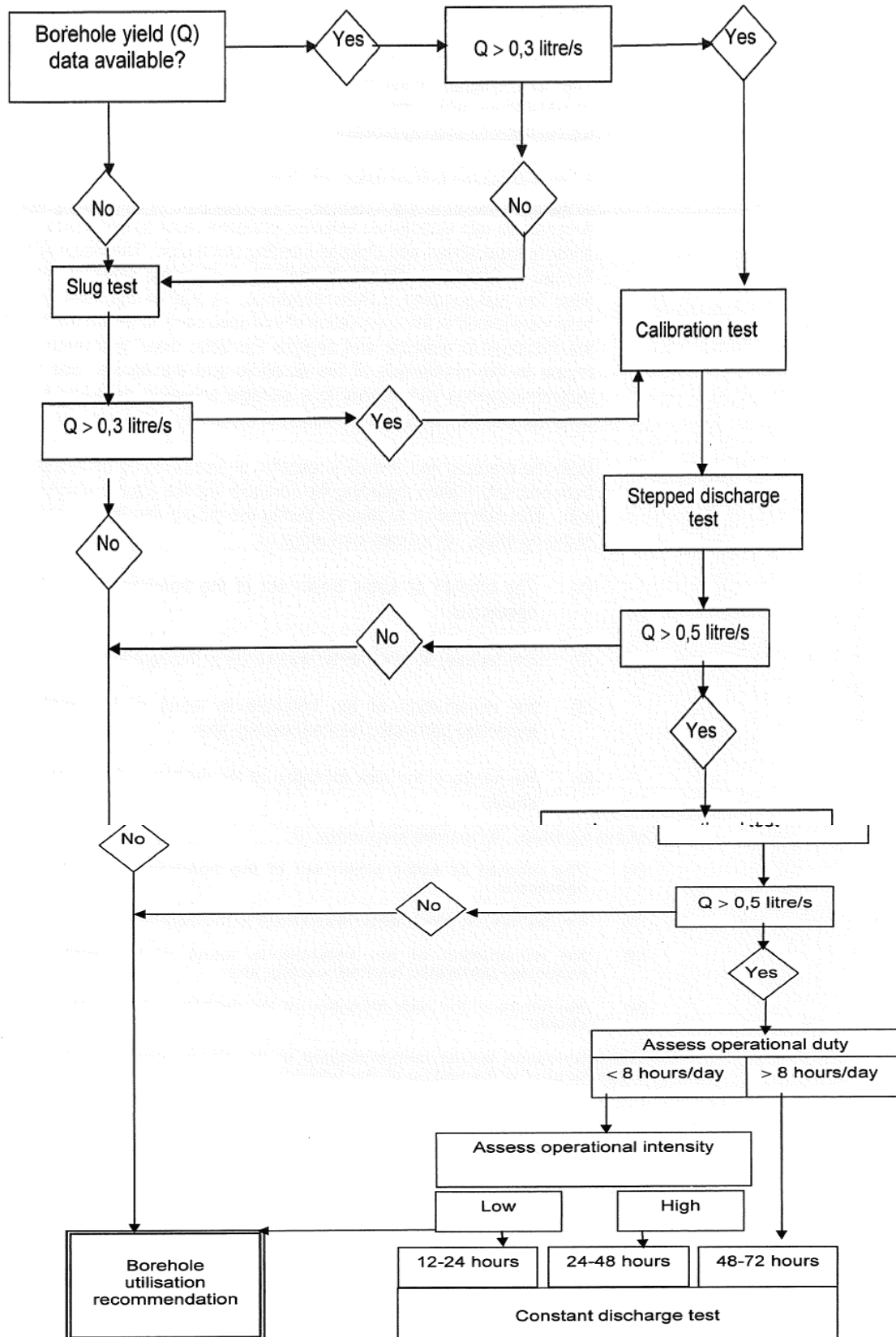
The Engineer will formulate a test pumping schedule for each borehole. The flow diagram presented overleaf provides an indication of the considerations which determine the scope of test pumping based on a logical decision-making process.

All project-related test pumping activities will also be carried out under the direct supervision of the Engineer. The execution of a pumping test in accordance with established scientific protocols must be undertaken by a suitably experienced and equipped testing contractor. The South African Bureau of Standards (SANS) is finalising a Standard Code of Practice titled *The test-pumping of water boreholes*. A draft of this Standard has been considered in the compilation of this document. It will be the task of the Engineer to evaluate and analyse the data, draw conclusions with regard to the productivity of the borehole and the aquifer, and make recommendations with regard to a suitable operating schedule for the borehole and the optimum exploitation of the ground-water resource.

Both the practical and analytical aspects of test pumping benefit greatly from prior information regarding the borehole and the aquifer which it taps into. This information is gleaned during the drilling and the construction of the borehole. It includes knowledge of:

- (1) The amount of water blown out of the borehole during drilling operations;
- (2) the depth(s) at which water was struck in the borehole;
- (3) the construction of the borehole in terms of the setting of especially perforated (slotted) casing, and
- (4) the nature of the rock formation at the depth(s) where water was struck.

This information will be communicated to the testing contractor by the Engineer prior to the testing of any borehole.



The Contractor shall keep a full record of the test pumping which is undertaken and submit the record on completion of the test. This record must include the following basic information:

- (1) The depth to water level before the start of testing;
- (2) the depth at which the test pump was installed;
- (3) the type, make and model of the test pump used;
- (4) the pumping rate as measured at regular intervals during the test, and
- (5) the water level in the borehole as measured according to a prescribed time schedule both during and after pumping.

The Contractor must be sufficiently well-equipped to gather this information with acceptable accuracy.

The rationale behind the flow diagram is explained as follows. A slug test should be performed on a borehole in instances where there is no prior indication of its possible yield. The result of the slug test will indicate whether additional test pumping is warranted. A slug test shall also be performed in instances where the possible yield of a borehole from prior information is indicated to be less than 0,3 litre/s. The result of the slug test will again indicate whether additional test pumping is warranted. In instances where the possible yield of a borehole from prior information is indicated to be equal to or greater than 0,3 litre/s, then a calibration test followed by a stepped discharge test shall be performed.

The result of the stepped discharge test will indicate whether further test pumping in the form of a constant discharge test is warranted or whether the borehole is judged to be sufficiently weak (potential production yield less than 0,5 litre/s) to make a utilisation recommendation without further testing. Should the result of the stepped discharge test indicate that a constant discharge is warranted, then the Engineer will need to make an assessment of the possible operational duty to which the borehole might be subjected.

The operational duty describes the number of hours per day for which the borehole must operate in order to meet the local water demand. By implication, the potential production yield of the borehole must be compared to the water demand. In qualitative terms, a lower yielding borehole would need to operate for a longer period per day to meet a given demand than a higher yielding borehole would need to. Further, the water demand is often too great for even a high yielding borehole pumping continuously to meet. The flow diagram indicates, however, that any borehole which reveals the potential to yield more than 0,5 litre/s and which will operate for a period in excess of 8 hours per day must be subjected to a constant discharge test of 48 to 72 hours duration. A borehole which does not fit this category requires an assessment of its possible operational intensity.

The operational intensity describes the yield at which a higher yielding borehole must operate in order to meet a water demand in a pumping period of eight hours or less per day. By implication, a high operational intensity requires the borehole to be pumped at a yield approaching its maximum, whereas a low operational intensity will place less stress on the borehole. These considerations will indicate whether a 24 to 48 hour or a 12 to 24 hour duration constant discharge test respectively will be performed.

The final step in the flow diagram requires the Engineer to make a borehole utilization recommendation.

## DA 04.02.02

**Equipment and materials**

This represents the test unit and all ancillary equipment and materials required to accurately and efficiently perform borehole testing. Details are provided below.

**(a) Test unit**

The **test** unit shall **comprise a positive displacement (PD) type pump element and a pump head driven by a motor fitted with an accelerator, gearbox and clutch**. The unit **must be in good working order** and capable of maintaining a minimum **of 72 hours** of continuous operation.

The unit must **be capable** of delivering **water** at a rate in **excess** of the **expected maximum yield of the borehole to be tested**. It may be acceptable under certain circumstances to employ a submersible pump for testing purposes. This must, however, be identified in the tender enquiry document. It is imperative that any submersible pump used for testing purposes be equipped with a non-return valve fitted at the bottom of the pump column (rising main).

**(b) Discharge piping**

Discharge piping comprises both the pipe (rising main or pump column) which brings the water to surface and the pipe (discharge hose) used to lead the pumped water away from the borehole being tested. The Contractor shall supply sufficient rising main to set the test pump at a depth of at least 100 m below the surface. It may, however, be required under certain circumstances to set the test pump at a greater depth in the borehole. Where necessary it shall be discussed with the Engineer prior to the installation of the test pump. The pump column must be of uniform diameter throughout. The Contractor shall also provide at least 50 m discharge piping. This must be free of leaks for its entire length. It may again, under certain circumstances, be required to discharge the pumped water at a point further away than 50 m (possibly in excess of 300 m) from the borehole being tested. In such instances, a similar procedure to that discussed above in regard to the rising main must be followed.

**(c) Discharge measuring equipment/Instrumentation**

This equipment/Instrumentation must be adequate to accurately measure the pumping rate within the range of yields expected from successful project boreholes. If volumetric methods are used, a stopwatch for measuring time to an accuracy of at least one-tenth of a second is required. The full capacity of each container shall be determined accurately. The Contractor shall also ensure that a container stands level when used for discharge measurements. Guidelines regarding the use of different size containers for volumetric discharge rate measurements in specific yield ranges are given in table DA 04.02.02/1. Other acceptable instruments that may be used for discharge measuring are: (1) an orifice weir and (2) a flow meter. The use of these instruments is subject to various application criteria.

**(i) Orifice weirs**

**These must be installed in a horizontal position at the end of the discharge pipe. The orifice plate opening must be sharp, clean, bevelled to 45 degrees and have a diameter less than 80 per cent of the diameter of the approach tube to which it is fixed. The**

orifice plate must be vertical and centred on the end of the approach tube. There must be no leakage around the perimeter of the orifice plate mounting. The piezometer tube must not contain entrained air bubbles at the time of pressure head measurement. The latter measurement must be at least three times the diameter of the orifice.

TABLE DA 04.02.02/1 YIELD RANGE VERSUS CONTAINER SIZE FOR VOLUMETRIC MEASUREMENTS

YIELD RANGE	CONTAINER SIZE
Less than 2 litre/s	20 litre
2 litre/s to 5 litre/s	50 litre
5 litre/s to 20 litre/s	210 litre
20 litre/s to 30 litre/s	500 litre
30 litre/s to 50 litre/s	1000 litre
More than 50 litre/s	Other suitable methods

The orifice weir equipment must be calibrated for various combinations of approach tube and orifice diameters so that pressure head readings can be converted to accurate discharge measurements.

(ii) Flow meters

Flow meters must be calibrated and of similar diameter to that of the discharge pipe. The latter must be straight and of uniform diameter for a distance of four times the diameter of the pipe before the position of the meter. There must be no turbulent flow or entrained air in the discharge pipe before the meter. The discharged water must be free of solid material carried in suspension.

It is recognised that some water leakage will generally occur especially at the borehead during pumping. This is acceptable provided that: (1) such leakage does not interfere with any water-level monitoring and (2) the total amount of leakage to the end of the discharge pipeline does not exceed one per cent of the pumping rate as measured at the end of this pipeline.

(d) Water-level measuring equipment/instrumentation

The Contractor shall provide at least three water-level measuring devices which are each capable of providing an accuracy of at least 0,01 m (10 mm) and are of sufficient length to match the pump installation depth. If ungraduated electrical contact meters (dip meters) are used for this purpose, each such instrument must be equipped with a measuring tape of an acceptable length and approved standard and which is graduated to an accuracy of at least 0,01 m (10 mm). These instruments must be in good working order and number at least one spare for each two on site.

The Contractor shall further provide conduit tubing of sufficient length to match the pump installation depth. The diameter of this tube must be large enough (minimum 15 mm) to allow free movement of the dip meter probe and cable therein. The tubing must be made of material strong enough to withstand reasonable pressure on its sidewall which might cause a constriction. The tube must be open at its lower end to allow the free entrance of water into the tube. This is facilitated by perforating the bottom section of the conduit tube sidewall. Precautions shall also be taken to prevent the dip meter probe from passing beyond the bottom end of the conduit tube and, as a result of entanglement, not able to be withdrawn.

(e) Other materials

No pumping test should commence without field data sheets on which to record all data and information relevant to the test pumping activities in an acceptable format. These can either be provided by the Contractor or the Engineer.

**DA 04.02.03**

**Ground-water sam.Eill!:.lg**

(a) Sampling for macro-element analysis

The Institute for Water Quality Studies of the DWAF, in conjunction with the Department of Health, commenced in May 1996 with the compilation of guidelines addressing all aspects of water sample collection aimed at routinely establishing the quality thereof for drinking purposes. Until such time as these guidelines become available, the following recommendations in this regard should be followed.

A water sample shall be collected from the end of the discharge pipeline no sooner than 15 minutes before the scheduled end of a pumping test, whether of a calibration, stepped discharge or constant discharge nature. This will ensure that a water sample is collected in case testing does not proceed to include either one or both of the latter two types of test. The standard amount of sample normally collected is in a clean, sterilised plastic bottle of capacity 240 millilitre or larger and equipped with a watertight screw-on cap. This is the standard issue sample bottle provided by the DWAF. Depending on the analysing laboratory's requirements, however, a sample of up to two litres in volume may have to be collected. The Engineer will advise on this matter in instances where the Contractor is required to collect samples, in which case the Engineer will provide ampoules containing preservative chemicals if required. All other materials such as sample bottles, tie-on labels and sample custody forms are to be provided by the Contractor. The mandatory sample custody form DW45 must be completed for each sample collected. Note that the code MACRO1 in Instruction 8 ("analyse for") of form DW45 defines the macro-element analysis.

(i) Sampling procedure

Wash hands thoroughly and rinse the sample bottle three times with the water to be sampled, ie the water being pumped from the borehole. Fill the bottle so that a space of five to ten millimetres is left at the top. Add the preservative as instructed in (ii).

## (ii) Sample preservation

Gently tap the bottom of an ampoule of preservative on a firm surface so that all the chemical flows to below the constriction. Hold the ampoule firmly upright with thumbs placed either side of the constriction, flex off the neck, turn the ampoule upside down and place it in the bottle together with the broken-off neckpiece. Firmly screw on the cap of the sample bottle after rinsing it well with water from the borehole. Shake the capped sampled bottle well. Caution shall be exercised when handling the preservative, since this chemical is poisonous.

## (iii) Sample custody

Fill in the information requested on the tie-on label and attach this securely to the neck of the sample bottle. Place the sample bottle in a cooler or ice-box and keep it stored under chilled conditions. Complete the sample custody form (DWAF form DW45). The water sample and its custody form will be collected by the Engineer. The above procedures shall be adhered to and complied with to the satisfaction of the Engineer.

(b) Sampling for environmental isotope analysis

Use a new, clean, one-litre polyethylene bottle with watertight screw-on cap for routine stable (hydrogen and/or oxygen) isotope and tritium analysis. Take the same basic precautions as for macro-element analysis. Ensure that the water is as clean as possible, but do not filter or add anything. Turbidity does not matter. Rinse the bottle three times with the water to be sampled, fill till overflowing and tighten cap well. Turn bottle upside down and squeeze to test for tightness. Clearly label the bottle by waterproof marking pen on the bottle shoulder or tie-on label.

In special cases of confined to semi-confined (older) water, where tritium values  $< 0,5$  TU are observed, or where it is specifically requested, samples for radiocarbon analysis may be required. Since this involves special procedures of field extraction of larger quantities of water, the Engineer shall contact experts in this field for the procedures and materials required.

This test shall only be conducted when requested by the Engineer.

The standards of isotopic measurement for hydrological applications are defined as follows:

## (i) Minimum detectable values

Tritium: 0,3 TU (tritium units)

Radiocarbon: 2 pMC (per cent modern carbon)

## (ii) Maximum analytical error

Tritium:  $\pm 0,3$  TU (0 - 3 TU); otherwise  $\pm 10\%$

Radiocarbon:  $\pm 2$  pMC ( $> 40$  pMC);  $\pm 1$  pMC ( $< 40$  pMC)

Oxygen-18:  $8^{18}\text{O}; + 0,15\text{‰}$

Deuterium:  $8^2\text{H}; \pm 1,5\text{‰}$



DA 04.02.04 Aborted tests and bre\_akd\_0wns

The Engineer may at any stage during the execution of a pumping test request the testing contractor to abort a test if, in the opinion of the Engineer, continuation of the test is not in the interests of the project. Factors which may contribute to such a decision by the Engineer are:

Sufficient data having been collected for an adequate scientific evaluation thereof;

the execution of the test not meeting project criteria and requirements (such as for constancy of yield, accuracy of yield measurements or accuracy of water-level measurements, sufficiency of discharge line length, etc), or

a mechanical breakdown occurring during pumping which causes a test to be interrupted or aborted.

(a) Tests aborted due to sufficiency of data

The Engineer will fully motivate his decision to abort the test in a written statement to the User Client. In such instances, the testing contractor will be remunerated for the actual duration of testing (including recovery testing) at the hourly rates set out in the Schedule of Quantities.

(b) Tests aborted due to incorrect execution

The testing contractor will be required to remedy the cause(s) for an abort decision by the Engineer. The test shall be restarted, as if it were the first attempt, after the water-level has recovered to within five per cent of the pre-test rest water-level or the contractor is instructed thereto by the Engineer. The testing contractor shall not be entitled to remuneration for any test which is aborted under these circumstances irrespective of the time elapsed up to receipt of the instruction to abort.

(c) Tests aborted due to breakdowns

The following procedures are recommended when a mechanical breakdown occurs during pumping which causes a test to be interrupted or aborted.

(i) Calibration test

Start immediately with the measurement and recording of the water-level recovery rate according to the periodicity given in table DA 04.02.04/1. Irrespective of how long after the start of pumping the breakdown occurs or how rapidly the breakdown can be fixed, continue with water-level recovery measurements until the water level is within five per cent of the pre-test rest water level or, at the discretion of the Engineer, may be discontinued. Restart the calibration test as if it is the first attempt. The Testing Contractor shall not be entitled to remuneration for a calibration test which is aborted under such circumstances.



## (ii) Stepped discharge test

Record the time of the breakdown and start immediately with the measurement and recording of the water level recovery according to the periodicity given in Table 4-9. If the breakdown occurs during the first or second steps of the test, continue with water-level recovery measurements until the water-level is within five per cent of the start rest water level and then restart the stepped discharge test as if it is the first attempt. If the breakdown occurs during the third step of the test, can be fixed and the pump restarted to produce the same yield (as before the breakdown) within five minutes of the breakdown occurring, continue with the test at this yield after measuring and recording the water level immediately before restarting the pump. Only one such breakdown event is allowed.

If a second breakdown occurs, proceed as described for a first step breakdown. If the breakdown occurs during the fourth or later step of the test, can be fixed and the pump restarted to produce the same yield (as before the breakdown) within five minutes of the breakdown occurring, continue with the test and complete it at this yield after measuring and recording the water level immediately before restarting the pump. If a breakdown at this stage can not be fixed within five minutes, continue with water-level recovery measurements as if the test has been fully completed. The Contractor shall not be entitled to remuneration for a stepped discharge test which is aborted: (1) within the first or second step, or (2) within the third step and can not be restarted within the time allowed for repair.

## (iii) Constant discharge test

Note the time of the breakdown and start immediately with the measurement and recording of the water-level recovery according to the periodicity given in table DA 04.02.04/1. If the breakdown occurs within the first two hours after the start of pumping, continue with water-level recovery measurements until the water-level is within five per cent of the pre-test (start) rest water level and then restart the test. If the breakdown occurs later than two hours into the test, can be fixed and the pump restarted to produce the same yield as before the breakdown within the time periods (after the breakdown occurring) given in table DA 04.02.04/1, continue with the test at this yield after measuring and recording the water level immediately before restarting the pump.

If the breakdown can not be fixed and the pump started within one hour of the breakdown occurring, continue with water-level recovery measurements until the water level is within five per cent of the pre-test rest water level and then restart the constant discharge test as if it is the first attempt unless the following condition has been met. If the breakdown occurs after approximately 80 per cent of the planned duration of the constant discharge test has been successfully completed, continue with water-level recovery measurements as if the test has been fully completed. The allowable elapsed time (in hours) with regard to selected constant discharge test total durations in order for this specification to be acceptable is given in table DA 04.02.04/2.

(c) Borehole information register

A data register containing the following information shall be compiled during the repair contract and further developed during the maintenance contract:

- (i) Borehole pumping equipment and maintenance tasks, records, etc
- (ii) Borehole utilisation (rate of discharge and duration of discharge)
- (iii) Borehole water-level.

(d) Commissioning

All components at each borehole will be fully commissioned after reconditioning or replacement as described in Additional Specification SC: General Decommissioning, Testing and Commissioning Procedures.

**DA 04.05 SUBMERSIBLE CENTRIFUGAL PUMPS**

This Specification covers the supply, delivery and installation of submersible centrifugal pumps. Testing and commissioning is covered in Clause DA 05 and in Additional Specification SC: General Decommissioning, Testing and Commissioning Procedures.

**DA 04.05.01 General**

Centrifugal pumps supplied under this Contract shall be suitable for vertical installation in submerged conditions, shall consist of a submersible motor coupled directly to a multistage centrifugal pump and shall be suitable for pumping water for domestic use.

The details of the existing installation were unknown at the time of tender. Allowance has been made for the servicing of pumping equipment.

Should it become apparent during the servicing that components need to be replaced such as bearings, shafts, etc., a payment item for the reconditioning of the pumping equipment has been allowed. The "reconditioning" payment item will replace the "servicing" payment item in this event.

No orders shall be placed for any pumping equipment until the boreholes have been tested and the report submitted to the Engineer. The Engineer shall then provide the pump requirements to the Contractor for ordering of equipment.

Preference will be given to pumps of the self-regulating type and where the power consumption characteristic is such that with an increase in delivery to beyond a certain limit, the power consumption decreases, thereby ensuring that the motor is not overloaded in the event of a large reduction in pumping head.

Preference will be given to locally manufactured pumps and motors, with a reliable and efficient after sales service and readily available spares.

**DA 04.05.02 Depth of installation**

The most suitable depth of installation and safe pumping rate shall be confirmed by an experienced borehole contractor by virtue of the supplied borehole record, test and calculated information. All costs involved in confirming the most suitable depth of installation and safe pumping rate shall be deemed included in payment item DA.01.

**DA 04.05.03 Material**

All parts of the pump shall be manufactured from material most capable of withstanding wear. Full specification in this respect shall accompany the Tender and the Tenderer's advice in this respect will be considered.

**DA 04.05.04 Speed**

The pump shall have a rotational speed not exceeding 1 450 rpm. If a higher rotational speed is required, this shall be motivated in a covering letter or in the technical data sheets.

**DA 04.05.05 Design**

All working parts of the pumps shall be removable and serviceable and shall under no circumstances be integrated into the body of the pumps.

**DA 04.05.06 Turbine bowls**

Turbine bowls shall be manufactured from high-grade cast steel and shall be finished off smoothly before a high-quality corrosion protection system is applied. Grey Iron No 30 turbine bowls may be approved by the Engineer, or if so stated in the Project Specifications. The bowls shall be selected for a minimum of 2 500 kPa or 1,5 times the maximum discharge pressure, whichever is the greater. The casing, suction strainer, cable shield and all fastenings, nuts and bolts shall be manufactured from stainless steel.

**DA 04.05.07 P1.111.12 shaft**

The shaft shall be manufactured of stainless steel. Where the shaft passes through stuffing boxes it shall be fitted with renewable sleeves of high-quality, wear-resistant alloy.

The shaft shall be so designed that the running speed is well below the first critical speed, and the complete rotor shall be accurately balanced after assembly.

The rotating elements shall be accurately balanced statically and dynamically to eliminate noise and vibration when running.

**DA 04.05.08 Pump...lm.Elellers**

Impellers shall be manufactured of stainless steel or bronze and shall be carefully bored and keyed. All parts inaccessible to machining shall have a smooth finish. Balancing of impellers shall not be done by means of drilling balancing holes, but rather by accurate and careful machining of impellers.

**DA 04.05.09 Se ls and bearings**

Pumps shall be fitted with mechanical seals with sand deflectors. Pump bearings and thrust collars shall be bronze and shall be lubricated by the fluid handled. The pump and motor shall not be adversely affected by suspended sand concentrations of up to 25 g/m<sup>3</sup>.

**DA 04.05.10 Rising pipe**

The rising pipe shall have threaded or approved bolted couplings at a spacing of approximately 6 m intervals. The rising pipe shall have a minimum internal diameter of 50 mm and shall internally and externally be protected against corrosion by a fusion-bonded powder epoxy coating to a minimum thickness of 250 micron. All bolts used shall be stainless steel. The couplings shall not totally obstruct the borehole, but shall allow for sufficient clearance between the coupling and borehole casing to prevent any damage to the drop cable set and earth wire. The pump and rising pipe shall be centered in the borehole by means of approved centralisers at a preferred spacing of not more than 3 m. The centralisers shall be manufactured of an approved corrosion-resistant material and shall assist in eliminating any vibration that may occur in the borehole/rising pipe installation.

**DA 04.05.11 Borehole vents**

The borehole shall be adequately vented to prevent the build-up of pressure or vacuum. All borehole vent openings shall be piped watertight to the atmosphere outside of any enclosure and not less than 200 mm above any low ground level or the highest recorded flood level. Such vent openings shall be at least 12 mm in diameter. The terminal of the vent shall be suitably shielded and screened so as to prevent the entrance of foreign matter and insects.

**DA 04.05.12 Pump motor**

Unless otherwise specified, each pump shall be supplied complete with an electrical motor. Each electrical motor shall comply with the requirements as specified in Specification GB: Electrical installation for mechanical and pumping equipment and Clause DA 05 of this specification and Specification PF: Acceptance tests for pumps.

The depth setting shall be such that an up-flow of water past the motor is created. If insufficient up-flow of water past the motor is available, a suitable flow induced tube shall be fitted to the pump and motor to ensure sufficient cooling of the motor.

**DA 04.05.13 Base plate**

A suitable base plate shall be used to effectively close the top of the borehole to prevent any foreign matter from entering. The rising pipe shall be effectively bolted to the base plate. The base plate shall further be provided with the necessary openings for the drop cable site, earth wire and water-level monitoring device.

**DA 04.05.14 Accessories**

Over and above any reflux valves installed and specified above ground level, the pump shall be fitted with a non-slam type reflux valve situated at the pump outlet. The reflux valve shall be a matched component supplied and tested by the pump manufacturer for efficient and troublefree operation.

**DA 04.05.15 Pump technical details**

The pump shall be a currently catalogued product. Documentation shall include performance curves or selection tables, indicating flow, head, NPSH required, power absorbed, speed and efficiency for the expected range of operational conditions.

Performance curves and selection tables shall be based on a reproducible and certified test carried out in an approved laboratory. Certified detail selection shown on these performance curves or tables shall be submitted.

The flow rate at break-off point of the curve for the impeller selected shall be at least 1,5 times that of the maximum flow rate specified.

## DA. 25

The head at zero delivery of the curve for the impeller selected shall be at least 1,2 times the operating head.

The efficiency of the pump shall not be less than 95 % of its maximum efficiency at the selected duty point. The efficiency of the pump at the selected duty point as stipulated in table DA 04.05.01/1 shall not be less than 75 %.

The possible percentage variation of data measured on Site by the supplied and/or installed instrumentation when compared with the catalogued performance data must be submitted.

All calculations for static and dynamic heads are to be based on an atmospheric pressure above mean sea level of approximately 1 410 m, which is the site elevation of the borehole site.

The pump shall be installed in accordance with the manufacturer's instructions and shall be maintained in "as new" condition at start up.

Details of the equipment shall include the following:

- (a) Operating, testing and commissioning instructions
- (b) Trouble analysis guide.

Full details of periodic and annual maintenance and service to be undertaken by the maintenance staff in accordance with a preventive maintenance programme shall be submitted.

The Contractor shall state in the technical data sheets the minimum selected service life for which the pump has been engineered and the components selected when operated under normal working conditions with optimum servicing and maintenance.

The minimum acceptable service life is 15 years with 8 500 operating hours per annum.

The Engineer reserves the right to call for -

- (a) Test certificates and reports from the manufacturer's quality control laboratory or an independent test laboratory such as SANS, and/or
- (b) site inspection, customer reports/references and user's interviews, and/or
- (c) full engineering, design and component selection details,

in order to check the correctness of the service life claimed.

## DA 04.06

### **SUBMERSIBLE PROGRESSING CAVITY PUMPS**

This Specification covers the supply, delivery and installation of belt-driven submersible progressing cavity pumps. Testing and commissioning is covered in Clause DA 05 and Additional Specification SC: General decommissioning, testing and commissioning procedures.

**DA 04.06.01 General**

The pumps supplied under this Contract shall be of the progressing cavity type with a stator and a rotor, similar to Mono, Orbit or approved equivalent pumps.

The pumps shall be belt-driven and suitable for vertical installation in submerged conditions and shall be suitable for pumping water for domestic use.

Preference will be given to locally manufactured pumps, with reliable and efficient after sales service and readily available spares.

**DA 04.06.02 DeQth of installation**

The most suitable depth of installation and safe pumping rate if not required in the detail specification shall be confirmed by an experienced borehole contractor by virtue of the supplied borehole record, test and calculated information. All costs involved in confirming the most suitable depth of installation and safe pumping rate shall be deemed included in payment item DA.01.

**DA 04.06.03 Material**

The Contractor shall take cognisance of the operating environment and the properties of the pumped liquid when selecting the materials of manufacture for the pump components to ensure that the components are resistant to corrosion.

All parts of the pump shall be manufactured from material most capable of withstanding wear. Full specification in this respect shall accompany the Tender and the Tenderer's advice in this respect will be considered.

**DA 04.06.04 PumR...!Reed**

The pump shall have a rotational speed not exceeding 1 500 rpm. If a higher rotational speed is required this shall be motivated in a covering letter or in the technical data sheets.

**DA 04.06.05 Design**

All working parts of the pumps shall be removable and serviceable and shall under no circumstances be integrated into the body of the pumps.

**DA 04.06.06 PumQ shaft and rotor**

The pump shaft and rotor shall be manufactured from stainless steel.

The shaft shall be so designed that the running speed is well below the first critical speed.

The rising shaft shall be supported by a bobbin bearing every 1,5 metres.

The shaft supporting bearings shall be made of stainless steel with a vulcanised rubber outer sleeve and rubber linings with bushes of a synthetic material and shall be lubricated by the fluid handled.

**DA 04.06.07 PumQ stator**

The stator of the pumps shall be manufactured from a suitable wear-resistant rubber and shall be formed by moulded-to-metal construction. The rubber shall be resistant to wear and heat caused by the occasional dry running of the pumps and the maximum permissible time span during which the pumps can run dry without any damage caused to the pumps, shall be indicated in the covering letter at tender stage.

**DA 04.06.08 Rising pipe**

The rising pipe shall withstand a 1 600 kPa working pressure.

The rising pipe shall have threaded or approved bolted couplings at a spacing of approximately 3 m intervals. The rising pipe shall have a minimum internal diameter of 50 mm and shall internally and externally be protected against corrosion by a fusion-bonded powder epoxy coating to a minimum thickness of 250 micron. All bolts used shall be stainless steel. The pump shaft shall run inside the rising pipe.

The pump and rising pipe shall be centred in the borehole by means of approved centralisers at a preferred spacing of not more than 6 m. The centralisers shall be manufactured of an approved corrosion-resistant material and shall assist in eliminating any vibration that may occur in the borehole/rising pipe installation.

**DA 04.06.09 Borehole vent**

The borehole shall be adequately vented to prevent the build-up of pressure or vacuum. All borehole vent openings shall be piped watertight to the atmosphere outside of any enclosure and not less than 200 mm above any low ground level or the highest recorded flood level. Such vent openings shall be at least 12 mm in diameter. The terminal of the vent shall be suitably shielded and screened so as to prevent the entrance of foreign matter and insects.

**DA 04.06.10 Pulley head and base plate**

A pulley head which includes the pulleys, shaft seals, bearings and pump delivery flange shall be mounted on a suitable base plate.

The pulley head and base plate shall effectively close the top of the borehole to prevent any foreign matter from entering.

The rising pipe shall be effectively bolted to the pulley head.

A double bearing configuration shall be installed where the shaft exits the pulley head frame. The bearing configuration shall consist of a lower thrust bearing and an upper sealed ball or roller locating bearing.

The pulley head shall be fitted with a stuffing box and shall have gland packings of adequate depths for sealing around the shaft, where the shaft exits the pump casing.

The gland packing shall be designed to permit high speed rotation without the possibility of seizing and charring the packing material or shaft. An automatic water seal shall be provided to prevent the entry of air into the pump.

**DA 04.06.11 Belt drives**

This clause only deals with V-belts, but full details of alternatives may be submitted to the Engineer for approval.

The Contractor shall install at least two belts per coupling.

The coupling (the belts, pulleys, shafts and keys) shall be selected such that it can safely transfer 200 % of the design starting torque and can operate up to a rotational speed of 150 % of the nominal duty speed.

The motor/engine and driven equipment shall be aligned and installed such that misalignment and stagger is within 60 % of the safe allowable limits specified by the supplier of the driving and/or driven equipment. Radial run-out on pulleys shall not be more than 1 % of the pulley diameter.



If the driving and driven pulleys are not in the same plane a maximum of a quarter twist turn between the driving and driven pulleys is allowed with a suitable belt length to prevent damage to the V-belts or pulleys.

Keys and keyways for load transfer to and from shafts shall comply with BS46 Part 1 and BS 4235 Part 2.

Suitable and accessible methods for adjusting the tension of the belts shall be provided.

The driving and driven pulleys and belts shall be enclosed in a single sturdy guard which allows visual inspection of the belt condition with the guard fitted. The guard shall be easily removable for belt maintenance.

Pulley sizes and ratios shall be selected such that operational belt speeds never exceed 25 *mis* and are never less than 10 m/s.

The arc of contact on the small pulley shall be more than 120°. The pulley ratio shall not be less than 2,25:1, unless prior approval is obtained from the Engineer.

Belts shall be easily removed and installed for maintenance purposes and shall be to the approval of the Engineer.

The required belt tension to transfer the required load, including starting, shall not result in side thrusts in the prime mover and pump head pulley bearing which exceed 60 % of the manufacturer's specified maximum allowable side thrusts.

#### **DA 04.06.12 Accessories**

Each pump discharge line shall be fitted with the fittings and accessories as indicated by the Engineer.

Each pump shall be fitted with a suitably calibrated pressure relief valve fitted in the delivery pipework immediately downstream of the outlet flange.

Each pump shall be fitted with a non-slam type reflux valve situated at the pump outlet. The reflux valve shall be a matched component supplied and tested by the pump manufacturer for efficient and troublefree operation.

#### **DA 04.06.13 Pump efficiency**

The efficiency of the pumps shall not be less than 75 %. The normal operational efficiency of the pumps shall not be less than 3 % below the peak efficiency of the pumps.

#### **DA 04.06.14 PumQ technical details and installation**

The pump shall be a currently catalogued product. Documentation shall include performance curves or selection tables, indicating flow, head, power absorbed, speed and efficiency for the expected range of operational conditions.

Performance curves and selection tables shall be based on a reproducible and certified test carried out in an approved laboratory. Certified detail selection shown on these performance curves or tables shall be submitted.

The Contractor shall state in the technical data sheets, the minimum selected service life for which the pump has been engineered and the components selected when operated under normal working conditions with optimum servicing and maintenance.

The minimum acceptable service life is 15 years with 8500 operating hours per annum.

The pumps required shall be determined by the Engineer after the borehole yield testing to ensure the optimum use of each borehole.

The Engineer or his representative reserves the right to call for -

- (a) Test certificates and reports from the manufacturer's quality control laboratory or an independent test laboratory such as SANS, and/or
- (b) site inspection, customer reports/references and user's interviews, and/or
- (c) full engineering, design and component selection details,

in order to check the correctness of the service life claimed.

The pump shall be installed in accordance with the manufacturer's instructions and shall be maintained in "as new" condition at start up.

Details of the equipment shall include the following:

- (a) Operating, testing and commissioning instructions
- (b) Trouble analysis guide.

Full details of periodic and annual maintenance and service to be undertaken by the maintenance staff in accordance with a preventive maintenance programme shall be submitted.

**DA 04.06.15 Prime mover**

The pump shall be belt-driven by either an electric motor or diesel engine as specified in the schedule of quantities.

The prime mover and the pump pulley head shall be mounted on separate base frames.

**DA05 GENERAL SPECIFICATION FOR ELECTRIC MOTORS**

**DA 05.01 SCOPE, REFERENCE SPECIFICATIONS, STANDARDS AND CODES**

This specification covers all aspects related to electric motors that may be incorporated in any of the items of equipment to be supplied under the contract.

**DA 05.02 GENERAL REQUIREMENTS**

- (a) Electric motors shall be manufactured in South Africa and shall comply with the requirements of SANS 948.
- (b) Where imported motors are offered they shall be submitted to the South African Bureau of Standards to be tested in accordance with the requirements of SANS 948 and the Engineer shall be provided with the appropriate certificate obtained from the South African Bureau of Standards stating that such motors do comply, prior to the installation of the motors. However, where tests reveal that motors do not comply, it shall be the responsibility of the Contractor to supply alternative motors which comply with the requirements of SANS 948 and which are acceptable to the Engineer. Where imported motors are not normally kept in stock in South

- (c) All motors shall be standard catalogue models and shall be readily available.
- (d) All motors shall, where possible, be from the same manufacturer and shall have the same interchangeable frames. Variations in type and size shall, where possible, be limited to prevent stocking a variety of special spares.

## WORKING VOLTAGE AND SUPPLY SYSTEMS

- (a) The motors shall be capable of operating within  $\pm 10\%$  of the nominal voltage supply without risk of damage. All motors shall be suitable for operating continuously at the specified 3-phase voltage under actual service conditions, including the  $\pm 10\%$  system voltage tolerance, without exceeding the specified temperature rise determined by the resistance on a basic full load heat run.
- (b) All motors shall be capable of operating continuously under actual service conditions at any supply frequency between 48 and 51 Hz together with any voltage between plus and minus 5 per cent of the nominal supply voltage.
- (c) The slip-in speed of any motor at 80 per cent of the nominal voltage at 50 Hz shall not exceed a percentage agreed on by the Engineer, and the motors shall be capable of operating at this voltage for a period of five minutes without deleterious heating.

## TEMPERATURE RISE

The temperature rise, as determined by resistance, of all motors, shall not exceed the following derated values:

Insulation class	E	B	F	H
Temperature rise (K)	50	60	80	100

## EFFICIENCY AND POWER FACTOR

- (a) The efficiency of all motors shall be guaranteed by the Contractor. Deviations from the guaranteed efficiency shall be within the limits specified in SANS 948.
- (b) The guaranteed efficiency of each size and rating of motor shall be as determined in accordance with BS 4999: Part 102. A basic test certificate of efficiency will be accepted for a motor of identical size and rating or a basic test of efficiency shall be conducted if no certificate is available.
- (c) The power factor of motors with a capacity of 20 kW or more shall not be less than 0,9 under all operating conditions.

## VIBRATION

- (a) Motors shall be statically and dynamically balanced.
- (b) All motors shall be checked for vibration without load, and at full rated voltage at the manufacturer's works, and the vibration amplitude as measured shall be in accordance with BS 4999: Part 142, quality grade 'Normal'.

- (c) The ratio of axial to radial vibration shall not exceed 0,5.

**DA 05.07 NOISE LEVEL**

Unless otherwise specified motors shall be of 'normal sound power', in compliance with BS 4999.

**DA 05.08 ENCLOSURE AND FRAME**

- (a) Each motor shall be protected to the degree required by its application, and its enclosure shall be designed for the system of cooling associated therewith.
- (b) Notwithstanding the requirements of DA 05.08 above, the minimum degree of protection shall be IP55 to SANS 1222 and, unless otherwise required, motors shall preferably be of the totally enclosed fan-cooled (TEFC) type.
- (c) All motors of the vertical-spindle type and exposed to the weather, shall be provided with a robust canopy of approved design.
- (d) Medium-length motors are preferred but short-length motors may be accepted where space is limited and written permission has been granted by the Engineer.

**DA 05.09 MOTOR TYPE**

Motors shall be of the squirrel-cage induction motor type. Slip-ring induction motors or other approved types will be considered if the Contractor is of the opinion that better results could be obtained by using such motors. Full electrical and mechanical details of each alternative shall be submitted with the tender documents.

**DA 05.10 RATING AND STARTING REQUIREMENTS**

- (a) Motors shall be adequately rated for the service for which they are intended, and due allowance shall be made for the temperature, altitude, climatic conditions and variations in the supply voltage. Motors shall, however, not exceed 120 % of the required capacity without prior approval having been obtained from the Engineer.
- (b) Not only shall motors be based on the full load requirements, but the motor capacity and starting characteristics shall be compatible with the requirements of the driven equipment.
- (c) Where motors are required to drive high inertia loads, the starting torque of the motor and the torque curve of the driven load shall be submitted to the Engineer for approval prior to manufacture. Such motors shall be capable of three starts per hour, with two consecutive starts from normal operating temperature, or more frequently if required by the Engineer.
- (d) Motors shall be of the continuously running duty class S1 unless otherwise specified in the detailed specification or if a more onerous duty is dictated by the drive requirement.
- (e) All squirrel-cage induction motors shall be suitable for direct-on-line starting at full voltage. Single-speed motors shall conform to BS 4999 part 41, Design B characteristics unless otherwise approved by or dictated by the drive requirements.

- (f) All motors shall be capable of starting its associated load with a minimum accelerating torque of not less than 5 per cent of full-load torque when the voltage at the motor terminals during starting is reduced to 80 per cent of the nominal value.
- (g) Unless otherwise approved, the -15 per cent tolerance on locked-rotor torque permitted by BS 4999: Part 69 will not be accepted and shall be limited to -10 per cent.
- (h) Documentation shall include performance curves to suit the expected working conditions.

**DA 05.11      BEARINGS**

- (a) All motors shall, wherever possible, be provided with prelubricated sealed bearings.
- (b) Regreasable bearings shall require only one lubrication per year. Grease lubrication of ball or roller bearings, where approved, shall be by means of hexagonal button-type grease nipples to BS 1486: Part 2, Nos. 21A or 21B (industrial type).
- (c) Grease-lubricated bearings shall have relief holes to ensure that the bearings have been correctly packed, which holes shall be positioned so that the excess grease can be easily removed. Cups shall be fitted to contain excess grease.
- (d) Bearings shall be protected against eddy currents and shall be capable of withstanding vibrations caused by unbalanced loads.
- (e) All bearings shall be designed for a life of 100 000 hours at B10 rating.

**DA 05.12      EARTHING**

All motors shall be provided with a machined or spot-faced boss tapped to receive a bolt of not less than 10 mm in diameter for earthing purposes, which is located on one side between the mounting feet.

**DA 05.13      HEATERS AND DRAINAGE**

Non-submersible motors which will be located out of doors or in a damp location such as in a drainage sump, shall be provided with suitable means of drainage to prevent the accumulation of water due to condensation. They shall also be fitted with anti-condensation heaters suitable for a 220V AC supply if considered advisable by the manufacturer.

Where specified in the project specifications, motors shall be supplied with anti-condensation heaters to keep the motor temperature at 23 °C when the motor is not operational to prevent moisture from condensing in the motor.

Heater terminal boxes shall be fitted on the motor frame and shall be of robust design, liberally sized and complete with suitable terminal block and mechanical cable gland or conduit entry.

**DA 05.14**      **JER\_MINAL ARRANGEMENTS**

- (a) The line connections of each motor shall be brought out to a terminal box located in an approved position. In the case of two-speed motors, separate terminal boxes shall be provided for each speed.
- (b) Terminal boxes shall be of the totally enclosed type designed to exclude the ingress of dust and moisture and sealed from the internal circuit of the motor, and shall be manufactured from sand-cast metal. The wall thickness of the terminal boxes and the dimension of the cable inlet shall be as specified in SANS 948. The terminal box shall be so designed that the cable entry may be made in any one of four positions placed at right angles to one another.
- (c) Terminal boxes shall be of ample size to allow the cable to be terminated in the box. Under no circumstances will the cable be allowed to be in -contact with the inside of the box or lid.
- (d) Terminals shall be of a substantial design and shall be suited to receive cable lugs. Pinch-screw connections will not be accepted.
- (e) The terminal arrangement shall permit the motor to be disconnected from its supply cable without damaging the cable tails and shall allow the supply cable and motor windings to be tested separately.
- (f) The electrical clearance and creepage distances, with the correct cable terminations in position, shall comply with the requirements of BS 4999.
- (g) Terminal markings shall be clear and permanent and shall comply with BS 4999. Irrespective of the direction of rotation required on the site, the connections shall be such that, when the supply leads L1-L2-L3 are connected to the motor terminals U-V-W respectively, the motor shall rotate in a clockwise direction when viewed from the driving end.
- (h) Motors suited for only one-directional rotation, shall be clearly marked as such by an arrow fixed to the motor frame at the driving end.

**DA 05.15**      **MOTOR/LOAD COUPLING**

- (a) Motors shall be coupled direct to the equipment to be driven, by means of approved couplings. Vee-belt and chain drives shall be considered only if direct coupling of the motor to the equipment is impossible or impracticable. Motors driving vee-belt or chain drives shall be fitted with heavy-duty bearings suited to the full side thrust at 120 % of full load torque and short-term overloads of up to 250 % of the full load torques during starting. The stiffness of the rotor shaft shall be checked to ensure that resonance and fatigue do not occur.
- (b) Where applicable, the flanges of the motors and equipment shall be identical.
- (c) The precision tolerance class shall apply to all flange-mounted motors with regard to concentricity, perpendicularity and shaft run-out.

**DA 05.16 SUBMERSIBLE MOTORS**

The following additional requirements apply specifically to all submersible motors:

- (a) All submersible motors shall be suited for submersion up to a depth of 1,5 times the depth of submersion shown on the drawings for each application, or as specified in the project specifications.
- (b) All submersible motors shall have dynamically balanced rotors supported by maintenance-free, sealed-for-life ball bearings.
- (c) All motors shall be suitably coated to ensure the satisfactory operation of the motor under the specified class of service.
- (d) All terminal boxes shall be waterproof and suited for submersion up to the depth as specified for the motors.
- (e) An adequate length of waterproof cable, purpose-made for submerging, shall be supplied with each submersible motor. The coupling of this cable to the normal power-distribution cable, which usually is of the PVC type with steel-wire armour, shall be placed at least 1,0 m above the maximum water level by means of a purpose-made, weatherproof, outdoor junction box. The submerged cable shall be supported to minimize any movement of the cable which results from turbulence caused by the operation of the equipment or the flow of the water.
- (f) Thermistor protection shall be provided for submersible motors.

**DA 05.17 ADDITIONAL REQUIREMENTS**

- (a) The rotation speed of motors shall not exceed 1 500 r/m unless approved otherwise by the Engineer.
- (b) Thermistor protection shall be provided for each winding of each motor.
- (c) The preferred class of insulation is Class F, derated in accordance with DA 05.16(d) above.

**DA 05.18 TECHNICAL DATA SHEETS**

Details of all individual electric machines and equipment requiring electrical energy shall be indicated on the 380 V motor and equipment schedule included in the technical data sheets.

**DA06 TESTING AND COMMISSIONING****DA 06.01 TESTS TO BE PERFORMED**

- (a) All pumping equipment shall be subject to the commissioning tests as described in Additional Specification SC: General Decommissioning, Testing and Commissioning.
- (b) At least one of each type or size of pump supplied shall be subject to a delivery flow rate test. Flow rate or volumetric flow testing facilities will be supplied by others, unless otherwise specified in the detail specification.



- (c) The operating point of each pump shall be determined.
- (d) Efficiency tests will only be performed when specified in the detail specification.
- (e) NPSH tests will only be performed when specified in the detail specification.

**DA 06.02 PUMP OPERATING POINT**

During the day 1 commissioning tests the pump operating point shall be determined by observing the following:

- (a) Pump delivery and suction pressures, and
- (b) Electric motor power consumption.

If no efficiency tests are required in the detail specification then the motor power consumption shall be calculated from the voltage and current measurements obtained during the commissioning test.

The Contractor shall supply the necessary adaptors, fittings and pressure gauges to measure the suction and delivery pressures. If no gauge fittings exist on the suction side, then the suction pressure conditions will be calculated from the system properties.

**DA 06.03 FLOW RATE (DELIVERY), EFFICIENCY AND NPSH TESTS**

- (a) Testing will be done in accordance with BS 5316 Part 1, class C tests.
- (b) Power consumption of electric motors shall be as determined by the three-wattmeter method where efficiency tests are required in the detail specification.

**DA 06.04 TEST CONDITIONS**

- (a) All tests will be performed in situ.
- (b) The pumped medium or liquid specified as the process liquid in the detail specifications shall be utilised during the tests. The Contractor shall obtain from the pump manufacturer the test point for clean water corresponding to the specified duty point for the pumped liquid, in order to relate the measured performance to the pump supplier's curves which are based on water.

**DA 06.05 ADDITIONAL TESTS**

Additional tests may be specified in the detail specification.

**DA07 MAINTENANCE**

All borehole pumping equipment and systems shall be serviced and repaired, following practical completion of the installation of which it forms part, to maintain it in perfect functional condition.

Maintenance to be carried out shall include routine preventative maintenance in accordance with the manufacturer's specification to be set out in the operating and maintenance manual, as well as unforeseen repair work or replacement.

The remuneration for monthly maintenance of borehole pumping equipment and systems shall be deemed included in the tendered rate for ten points of the installation of which the system forms part. Installations are specified in Additional Specification SA: General Maintenance.

The routine maintenance of the installations, systems and equipment shall include, but not be limited to the items listed in table DA 07/1 below:

TABLE DA 07/1 ROUTINE MAINTENANCE OF INSTALLATIONS, SYSTEMS AND EQUIPMENT

NO	ITEM DESCRIPTION	MAINTENANCE FREQUENCY
1	Service submersible pumps	Six-monthly
2	Clean filters/strainers	Two-monthly
3	Check V-belts	Monthly
4	Measure rest water-level	Monthly
5	Check MCC panel	Two-monthly
6	Check electric motors	Monthly

**DA08 MEASUREMENT AND PAYMENT****DA.01 PUMP TESTING OF BOREHOLES ..... Unit: number**

The unit of measurement shall be the number of boreholes tested on the written instructions of the Engineer.

The tendered rate shall include full compensation for all labour, equipment and material required for the complete testing of the boreholes in accordance with the specification.

**DA.01.01 Extra over DA.01 for:****(a) The removal of existing equipment..... Unit: number**

The unit of measurement shall be the number of boreholes from which all the equipment is removed. The tendered rate shall include full compensation for the removal of existing operational pumps and motors and all associated pipework.

**(b) Recovery of lost equipment ..... Unit: number**

The unit of measurement shall be the number of boreholes from which all the lost equipment is retrieved. The tendered rate shall cover the recovery of lost pumps and pipework for boreholes.

- (c) Installation of temporary pumps ..... Unit: number

The unit of measurement shall be the number of temporary pumps installed and later retrieved. The tendered rate shall be fully inclusive of the pump and pipes required to effectively test the boreholes in accordance with the specifications.

- (d) Ground-water sampling ..... Unit: number

The unit of measurement shall be the number of boreholes of which the water is sampled. The tendered rate shall be fully inclusive of the requirements of the specification irrespective of the number of samples taken from a borehole.

- (e) Compilation of borehole report ..... Unit: number

The unit of measurement shall be the number of boreholes regarding which approved reports is compiled. The tendered rate shall be fully inclusive of the work required to compile and produce six copies of each borehole recommendation report.

- (f) Standing time ..... Unit: day

The unit of measurement shall be the number of days no work could be carried out. This will cover periods when the test pumping rig and crew or, if more than one rig and crew are fielded, when all rigs and crews are idle, waiting for decisions by the Engineer where those decisions or whose presence is required before the commencement or continuation of the work instructed. Under no circumstances will standing time be payable for any delays other than those incurred by the Engineer's decisions. Except only for abnormal weather conditions as provided for in PS14 of Portion 1 of the Project Specifications, no standing time will be payable due to inclement weather or prevention of access to a site by the Contractor due to inclement weather.

- (g) Interhole moves ..... Unit: number

The unit of measurement shall be the number of interhole moves made. The tendered rate shall include all labour and equipment costs incurred in moving plant, equipment and labour from one hole to another hole.

- (h) Removal of existing pumping equipment ..... Unit: number

The unit of measurement shall be the number of boreholes from which equipment is removed prior to testing the borehole. The tendered rate shall cover the removal of existing pumping equipment from a borehole to be tested. Payment for removal up to an installed depth of 50 m shall be made at the unit rate tendered for in the Schedule of Quantities. Installed depths in excess of 50 m shall be remunerated for the first 50 m at the tendered unit rate and, for each full metre thereafter, at the rate per metre tendered in the Schedule of Quantities.

- (i) Reinstallation of existing pumping equipment ..... Unit: number

The unit of measurement shall be the number of boreholes in which removed equipment is re-installed. The tendered rate shall cover the reinstallation of existing pumping equipment in a borehole following test pumping of the borehole. Payment for installation up to a depth of 50 m shall be made at the unit rate tendered for in the Schedule of Quantities. Reinstallation depths in excess of 50 m shall be remunerated for the first 50 m at the tendered unit rate and, for each full metre thereafter, at the rate per metre tendered in the Schedule of Quantities.

DA. 38

The existing pumping equipment shall be reinstalled and left in working condition as it was found before removal unless the Contractor is instructed otherwise by the Engineer.

DA.02 REPAIR OF EXISTING STRUCTURES

DA.02.01 Brickwork ..... Unit: m<sup>2</sup>

The unit of measurement shall be the area of brickwork repaired.

The tendered rate shall include full compensation for all labour, materials and equipment required for the complete repair of brickwork.

DA.02.02 **Concrete base slabs** ..... Unit: m<sup>3</sup>

The unit of measurement shall be the cubic metre of concrete used in the repair of base slab.

The tendered rate shall include full compensation for all labour, materials, and equipment required to carry out the work as well as for all work carried out.

DA.02.03 **Clean around borehole**..... Unit: number

The unit of measurement shall be the number of boreholes around which the area is cleaned and levelled.

The tendered rate shall cover full compensation for the cleaning of an area 20 m x 20 m around each borehole.

DA.02.04 **Removal of concrete base slab** ..... Unit: cubic metre (m<sup>3</sup>)

The unit of measurement shall be the cubic metre volume of concrete broken out of the existing base slab.

The tendered rate shall include full compensation for the removal of the concrete inclusive of all tools, labour, removal of surplus material to a dump site and all other work required to satisfactorily complete the task.

DA.02.05 **Painting of exposed pipework** ..... Unit: m

The unit of measurement shall be the metre of pipework painted inside the pump house. The approximate diameter of the pipework is 100 mm.

The tendered rate shall include full compensation for the tools, labour, material, supply and delivery. The paintwork shall be conducted in accordance with Technical Specification BJ.

DA.03 REPAIR/REPLACEMENT OF ELECTRICAL EQUIPMENT

DA.03.01 **Detailed inspection and testing of components** ..... Unit: number

The unit of measurement shall be the number of boreholes for which a detailed inspection has been performed and all electrical and mechanical components tested.

The tendered rate shall include full compensation for testing all electrical and mechanical components for carrying out inspections and for all labour and equipment needed to carry out the work.

DA.03.02      Commissioning ..... Unit: number

The unit of measurement shall be the number of borehole installations commissioned.

The tendered rate shall include full compensation for all labour and equipment supplied and for the commissioning of each borehole installation.

DA.03.03      Reconditioning of pumping equipment ..... Unit: number

The unit of measurement shall be the number of pumps and motors reconditioned.

The tendered rates shall include full compensation for replacement of components and materials and for, tools, transport, site handling and labour necessary for the complete reconditioning of pumping equipment to conform to all the specifications in Subclause DA 04.06.14: Pump technical details and installation.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

DA.03.04      Repair of pumping equipment ..... Unit: number

The unit of measurement shall be the number of submersible pumps and motors repaired.

The tendered rate shall include full compensation for supply of an identification label, resetting the spacer between impeller and back plate and ensuring that impeller rotates freely, as well as cleaning and corrosion protection and installing a new hoisting chain.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

DA.03.04      De-commissioning and removal of submersible pumping equipment ..... Unit: number

The unit of measurement shall be the number of submersible pumps and motors de-commissioned and removed.

The tendered rates shall include full compensation for tools, transport, site handling and labour necessary for the complete de-commissioning and removal of pumping equipment.

DA.03.06      Servicing of submersible borehole pumps ..... Unit: number

The unit of measurement shall be the number of pumps serviced. The tendered rate shall include full compensation for servicing (including all consumables), cleaning, corrosion protection (including pump and motor base), adjusting, aligning, including disassembling and re-assembling. The tendered rate shall include all labour, tools, equipment and spare parts that form part of servicing as set out in the operating and maintenance manuals or as specified by the supplier.

## DA.04 SUBMERSIBLE CENTRIFUGAL PUMPS

DA.04.01 Supply and delivery of submersible borehole pumps:(a) {Pump description}.....Unit: number(b) Etc for other pumps

The unit of measurement shall be the number of units supplied and delivered where each unit shall include one pump, one motor, one base plate, drop cable set, earth wire, flow inducer if required and all other accessories as specified.

The tendered rates shall include full compensation for the design, manufacture, corrosion protection, testing, delivery to site, storage, patent rights, etc, of all the equipment complete as specified in the Specifications.

DA.04.02 **Installation of submersible borehole pump!!!!!!PS:**(a) {Pump description}.....Unit: number(b) Etc for other pumps

The unit of measurement shall be the number of units installed. Each unit shall include one pump with motor or engine, base plate and all other accessories as specified.

The tendered rates shall include full compensation for the installation of the units, the making good of all damaged corrosion protection areas, maintenance and for all other costs and actions that are necessary to provide a complete and efficiently working system.

Payment under this item may only be claimed after the relevant operating manuals have been handed over to the Engineer.

DA.04.03 **Supply, deliver and install rising pipe (diameter and pressure class indicated)**.....Unit: number

The unit of measurement shall be the metre of rising pipe installed.

The tendered rate shall include full compensation for all labour, plant, transport and materials required to manufacture, supply and install the rising pipe, corrosion protection, fixing to the pump and base plate, including couplings, gaskets, nuts and bolts.

DA.04.04 **Remove existing equipment from borehole and store on site as directed by the Engineer:**(a) {Equipment description}.....Unit: number(b) Etc for other descriptions

The unit of measurement shall be the number of installations from which the equipment is removed.

The tendered rate shall include full compensation for the removal of the existing borehole equipment, providing a suitable storage facility, transporting the equipment to the storage facility and store the equipment for the period required.

DA.05 SUBMER\_SIBLE\_P\_RQG\_RESSING CAVITY PUMPS

DA.05.01 Supply and delivery of submersible progressing cavity pumping equipment:

- (a) Pump unit.....Unit: number
- (b) Pulley head and base frame Unit: number
- (c) Rising pipe Unit: m
- (d) Rising pump shaft Unit: m

The unit of measurement for subitem DA.05.01(a) shall be the number of submersible progressing cavity pump units supplied and delivered.

The unit of measurement for subitem DA.05.01(b) shall be the number of pulley heads including two complete sets of drive belts and their protective safety cages (sized to enclose the drive pulley heads of the motor or engine, suited to the particular installation) and a base frame for each pulley head supplied and delivered.

The unit of measurement for subitem DA 05.01(c) shall be the linear metre length of rising pipe supplied and delivered.

The unit of measurement for subitem DA.05.01(d) shall be the linear metre length of shaft supplied and delivered.

The tendered rates shall include full compensation for the manufacture, corrosion protection, predelivery testing, transport to site, off-loading and all handling of equipment which shall include the following:

- the pump unit
- pulley head and base frame
- rising pipework and centralisers
- rising shaft and locating bearings
- all accessories including valves, fittings, V-belts, fasteners and auxiliary materials to render a complete pump unit.

DA.05.02 Installation of submersible progressing cavity pumping equipment:

- (a) Pump unit.....Unit : number
- (b) Pulley head and base frame , Unit : number
- (c) Rising pipe ,Unit: m
- (d) Rising pump shaft Unit: m

The unit of measurement for subitem DA.05.02(a) shall be the number of submersible progressing cavity pump units installed.

The unit of measurement for subitem DA.05.02(b) shall be the number of pulley heads including two complete sets of drive belts and a base frame for each pulley head installed.

The unit of measurement for subitem DA.05.02(c) shall be the linear metre length of rising pipe installed.



DA. 42

The unit of measurement for subitem DA.05.02(d) shall be the linear metre length of shaft installed.

The tendered rate shall include full compensation for the site handling and positioning and installation of the equipment including all labour and consumables required for a fully installed submersible progressing cavity pump.

Payment under this item may only be claimed after the relevant operating manuals have been handed over to the Engineer.

## TECHNICAL SPECIFICATION

### DB PRESSURE FILTERS

#### CONTENTS

DB 01	SCOPE
0802	STANDARD SPECIFICATIONS
0803	OPERATING AND MAINTENANCE MANUALS
DB04	MOTOR DESIGN AND REQUIREMENTS
0805	WORKING VOLTAGE AND SUPPLY SYSTEMS
DB06	DETAIL OF WORK
0807	FILTER MEDIA
DB08	FILTER PROCESS REQUIREMENTS
DB 09	FLOW RATES
DB10	MAINTENANCE
DB 11	MEASUREMENT AND PAYMENT

#### DB 01 SCOPE

This specification covers the decommissioning, removal, replacement, repair and reconditioning, installation, testing, commissioning and maintenance of pressure filters and equipment such as backwash equipment, motor control centres, low voltage cables, filter media and filter under drain systems.

This specification shall form an integral part of the repair and maintenance contract document and shall be read in conjunction with portion 3: Additional Specifications included in this document. The repair work and maintenance of the particular filter systems are specified in the relevant clauses on detail of repair work and maintenance in this specification.

This specification shall act as a guideline to the Particular Specification and, in the event of any discrepancies between the Technical Specification and the Particular Specification, the latter shall take precedence.

#### DB02 STANDARD SPECIFICATIONS

##### DB 02.01 GENERAL STANDARD SPECIFICATIONS, REGULATIONS AND CODES

The latest edition, including all amendments up to date of tender, of the following specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

SANS 241	Drinking Water
SANS 1036	- The management of potable water distribution systems

**DB 02.02      OCCUPATIONAL HEALTH AND SAFETY ACT OF 1993**

All regulations and statutory requirements as laid down in the latest edition of the Occupational Health and Safety Act of 1993: Construction Regulations, 2003 as promulgated in Government Gazette No 25207 and Regulation Gazette No 7721 of 18 July 2003 shall be adhered to.

**DB 02.03      MANUFACTURER'S SPECIFICATIONS, CODES OF PRACTICE AND INSTALLATION INSTRUCTIONS**

All equipment and materials shall be installed, serviced and repaired strictly in accordance with the manufacturer's specifications, instructions and codes of practice.

**DB 02.04      MUNICIPAL REGULATIONS, LAWS AND BY-LAWS**

All municipal regulations, laws, by-laws and special requirements of the Local Authority shall be adhered to unless otherwise specified.

**DB03      OPERATING AND MAINTENANCE MANUALS**

The Contractor shall at the start of the Contract be given all available as-built information and operating and maintenance manuals.

The Contractor shall be responsible for the compilation of an inventory list and operating and maintenance manuals.

This shall be done in accordance with Additional Specification SB: Operating and Maintenance Manuals.

**DB04      MOTOR DESIGN AND REQUIREMENTS**

- (a) Electric motors shall comply with the requirements of SANS 948.
- (b) Imported motors forming an integral part of the pump shall be submitted to the South African Bureau of Standards to be tested in accordance with the requirements of SANS 948.
- (c) All motors shall be standard catalogue models and shall be readily available.
- (d) All motors shall, where possible, be from the same manufacturer and shall have the same interchangeable frames. Variations in type and size shall, where possible, be limited to prevent stocking a variety of special spares.
- (e) All motors shall have dynamically balanced rotors supported by maintenance-free, sealed-for-life ball bearings.
- (f) All motors shall be suitably coated to ensure the satisfactory operation of the motor under the specified class of service.
- (g) All terminal boxes shall be waterproof and suited for submersion up to the depth as specified for the pumps.

- (h) An adequate length of waterproof cable, purpose-made for submerging, shall be supplied with each submersible motor. The coupling of this cable to the normal power-distribution cable, which usually is of the PVC type with steel-wire armour, shall be placed at least 1,0 m above the maximum water level by means of a purpose-made, weatherproof, outdoor junction box. The submerged cable shall be supported to minimise any movement of the cable, which results from turbulence caused by the operation of the equipment or the flow of the water.
- (i) Thermistor protection or Klaxon type temperature switches shall be provided for submersible motors.
- U) Seal monitors shall be provided for submersible motors, together with the required seal monitor relays. The cost for the seal monitor relays shall be deemed to be included in the rates tendered for the equipment.

#### 0805 WORKING VOLTAGE AND\_SUPPLY SYST\_EMS

The motors shall be capable of operating within  $\pm 10\%$  of the nominal supply voltage without risk of damage. All motors shall be suitable for operating continuously at the specified three-phase voltage system under actual service conditions, including the  $\pm 10\%$  voltage tolerance, without exceeding the specified temperature rise determined by the resistance on a basic full load heat run.

All motors shall be capable of operating continuously under actual service conditions at any supply frequency between 48 and 51 Hz together with any voltage between  $\pm 5\%$  of the nominal supply voltage.

The slip-in speed of any motor at 80 % of the nominal voltage at 50 Hz shall not exceed a percentage agreed on by the Engineer, and the motors shall be capable of operating at this voltage for a period of five minutes without deleterious heating.

#### 0806 DETAIL OF WORK

The existing dual media filters at Emahlathini Port of Entry will only be maintained by the contractor under this contract.

#### DB 06.01 PRESSURE DUAL/MULJI\_MEDJ\_A\_FILTER SYSTEMS

##### Filter data:

Filter diameter	700mm
Filter effective area	0,385m <sup>2</sup>
Filter height	1380mm
Material of construction	Glass Reinforced fibre (GRP)
Under-drain	225 micron slotted ABS on segmented balanced grid
Project design pressure	100 kPa
Max operating pressure	240 kPa
Test pressure	360 Kpa

**DB 06.03 UNDER DRAIN SYSTEMS**

The under drain system shall be replaced whenever the filter media is replaced. Only authentic under drain systems obtainable from the supplier of the filter shall be installed.

**DB07 Fil TER MEDIA**

Silica sand and hydro anthracite media shall be used as filtration media. The composition of the filter media shall be as follows:

- 150 litre Silica Sand: grain size:0.4mm - 0.8mm
- 150 litre Hydro Anthracite grain size :0.8mm - 1.6mm

**DB08 Fil TER PROCESS REQUIREMENTS**

The Pressure Filters conform to the following process requirements:

- Only chemically treated (flocculated} and clarified water shall be treated in the filters.
- Filtered water is collected in the under drain system.
- The same under drain system is used for the backwash system of the filter.
- Operating pressure maximum 200kpa

**DB09 FLOW RATES**

- The filtration rate shall be not more than 4m/hour.

**DB10 MAINTENANCE**

**DB 10.01 GENERAL**

All wastewater pumping equipment and systems shall be serviced and repaired, following practical completion of the installation of which it forms part, to maintain it in perfect functional condition.

Maintenance shall be carried out and shall include routine preventative maintenance according to the manufacturer's specification to be set out in the operating and maintenance manual, as well as unforeseen repairwork or replacement.

The remuneration for monthly maintenance of wastewater pumping equipment and systems shall be deemed included in the tendered rate for ten points of the installation of which the system forms part. Installations are specified in Additional Specification SA: General Maintenance, and illustrated in detail on the mechanical flow diagram.

**DB 10.02 ROUTINE PREVENTATIVE MAINTENANCE**

The routine preventative maintenance work to be carried out shall include but not be limited to the items listed in table EB 10.2/1 below.

These actions and findings shall be logged and reported on the relevant approved schedules and reports.

TABLE EB 10.02/1

NO	ROUTINE PREVENTATIVE MAINTENANCE OF PRESSURE FILTER SYSTEMS	MAINTENANCE FREQUENCY
1	Visually inspect and report on complete system	Monthly
2	Check back wash and filtration flow rates	Monthly
3	Check, inspect, report and repair leaks	Monthly
4	Check filter inlet and outlet pressure	Daily
5	Check valve settings for specific mode	Daily

**DB 11 MEASUREMENT AND PAYMENT****DB11.01 SUPPLY AND DELIVERY OF FILTER EQUIPMENT ..... Unit: number**

The unit of measurement shall be the number of filter equipment units supplied and delivered.

The tendered rates shall include full compensation for the design, manufacture, corrosion protection, patent rights, pre-delivery testing and test certificates, transport for delivery to site and off-loading including all handling of the equipment. The equipment shall include the following:

- (a) The GRP filter vessel with lid, O-rings and holding down bolts, nuts and washers.
- (b) Filter media
- (c) Under drain pipe work

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

**DB11.02 INSTALLATION, TESTING AND COMMISSIONING OF FILTER EQUIPMENT ..... Unit: number**

The unit of measurement shall be the number of filter equipment units installed, tested and commissioned.

The tendered rates shall include full compensation for the site handling and positioning of the pumping equipment, including the fastening of the equipment in its designated position. The following shall also be included in the tendered rates:

- (a) The pump(s) as an integrated unit of the filter system
- (b) Electrical power cable.
- (c) The GRP filter vessel and its associated parts.
- (d) Filter media
- (e) Under drain pipe work
- (f) Routing and fastening of the power cable up to the isolator box;
- (g) All required installation materials, labour and consumables to render a complete and working installation.

The tendered rates shall also include full compensation for all preliminary tests, delivery and efficiency tests if required and commissioning tests. Commissioning tests shall comply with the section dealing with testing and commissioning.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

## DECOMMISSIONING AND REMOVAL OF FILTER EQUIPMENT.....

The tendered rates shall include full compensation for all labour, machinery, tools, transport and site handling necessary for the decommissioning and removal of filter equipment.

**SERVICE/RECONDITIONING\_O\_f\_fJLTER EQUIPMENT** Unit: number

## SERVICE/RECONDITIONING\_O\_f\_fJLTER EQUIPMENT

The tendered rates shall include full compensation for the reconditioning/servicing of components and materials, and for tools, transport, site handling and labour necessary for the complete reconditioning of filter equipment to conform to all the specifications in Clause DB.OS: Motor design and requirements.

REPAIR OF FILTER EQUIPMENT. ..... Unit: number

### REPAIR OF FILTER EQUIPMENT.

The tendered rate shall include full compensation for supply of an identification label, resetting the spacer between impeller and back plate and ensuring that impeller rotates freely, as well as cleaning and corrosion protection and installing a new hoisting chain.

Mahamba, Bothashoop &amp; Emahlathini follow-on



## TECHNICAL SPECIFICATION

**DL CHLORINATION SYSTEMS FOR THE DISINFECTION OF DRINKING WATER AT REMOTE BOREHOLE INSTALLATIONS**

## CONTENTS

DL 01	SCOPE
DL 02	STANDARD SPECIFICATIONS
DL 03	OPERATING AND MAINTENANCE MANUALS
DL04	PROCUREMENT AND INSTALLATION OF CHLORINATION SYSTEMS
DL 05	TESTING AND COMMISSIONING
DL06	OPERATION AND MAINTENANCE
DL 07	MEASUREMENT AND PAYMENT

**DL01 SCOPE**

This specification states the requirements for all work related to the procurement, installation, testing, commissioning, operation and maintenance of chlorination equipment for the disinfection of drinking water at remote borehole installations. Chlorination equipment shall be provided as one of the following three technological systems, according to site-conditions and the relevant stipulations in this document:

- 1) Calcium hypochlorite dosing systems.
- 2) Sodium hypochlorite dosing systems.
- 3) Vacuum systems for gas chlorination.

Any on-site sodium hypochlorite generators, chlorine dioxide preparation systems or pressure systems for gas chlorination (direct chlorination) shall be deemed UNACCEPTABLE and are all excluded from the scope of this work.

**DL02 STANDARD SPECIFICATIONS****DL 02.01 GENERAL STANDARD SPECIFICATIONS, REGULATIONS AND CODES**

The latest edition, including all amendments up to date of tender, of the following specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

SANS 10298	- Indirect small to medium-sized gas chlorination systems for the disinfection of water
SANS 241	- Drinking water
SANS 10306	- The management of potable water in distribution systems
SANS 6052	- Residual chlorine content of water

**DL 02.02 OCCUPATIONAL HEALTH AND SAFETY ACT OF 1993**

All regulations and statutory requirements as laid down in the latest edition of the Occupational Health and Safety Act of 1993: Construction Regulations, 2003 as promulgated in Government Gazette No 25207 and Regulation Gazette No 7721 of 18 July 2003 shall be adhered to.

## DL.2

### DL 02.03 **MANUFACTURERS' SPECIFICATIONS. CODES OF PRACTICE AND INSTALLATION INSTRUCTIONS**

All equipment and materials shall be installed, serviced and repaired strictly in accordance with the manufacturers' specifications, instructions and codes of practice.

### DL 02.04 **MUNICIPAL REGULATIONS, LAWS AND BY-LAWS**

All municipal regulations laws, by-laws and special requirements of the Local Authority shall be adhered to unless otherwise specified.

### **DL03 OPERATING AND MAINTENANCE MANUALS**

The Contractor shall be responsible for the compilation and production of operating and maintenance manuals including an inventory of all chlorination equipment.

This shall be done in accordance with Additional Specification SB: Operating and Maintenance Manuals. The completion of operating and maintenance manuals shall be a requirement for practical completion.

### **DL04 PROCUREMENT AND INSTALLATION OF CHLORINATION SYSTEMS**

#### DL 04.01 **GENERAL**

Chlorine and hypochlorite are strong bleaching and oxidizing agents and pose a SUBSTANTIAL SAFETY RISK.

The Contractor shall submit proof to the Engineer to demonstrate his (or his subcontractor's) understanding, skill and experience in the assembly of chlorination systems

All chlorine dosing equipment shall be manually adjustable to set accurate dosing rates within the range of average daily flow rates specified. The concentration of chlorine at the point of dosing shall be between 1 - 5 mg/l, so that the free residual chlorine concentration shall be between 0.2 - 1.0 mg/l at the furthest point of use in the water distribution system.

The chlorination system shall be installed in such a way as to dose upstream of overhead tanks/ reservoirs to provide for contact time. Where more than one borehole is used for water supply, the dosing point shall be installed in a common rising main, upstream of the overhead tanks/ reservoirs.

#### DL 04.02 **CALCIUM HYPOCHLORITE DOSING SYSTEM**

Calcium hypochlorite dosing shall be the system of choice for disinfection at small remote bore-hole water supply installations.

Dosing is based on the principle of erosion of solid calcium hypochlorite ( $\text{Ca}(\text{ClO})_2$ ), which dissolves in water and is introduced into the main water supply system through a venturi system. This means that the dosing only takes place while there is flow in the main pipe.

Calcium hypochlorite can be supplied as briquettes, chips or pellets. Chlorinators shall be designed to provide a consistently accurate dose of

### DL.3

available chlorine to small water systems. Corrosion resistant plastics (polyethylene) shall be used in the product's construction.

The venturi shall be installed in a pipe section forming a U-loop that is connected to the main pipe with isolating ball valves. A ball valve shall also be installed in the main pipe that shall normally be closed to direct water through the venturi, as illustrated in figure DL1. Partial opening of the ball valves shall ensure the correct backpressure to set dose rate. Closing of the ball valves in the U-loop shall enable dismantling of the venturi without interrupting the main water flow. Easy access to clear blockages shall be provided in the design of the installation. A UV-stabilized polyethylene (PE) off-white or semitransparent dose tank is required.

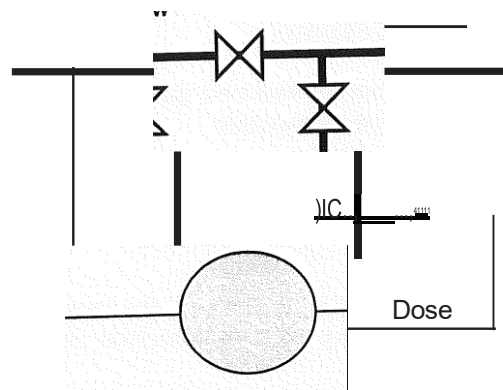


Figure DL 1: Schematic layout of venturi system for calcium hypochlorite dosing.

All  $\text{Ca}(\text{ClO})_2$  supplied shall have a chlorine content of between 65 and 70% and an average moisture content of less than 4%. Calcium hypochlorite shall be properly packaged prevent contact with moisture and to ensure safety of handling. A shelf life of at least 3 months shall be maintained for supplied calcium hypochlorite.

#### DL 04.03

#### SODIUM HYPOCHLORITE DOSING SYSTEM

Sodium hypochlorite is a colourless, transparent liquid, which shall be dissolved in cold water to a concentration of between 8 - 10% for liquid dosing. Sodium hypochlorite shall be safely stored, located in a cool, dark place, maintaining pH 11 or more and avoiding contact with copper or nickel.

The size of dosing tank shall be dimensioned such and kept at a maximum level to ensure that sodium hypochlorite ( $\text{NaOCl}$ ) does not break down to  $\text{NaCl}$  and  $\text{NaOH}$ .

A UV-stabilized polyethylene (PE) off-white or semitransparent dose tank is required, with a sintered drain-off connection and 4 lateral mounting places at the bottom on the tank shell. The dose tanks shall be optimized for stability and functionality.

The dosing apparatus shall be robust and shall not cause blockages. The dosing apparatus shall ensure absolutely precise dosing through a dosing process that is always strictly proportional to the quantity of water flowing through the main delivery pipe. This could be achieved through a flow meter in the dosing apparatus. The following special features shall be required:

- (i) adjustable dosing capacity that avoids over- or under-dosing

## DL.4

- (ii) automatic stop of an overload-proof synchronous motor under conditions of short-term pressure shocks, with automatic re-start when pressure drops to normal again
- (iii) a control LED that indicates pump strokes, with a second LED that flashes if the liquid level becomes too low causing the dose pump to switch off automatically: the empty indication is directly combined with the suction line for this purpose.

### DL 04.04 YACUUM GAS CHLORINATION SYSTEM

Vacuum gas chlorination systems shall only be considered where average daily flow rates are more than 8 l/s (i.e. around 700 m<sup>3</sup>/d). The mean residence time of gas cylinders shall never be more than two months. Gas cylinders shall be mounted on mechanical balances.

Pressure systems feeding pressurized gaseous chlorine directly into the water supply system shall not be acceptable.

A dual system with two cylinders is required, including an automatic change-over device to switch between cylinders that shall be installed with a wall mounted manifold.

All chlorination equipment and ancillaries, the layout and installation, materials, operational safety measures and maintenance shall be strictly in accordance with SANS 10298.

### DL 04.05 SAFETY SIGNS AT CHLORINATION INSTALLATION

Regardless of the type of chlorination system installed, warning signs shall be installed at the chlorination systems to be clearly visible. Warning signs shall also include all safety precautions for the operation and maintenance of chlorination systems, in accordance with the manufacturer's specifications and other relevant safety specifications and acts. A warning sign with first aid instructions shall also be installed at the chlorination system, specifying instructions for instances of skin exposure, eye exposure, inhalation exposure and swallowing, according to the manufacturer's specifications and SANS 10298.

## **DL05 TESTING AND COMMISSIONING**

After installation, the contractor shall evaluate the functioning of chlorination systems to ensure that there are no leaks and that the rate of dosing is set correctly.

## **DL06 OPERATION AND MAINTENANCE**

### **DL 06.01 GENERAL**

Maintenance shall be carried out according to an approved maintenance plan and operation and maintenance manual, which shall specify actions including routine preventative maintenance according to the manufacturer's specifications, as well as unforeseen repair work, corrective maintenance and/or replacement of parts of the system.

### **DL 06.02 OPERATION AND \_ROUTINE PREVENTATIVE MAINTENANCE**

The tasks related to the operation and routine preventative maintenance work shall include but not be limited to the GENERAL actions listed in table DL 06.02/1 below.

## DL.5

SANS 241 shall be adhered to in the routine preventative maintenance of vacuum systems for gas chlorination.

These actions and findings shall be logged and reported on the relevant approved schedules and reports.

TABLE DL 06.02/1

NO	ROUTINE PREVENTATIVE MAINTENANCE OF CHLORINATION SYSTEMS AND ANCILLARIES	MAINTENANCE FREQUENCY
1	Visually inspect and report on complete system.	Daily
2	Clean complete installation thoroughly so that leaks would be obvious and clear when they occur.	Weekly
3	Check, service, repair and clean dosing apparatus from blockages.	Monthly
4	Corrosion protect all equipment and ancillaries.	Whenever necessary
5	Check for and repair all leaks. Report leaks.	Monthly
6	Check dosing rate and reset regulators if necessary.	Monthly
7	Measure residual chlorine in the drinking water system (DPD 4 or similar).	Weekly

### DL 06.03 OPERATION

Operation of all chlorination systems shall include the supply of chemicals, including chlorine gas or sodium hypochlorite or calcium hypochlorite. The contractor shall supply chemicals to ensure that there is always enough supplied for a full month's requirement.

### DL 06.04 SAFETY PROCEDURES AND REQUIREMENTS

SANS 10298 specifies operational safety in terms of general safety requirements, emergency action plans, personal protective equipment and handling of containers, which shall at all times be adhered to. Only personnel who are adequately trained shall be allowed to operate and maintain the chlorination systems.

### DL 06.05 REMUNERATION

Remuneration for the monthly operation of chlorination systems, the supply of chlorine or hypochlorite as well as ALL maintenance activities related to chlorination systems shall be deemed included in the tendered rate for ten points of the installation of which the system forms part. Installations are specified in Additional Specification SA: General Maintenance.

## **DL07 MEASUREMENT AND PAYMENT**

### **DL.01 SUPPLY AND DELIVERY OF CHLORINATION SYSTEMS .....Unit: number**

The unit of measurement shall be the number of chlorination systems supplied and delivered, including all equipment and ancillaries deemed part of a functional system.

The tendered rates shall include full compensation for the design, manufacture, corrosion protection, patent rights, pre-delivery testing and test certificates. Different systems as specified in this document shall be listed in the Schedule of Quantities, according to:

## DL.6

- i) Calcium hypochlorite dosing systems.
- ii) Sodium hypochlorite dosing systems.
- iii) Vacuum systems for gas chlorination.

Tendered rates shall include full compensation for all transport cost, including all handling of the equipment, loading and off-loading of chlorination systems.

Different systems shall be based on the daily average flow rate of the main water supply.

### DL.02

#### **INSTALLATION, TESTING AND COMMISSIONING OF CHLORINATION SYSTEMS.....Unit: number.**

The unit of measurement shall be the number of chlorination systems installed, tested and commissioned.

The tendered rates shall include full compensation for the site handling and positioning of the chlorination equipment, including the fastening of the equipment in its designated position. The following shall also be included in the tendered rates:

- (a) Installation of all equipment, ancillaries and all other necessary appurtenances required to render a fully functional chlorination system;
- (b) Coupling of all required pipes flanges, including all required gaskets, nuts, bolts and washers;
- (c) Routing and fastening of all power cables, connecting of all electrical material and switchgear;
- (d) All required installation materials, labour and consumables to render a complete and working installation.

The tendered rates shall also include full compensation for all preliminary tests, delivery and efficiency tests if required and commissioning tests to ensure a leak-free system and the correct settings of regulators to ensure accurate dosing.

Separate items will be listed in the Schedule of Quantities for different types and sizes of systems, as specified under payment item DL.01.

TECHNICAL SPECIFICATIONDN DOSING SYSTEMS FOR THE FLOCCULATION OF DRINKING WATER

## CONTENTS

DN 01	SCOPE
DN 02	STANDARD SPECIFICATIONS
DN 03	OPERATING AND MAINTENANCE MANUALS
DN 04	PROCUREMENT AND INSTALLATION OF DOSING SYSTEMS
DN 05	PROJECT SPECIFICATIONS
DN 06	TESTING AND COMMISSIONING
DN 07	OPERATION AND MAINTENANCE
DN 08	MEASUREMENT AND PAYMENT

DN 01 SCOPE

This specification states the requirements for all work related to the procurement, installation, testing, commissioning, operation and maintenance of dosing equipment for the coagulation and flocculation of drinking water at the water works of the Lebombo Port of Entry Prison.

DN02 STANDARD SPECIFICATIONS**DN 02.01 GENERAL STANDARD SPECIFICATIONS, REGULATIONS AND CODES**

The latest edition, including all amendments up to date of tender, of the following specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

- |              |   |
|--------------|---|
| SANS 10298   | - Indirect small to medium-sized gas chlorination systems for the disinfection of water |
| SANS 241     | - Drinking water  |
| SANS 10306   | - The management of potable water in distribution systems                               |
| SANS SM 1052 | - Residual chlorine content of water  |

**DN 02.02 OCCUPATIONAL HEALTH AND SAFETY ACT OF 1993**

All regulations and statutory requirements as laid down in the latest edition of the Occupational Health and Safety Act of 1993: Construction Regulations, 2003 as promulgated in Government Gazette No 25207 and Regulation Gazette No 7721 of 18 July 2003 shall be adhered to.

## **DN.2**

### **DN 02.03      MANUFACTURERS' SPECIFICATIONS, CODES OF PRACTICE AND INSTALLATION INSTRUCTIONS**

All equipment and materials shall be installed, serviced and repaired strictly in accordance with the manufacturers' specifications, instructions and codes of practice.

### **DN 02.04      MUNICIPAL REGULATIONS, LAWS AND BY-LAWS**

All municipal regulations laws, by-laws and special requirements of the Local Authority shall be adhered to unless otherwise specified.

### **DN 03      OPERATING AND MAINTENANCE MANUALS**

The Contractor shall be responsible for the compilation and production of operating and maintenance manuals including an inventory of all chemical dosing equipment.

This shall be done in accordance with Additional Specification SB: Operating and Maintenance Manuals. The completion of operating and maintenance manuals shall be a requirement for practical completion.

### **DN 04      PROCUREMENT AND INSTALLATION OF DOSING SYSTEMS**

#### **DN 04.01      GENERAL**

The Contractor shall submit proof to the Engineer to demonstrate his (or his subcontractor's) understanding, skill and experience in the assembly of chemical dosing systems for water purification

All dosing equipment shall be manually adjustable to set accurate dosing rates within the range of average daily flow rates specified. The dosing range shall be between 1 - 200 mg/l .

The dosing system shall be installed in such a way as to dose at the start of the coagulation cascade to utilize the full potential of the mixing energy available..

#### **DN 04.02      COAGULATION AND FLOCCULATION SYSTEM**

The dosing system required shall consist of the following components:

- 150 L dosing tank with electric stirrer, no 2.
- Extraction device and level indicator, no 2.
- Suction pulsation damper, no 2.
- Metering pumps, 20 l/ hour @ 10 bar working pressure, no 2.
- Overflow valve, no 2.
- Pressure retention valve, no 2.
- Pulsation damper, no 2.
- Metering tube, no 2.
- Injection unit, no 2.
- 63mm dia uPVC class 16 pipe including wall brackets at 0.5m c/c, 90°bends and couplings, 10m.



## **DN05 PROJECT SPECIFICATION**

The raw water to be purified and reticulated as potable water to consumers residing at the Emahlathini Port of Entry is pumped from the river. The raw water shall be treated to remove turbidity and colour and the final clarified and filtered drinking water shall be disinfected to achieve the statutory requirement for the physical, organoleptic, chemical and microbiological requirements in accordance with SANS 241-2006.

The purification process includes the following:

- Destabilisation of particles by introducing a coagulant/flocculent into a rapid mixing zone.
- Followed by flocculation in a slow mixing zone.
- Followed by clarification in sedimentation tank
- Followed by filtration in sand filter
- Followed by disinfection by chlorination at the clean water reservoir inlet.

### **DN 05.01 MATERIALS**

All materials used to assemble the dosing equipment shall be in accordance with the manufacturer's specification and within the prescribed working range specified.

### **DN 05.02 SYSTEM COMPONENTS**

Notwithstanding the system components described in this specification or in the data sheets, the supplied system must be a complete working system, including dosing pumps, chemical containers for working solutions and chemical supply lines. Dosing tanks shall be installed in such a manner that it can be removed and cleaned before the new batch of working solutions are prepared.

The components of a typical dosing system shall include the following:

- Dosing tanks with electrical agitator for the preparation and dispensing of working solutions.
- An extraction device and level indicator
- A suction pulsation damper.
- Dosing pumps( Duty and Standby)
- Overflow valve.
- Pressure retention valve.
- Pulsation damper (Delivery side)
- Measuring tube
- Injection unit

The final assembly of the dosing system shall be approved by the Engineer.  
For a schematic layout please see Annexure 2

### **DN 05.03 ELECTRICAL POWER SUPPLY**

Electrical power supply at 220V, single phase, 50Hz will be made available in the dosing room as well as the chlorine store.

The Contractor shall co-ordinate the interfacing requirements of the Electrical Subcontractor and the relevant Mechanical Subcontractor.

**ON 05.04      CIVIL REQUIREMENTS**

The Contractor shall construct and install plinths, holding-down bolts, pipe ducts, excavate trenches and perform other civil construction work with due cognizance of the relevant Sub-contractor's requirements. Grouting of the bolts shall only be performed after setting up of the plant by the Contractor.

The Contractor shall be responsible for erecting, installing and fixing all pumps, pipe work and ancillary equipment.

**DN06      TESTING AND COMMISSIONING**

After installation, the contractor shall evaluate the functioning of the dosing systems to ensure that there are no leaks and that the rate of dosing is set correctly.

**DN07      OPERATION AND MAINTENANCE****ON 07.01      GENERAL**

Maintenance shall be carried out according to an approved maintenance plan and operation and maintenance manual, which shall specify actions including routine preventative maintenance according to the manufacturer's specifications, as well as unforeseen repair work, corrective maintenance and/or replacement of parts of the system.

**ON 07.02      OPERATION AND ROUTINE PREVENTATIVE MAINTENANCE**

The tasks related to the operation and routine preventative maintenance work shall include but not be limited to the GENERAL actions listed in table DL 07.02/1 below.

These actions and findings shall be logged and reported on the relevant approved schedules and reports.

TABLE PbL 07.02.1

NO	ROUTINE PREVENTATIVE MAINTENANCE OF CHEMICAL DOSING SYSTEMS AND ANCILLARIES	MAINTENANCE FREQUENCY
1	Visually inspect and report on complete system.	Daily
2	Clean complete installation thoroughly so that leaks would be obvious and clear when they occur.	Weekly
3	Check, service, repair and clean dosing room and apparatus.	Monthly
4	Corrosion protect all equipment and ancillaries.	Whenever necessary
5	Check for and repair all leaks.	Monthly
6	Check dosing rate and reset regulators if necessary.	Monthly

**DN 07.03****OPERATION**

Operation of all chemical dosing systems shall include:

- The supply of water purification chemicals. The contractor shall supply chemicals to ensure that there is always enough supplied for a full month's requirement.
- Record keeping of the turbidity readings of raw water as well as purified water.
- The concentration of chemical working solutions.
- The % settings on the dosing pumps.
- The capacity of the dosing pump in use.
- The actual volume of chemicals consumed.
- Monthly analysis of the product water in terms of SANS 241:2006
- Reporting in writing preferably electronically of the above.

**DN 07.05****REMUNERATION**

Remuneration for the monthly operation of chemical dosing systems, the supply of water purification chemicals as well as all maintenance and reporting activities related to chemical dosing systems shall be deemed included in the tendered rate for ten points of the installation of which the system forms part. Installations are specified in Additional Specification SA: General Maintenance.

**DN 08****MEASUREMENT AND PAYMENT****DN.01****SUPPLY AND DELIVERY OF CHEMICAL DOSING SYSTEMS ..... unit: number**

The unit of measurement shall be the number of chemical dosing systems supplied and delivered, including all equipment and ancillaries deemed part of a functional system.

- The tendered rates shall include full compensation for the design, manufacture, corrosion protection, patent rights, pre-delivery testing and test certificates.
- The tendered rate shall include all components as listed in PON 05.02 above

Tendered rates shall include full compensation for all transport cost, including all handling of the equipment, loading and off-loading of chemical dosing systems.

**DN.02****INSTALLATION, TESTING AND COMMISSIONING OF CHEMICAL DOSING SYSTEMS ..... Unit: number**

The unit of measurement shall be the number of chemical dosing systems installed, tested and commissioned.

The tendered rates shall include full compensation for the site handling and positioning of the equipment, including the fastening of the equipment in its designated position. The following shall also be included in the tendered rates:

## DN.6

- (a) Installation of all equipment, ancillaries and all other necessary appurtenances required to render a fully functional dosing system;
- (b) Coupling of all required pipes flanges, including all required gaskets, nuts, bolts and washers;
- (c) Routing and fastening of all power cables, connecting of all electrical material and switchgear;
- (d) All required installation materials, labour and consumables to render a complete and working installation.

The tendered rates shall also include full compensation for all preliminary tests, delivery and efficiency tests if required and commissioning tests to ensure a leak-free system and the correct settings of regulators to ensure accurate dosing.

### DN.03      **SERVICING, TESTING AND COMMISSIONING OF CHEMICAL DOSING SYSTEMS** .....

Unit: number

The unit of measurement shall be the number of dosing systems serviced, tested and commissioned.

The tendered rates shall include full compensation for the servicing, testing and commissioning, site handling and positioning of the dosing equipment, setting of the dosing rate including the fastening of the equipment in its designated position.

### DN.04      **DECOMMISSIONING AND REPAIR/RECONDITIONING OF VALVES AND SLUICE GATES** .....

Unit:

number

The unit of measurement shall be the number of gate valves, flow control valves and sluice gates decommissioned and repaired or reconditioned.

The tendered rate shall include full compensation for replacement of components and materials for tools, transport, site handling and labour necessary for the complete decommissioning, dismantling, cleaning, repair or reconditioning of gate valves, flow control valves and sluice gates.

### DN.05      **INSTALLATION, TESTING AND COMMISSIONING OF VALVES AND SLUICE GATES** .....

Unit:

number

The unit of measurement shall be the number of gate valves, flow control valves and sluice gates installed, tested and commissioned.

The tendered rate shall include full compensation for the installation, testing, and commissioning making good all corrosion protected areas and for all other costs and actions necessary to obtain a complete working valve, control valve and sluice gate system as well as for materials, tools, transport, site handling and labour.

## TECHNICAL SPECIFICATION

## WASTEWATER PUMP SYSTEMS AND AERATORS

## CONTENTS

EB 01	SCOPE
EB 02	STANDARD SPECIFICATIONS
EB 03	OPERATING AND MAINTENANCE MANUALS
EB 04	PUMP DESIGN AND REQUIREMENTS
EB 05	MOTOR DESIGN AND REQUIREMENTS
EB 06	WORKING VOLTAGE AND SUPPLY SYSTEMS
EB 07	PROTECTION AND CONTROL DEVICES
EB 08	DETAIL OF WORK
EB 09	TESTING AND COMMISSIONING
EB 10	MAINTENANCE
EB 11	MEASUREMENT AND PAYMENT

**EB 01 SCOPE**

This specification covers the decommissioning, removal, repair and reconditioning, installation, testing, commissioning and maintenance of pumping equipment, motor control devices and low voltage cables. The function of wastewater pump systems shall be delivery of sewage or sludge at a specified flow rate and head to the required location.

This specification shall form an integral part of the repair and maintenance contract document and shall be read in conjunction with portion 3: Additional Specifications included in this document. The repair work and maintenance of the particular wastewater pump systems are specified in the relevant clauses on detail of repair work and maintenance in this specification.

This specification shall act as a guideline to the Particular Specification and, in the event of any discrepancies between the Technical Specification and the Particular Specification, the latter shall take precedence.

**EB02 STANDARD SPECIFICATIONS****EB 02.01 GENERAL STANDARD SPECIFICATIONS, REGULATIONS AND CODES**

The latest edition, including all amendments up to date of tender, of the following specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

BS 5316, Part 1	-	Acceptance tests for centrifugal, mixed flow and axial pumps
SANS 948	-	Three-phase induction motors
SANS 1222		Enclosures for electrical equipment (classified according to the degree of protection that the enclosure provides)
BS 4999		General requirements for rotating electrical machines
BS 1486, Part 2		Heavy-duty lubrication nipples
ISO 281/1		Rolling bearings - dynamic load ratings and rating life.

## EB.2

### EB 02.02 OCCUPATIONAL HEALTH AND SAFETY ACT OF 1993

All regulations and statutory requirements as lay down in the latest edition of the Occupational Health and Safety Act, 1993 (Act no 85 of 1993) shall be adhered to.

### EB 02.03 MANUFACTURER'S SPECIFICATIONS, CODES OF PRACTICE AND INSTALLATION INSTRUCTIONS

All equipment and materials shall be installed, serviced and repaired strictly in accordance with the manufacturer's specifications, instructions and codes of practice.

### EB 02.04 MUNICIPAL REGULATIONS, LAWS AND BY-LAWS

All municipal regulations laws, by-laws and special requirements of the Local Authority shall be adhered to unless otherwise specified.

### EB 03 OPERATING AND MAINTENANCE MANUALS

The Contractor shall at the start of the Contract be given all available as-built information and operating and maintenance manuals.

The Contractor shall be responsible for the compilation of an inventory list and operating and maintenance manuals.

This shall be done in accordance with Additional Specification SB: Operating and Maintenance Manuals.

### EB04 PUMP DESIGN AND REQUIREMENTS

- (a) Submersible pumps shall be designed to be suitable for submersion in sewage up to a depth of 5 m.
- (b) The pump shaft shall be manufactured from stainless steel and shall be sealed with double mechanical face seals where it enters the casing.
- (c) The impeller shall be suitable for pumping a type of wastewater as specified in Clause EB 08: Detail of work. All impellers shall be of the non-clogging type. The spacer between the impeller and back plate shall be reset every six months to the minimum distance to prevent clogging of rags between impeller and back plate.
- (d) The impeller shall be manufactured from stainless steel or, in the case of other materials, shall be coated with an approved material resistant to abrasion and corrosion due to the environment specified. For pumps rated below 2 kW, non-metallic impellers may be utilised.
- (e) The impeller shall be statically, dynamically and hydraulically balanced. No holes may be drilled in the impeller to balance it with regard to mass distribution.
- (f) Only permanently sealed ball or roller bearings shall be installed.
- (g) Bearings shall have a B-10 life rating of 100 000 hours.
- (h) The pump shall be a currently catalogued product.

### EB.3

- (i) Performance curves shall be based on a reproducible and certified test carried out in an approved testing facility, such as the SABS.
- U) The flow rate at break-off point of the curve for the impeller selected shall be at least 1,5 times that of the maximum flow rate specified.
- (k) The head at zero delivery of the curve from the impeller selected shall be at least 1,2 times the maximum head in the pump's operational range.
- (l) Each submersible pump shall be clearly labelled. The label shall be a 0,5 mm thick stainless steel plate of dimensions 100 mm x 50 mm. The label shall be fixed to the pump exterior with an approved adhesive or other method over its full back surface after the completion of corrosion protection on the pump. It may follow the shape of the pump exterior over areas suited for the bending of flat surfaces excluding sharp folds. Under no circumstances shall the label plate influence, damage or otherwise have other detrimental effects on the corrosion protection system. The label shall include the following information:
  - pump rates
  - pump head
  - power required
  - NPSH(r) rotational speed
  - impeller detail.
- (m) All new submersible pumps shall be supplied with a length of power cable to suit the installation shown on the drawings.
- (n) All new pumps utilised for the pumping of biological sludges shall be fitted with double flushed mechanical seals, which shall be included in the cost of the pumps. The pump shafts shall be hardened and accurately ground where the seal bears on the shaft. The rotating seal face shall be mounted on a flexible member sealing on the shaft as well. The flexible member shall be manufactured from rubber, PTFE or equivalent material suitable for the operating environment.
- (o) Centrifugal pumps shall comply with relevant and applicable items under the clause on technical requirements regarding all pump types, as well as the following:
  - (i) Preference shall be given to pumps of the self-regulating type, and where the power consumption characteristic is such that the power consumption decreases with an increase in delivery to beyond a certain limit, thus ensuring that the motor is not overloaded in the event of a large reduction in pumping head.
  - (ii) The casing for centrifugal pumps shall be horizontally or vertically split to allow removal of parts.
  - (iii) The efficiency of the pump shall not be less than 95 % of its maximum efficiency at the selected operating point, where the latter shall not be less than 80 %.

## EB05

## MOTOR DESIGN AND REQUIREMENTS

- (a) Electric motors shall comply with the requirements of SANS 948.
- (b) Imported motors forming an integral part of the pump shall be submitted to the South African Bureau of Standards to be tested in accordance with the requirements of SANS 948.
- (c) All motors shall be standard catalogue models and shall be readily available.
- (d) All motors shall, where possible, be from the same manufacturer and shall have the same interchangeable frames. Variations in type and size shall, where possible, be limited to prevent stocking a variety of special spares.
- (e) All motors shall have dynamically balanced rotors supported by maintenance-free, sealed-for-life ball bearings.
- (f) All motors shall be suitably coated to ensure the satisfactory operation of the motor under the specified class of service.
- (g) All terminal boxes shall be waterproof and suited for submersion up to the depth as specified for the pumps.
- (h) An adequate length of waterproof cable, purpose-made for submerging, shall be supplied with each submersible motor. The coupling of this cable to the normal power-distribution cable, which usually is of the PVC type with steel-wire armour, shall be placed at least 1,0 m above the maximum water level by means of a purpose-made, weatherproof, outdoor junction box. The submerged cable shall be supported to minimise any movement of the cable, which results from turbulence caused by the operation of the equipment or the flow of the water.
- (i) Thermistor protection or Klixon type temperature switches shall be provided for submersible motors.
- U) Seal monitors shall be provided for submersible motors, together with the required seal monitor relays. The cost for the seal monitor relays shall be deemed to be included in the rates tendered for the equipment.

## EB 06

## WORKING VOLTAGE AND SUPPLY SYSTEMS

The motors shall be capable of operating within  $\pm 10\%$  of the nominal supply voltage without risk of damage. All motors shall be suitable for operating continuously at the specified three-phase voltage system under actual service conditions, including the  $\pm 10\%$  voltage tolerance, without exceeding the specified temperature rise determined by the resistance on a basic full load heat run.

All motors shall be capable of operating continuously under actual service conditions at any supply frequency between 48 and 51 Hz together with any voltage between  $\pm 5\%$  of the nominal supply voltage.

The slip-in speed of any motor at 80 % of the nominal voltage at 50 Hz shall not exceed a percentage agreed on by the Engineer, and the motors shall be capable of operating at this voltage for a period of five minutes without deleterious heating.



**EB 07      PROTECTION AND CONTROL DEVICES**

Submersible pumping equipment shall have float switches to switch the pump motor on and off, according to the level of the liquid. Switches shall operate freely and not be hindered by cables or other switches and shall switch off at a level where no damage to the pump or motor will occur.

Three level switches shall operate a pump control system:

- (a) Level switch one shall switch off pumps at low level;
- (b) Level switch two shall switch on one pump at an intermediate level, to draw the liquid down to level 1. When the level again rises to where level switch two is switched on, the pump duty shall rotate to start the motor parallel to the one which ran the first time;
- (c) Level switch three shall switch on both pumps to run in parallel at a high level;

In the event of a pump failing to start, the other pump must automatically restart.

Pumps shall be operated in both manual and automatic modes.

**EB 08      DETAIL OF WORK**

The Engineer will demarcate any areas to be repaired and shall instruct the Contractor with regard to the maintenance and servicing work to be done.

**EB 08.01      SLUDGE PUMP SYSTEMS**

Electrically operated submersible vortex impeller pump with a working point of 10 l/s at a total head of 6 meter, 3kW, 1450 rpm with 195mm dia impeller

**EB 08.02      TESTING EQUIPMENT**

N/A

**EB 08.03      HUMUS PUMPING EQUIPMENT**

0.75kW 380V settler sludge return pump similar or equal to Best model No.3

**EB 08.04      AERATORS**

Double stage side channel bower 3.4kW 380V 7.2A @ 410 mbar static pressure at sea level @74db similar or equal to Sirocco

**EB 08.05      MOTOR CONTROL CENTRE**

- (a) The inside and outside of all surfaces of the motor control centre must be thoroughly cleaned and metal surfaces treated for rust and corrosion and repainted to specification.
- (b) Missing, damaged or faulty float switches shall be replaced with new switches of similar and equal type. The switches must be installed and supported on suitable brackets to prevent the cables and switches from tangling due to the inflow of the sewage water.
- (c) Check and tighten all terminations of all equipment.

- ## EB 09 TESTING AND COMMISSIONING

- (a) All pumping equipment shall be subject to the commissioning tests as described in the standard specification.
- (b) At least one of each type or size of pump supplied, repaired or reconditioned, shall be subject to a delivery flow rate test. The Contractor shall supply flow rate or volumetric flow testing facilities.
- (c) The operating point of each pump shall be determined.
- (d) Efficiency tests shall be performed.
- (e) NPSH tests shall be performed.

The Contractor shall supply the necessary adaptors, fittings and pressure gauges to measure the suction and delivery pressures. If no gauge fittings exist on the suction side of a submersible pump, then the suction pressure conditions shall be calculated from the system properties.

- (a) Testing shall be done in accordance with BS 5316 Part 1, class C tests.
- (b) Power consumption of electric motors shall be as determined by the three-wattmeter method where efficiency tests are required in the detail specification.

EB 09.04 **TESJ' CONDITIONS**

- (a) All tests shall be performed *in situ*.
- (b) The pumped medium or liquid specified as the process liquid in the detail specifications shall be utilised during the tests. The Contractor shall obtain from the pump manufacturer the test point for clean water corresponding to the specified duty point for the pumped liquid, in order to relate the measured performance to the pump supplier's curves which are based on water.

EB 09.05 **ADDITIONAL TESTS**

Additional tests may be specified in the detail of the work.

EB 10 **MAINTENANCE**EB 10.01 **GENERAL**

All wastewater pumping equipment and systems shall be serviced and repaired, following practical completion of the installation of which it forms part, to maintain it in perfect functional condition.

Maintenance shall be carried out and shall include routine preventative maintenance according to the manufacturer's specification to be set out in the operating and maintenance manual, as well as unforeseen repairwork or replacement.

The remuneration for monthly maintenance of wastewater pumping equipment and systems shall be deemed included in the tendered rate for ten points of the installation of which the system forms part. Installations are specified in Additional Specification SA: General Maintenance, and illustrated in detail on the mechanical flow diagram.

EB 10.02 **ROUTINE PREVENTATIVE MAINTENANCE**

The routine preventative maintenance work to be carried out shall include but not be limited to the items listed in table EB 10.2/1 below.

These actions and findings shall be logged and reported on the relevant approved schedules and reports.

TABLE EB 10.02/1

NO	ROUTINE PREVENTATIVE MAINTENANCE OF WASTEWATER PUMP SYSTEMS	MAINTENANCE FREQUENCY
1	Visually inspect and report on complete system	Monthly
2	Check, service, repair and clean all pumps	Six-monthly
3	Corrosion protect pumps, motors and surface piping	Once per contract
4	Check, inspect, report and repair all leaks	Monthly
5	Check and lubricate moving parts	Four-monthly

## EB 11 MEASUREMENT AND PAYMENT

EB11.01 SUPPLY AND DELIVERY OF PUMPING EQUIPMENT Unit: number

The unit of measurement shall be the number of pumping equipment units supplied and delivered.

The tendered rates shall include full compensation for the design, manufacture, corrosion protection, patent rights, pre-delivery testing and test certificates, transport for delivery to site and off-loading including all handling of the equipment. The equipment shall include the following:

- (a) The pump and motor as an integrated unit
- (b) Electrical power cable.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

EB11.02 INSTALLATION, TESTING AND COMMISSIONING OF PUMPING EQUIPMENT.....Unit: number

The unit of measurement shall be the number of pumping equipment units installed, tested and commissioned.

The tendered rates shall include full compensation for the site handling and positioning of the pumping equipment, including the fastening of the equipment in its designated position. The following shall also be included in the tendered rates:

- (a) Installation of the guide rails and sealing frame;
- (b) Coupling of all required pipes flanges, including all required gaskets, nuts, bolts and washers;
- (c) Routing and fastening of the power cable up to the isolator box;
- (d) All required installation materials, labour and consumables to render a complete and working installation.

The tendered rates shall also include full compensation for all preliminary tests, delivery and efficiency tests if required and commissioning tests. Commissioning tests shall comply with the section dealing with testing and commissioning.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

EB11.03 DECOMMISSIONING AND REMOVAL OF PUMPING EQUIPMENT..... Unit: number

The unit of measurement shall be the number of pumping equipment units decommissioned and removed.

The tendered rates shall include full compensation for all labour, machinery, tools, transport and site handling necessary for the decommissioning and removal of pumping equipment.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

**EB11.04 SERVICE/RECONDITIONING OF PUMPING EQUIPMENT** , Unit: number

The unit of measurement shall be the number of pumps and motors reconditioned/serviced.

The tendered rates shall include full compensation for the reconditioning/servicing of components and materials, and for tools, transport, site handling and labour necessary for the complete reconditioning of pumping equipment to conform to all the specifications in Clauses EB.04: Pump design and requirements, and EB.05: Motor design and requirements.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

**EB11.05 REPAIR OF PUMPING EQUIPMENT** Unit: number

The unit of measurement shall be the number of submersible pumps and motors repaired.

The tendered rate shall include full compensation for supply of an identification label, resetting the spacer between impeller and back plate and ensuring that impeller rotates freely, as well as cleaning and corrosion protection and installing a new hoisting chain.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

**EB 11.06 RECONDITIONING OF FLOAT LEVEL SWITCHES OR OTHER LEVEL PROBES** Unit: number

The unit of measurement shall be the number of level switches or probes reconditioned.

The tendered rates shall include full compensation for replacement of components and materials and for tools, transport, site handling and labour necessary for the complete reconditioning of all components of the level control devices

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

**EB 11.07 CLEANING AND REMOVAL OF REDUNDANT EQUIPMENT FROM WASTE WATER PUMP SUMPS, PUMP ROOMS AND RELATED INFRASTRUCTURE** ..... Unit :sum

The unit of measurement shall be a sum to clean and remove redundant material from waste water pump sumps and related infra structure such as valve chambers and pump rooms.

The tendered rates shall include full compensation for all components, materials, tools, transport, site handling and labour necessary for the complete cleaning and reconditioning of wastewater pump sumps and related infrastructure in conformance with the specifications in Clause EA 08, Detail of Work.

## r\_e\_CHNICAL SPECIFICATION

SEDIMENTATION TANKS

## CONTENTS

EC 01	SCOPE
EC02	STANDARD SPECIFICATIONS AND ADDITIONAL SPECIFICATIONS
EC03	ADDITIONAL REQUIREMENTS FOR REPAIR OF SEDIMENTATION TANKS AND APPURTENANCES
EC04	OPERATING AND MAINTENANCE MANUALS
EC05	DETAIL OF REPAIR WORK
EC 06	MAINTENANCE OF SEDIMENTATION TANKS
EC 07	MEASUREMENT AND PAYMENT

**EC 01 SCOPE**

Sedimentation tanks for sewage treatment works include all circular primary settling tanks and circular secondary settling tanks (also referred to as final clarifiers in activated sludge works or humus tanks, where sedimentation tanks are downstream of biological trickling filters). In water purification works circular as well as rectangular clarifiers are used. The repair work and maintenance responsibilities of sedimentation tanks shall form part of the whole of a wastewater treatment works. The use of mechanical scrapers is excluded from the work and responsibilities described herein.

The function of the primary sedimentation tanks is the reduction in organic load entering the biological treatment facility. The reduction in organic load is achieved as a result of solid material (raw sludge) settling under the influence of gravity. Raw sludge shall be withdrawn to sludge treatment and disposal works.

The function of secondary sedimentation tanks/ clarifiers is to ensure sufficiently clarified water for filtration at water purification works, as well as thickened activated sludge as return activated sludge to a biological reactor, or withdrawal of humus where the sedimentation tank is downstream of a biological trickling filter. Water purification sludge withdrawal, activated sludge return and humus withdrawal systems are included in the work and responsibilities described in this specification.

The maintenance of sedimentation tanks shall include various responsibilities, as specified in the relevant clauses. Maintenance responsibilities shall include all work to ensure the functional performance of sedimentation tanks and to maintain the specified quality of effluent.

This specification shall form an integral part of the repair and maintenance contract document and shall be read in conjunction with portion 3: Additional Specifications included in this document. The repair work and maintenance of the particular wastewater sedimentation tanks are specified in the relevant clauses on detail of repair work and maintenance in this specification.

This specification shall act as a guideline to the Particular Specification and, in the event of any discrepancies between the Technical Specification and the Particular Specification, the latter shall take precedence.

**EC 02 STANDARD SPECIFICATIONS AND ADDITIONAL SPECIFICATIONS**

The latest edition, including all amendments up to date of tender, of the following specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

**EC 02.01 GENERAL STANDARD SPECIFICATIONS, REGULATIONS AND CODES**

SANS 1200 Standardized specification for civil engineering construction

SANS SM 1049 Water - suspended solids content, second edition, 1990

Operating manual for biological nutrient removal wastewater treatment works, WRC Report no TT83/97, 1997

Theory, design and operation of nutrient removal activated sludge processes, WRC Report no 15525, 1984

**EC 02.02 OTHER SPECIFICATIONS**

EB Wastewater pump systems  
EF Sludge treatment and disposal

**EC 02.03 OCCUPATIONAL HEALTH AND SAFETY ACT OF 1993**

All regulations and statutory requirements as lay down in the latest edition of the Occupational Health and Safety Act, 1993 (Act no 85 of 1993) shall be adhered to.

**EC 02.04 MANUFACTURERS' SPECIFICATIONS, CODES OF PRACTICE AND INSTALLATION INSTRUCTIONS**

All equipment and materials shall be installed, serviced and repaired strictly in accordance with the manufacturers' specifications, instructions and codes of practice.

**EC 02.05 MUNICIPAL REGULATIONS, LAWS AND BY-LAWS**

All municipal regulations laws, by-laws and special requirements of the Local Authority shall be adhered to unless otherwise specified.

**EC03 ADDITIONAL REQUIREMENTS FOR REPAIR AND RECOMMISSIONING OF SEDIMENTATION TANKS AND APPURTENANCES**

**EC 03.01 GENERAL**

Sedimentation tanks shall be repaired to the level of designed functionality or to comply with requirements of laws and regulations. The repair work shall enable the Contractor to maintain the units as new units for the period as specified.

**EC 03.02 FIXED BRIDGES**

Fixed bridges shall be repaired allowing safe access to the centre of sedimentation tanks. Bridges shall be repaired to comply with the Occupational Health and Safety Act 85 of 1993.

Bridge repair shall imply removal thereof to complete repair work where specified. Repair work shall include sanding and painting of metal to yield a finish protected against corrosion. Hand railings and walkways shall be cleaned, corrosion protected, fixed and replaced in part where necessary.

Access for cleaning of stilling wells shall not be impaired as a consequence of repair work.

#### **EC 03.03 INLET PIPEWORK AND VALVES**

Repair of inlet pipework shall include all lengths of pipe between the previous process unit and the centre stilling well outlet. Pipework shall be repaired where sedimentation tanks are taken out of commission and flow bypassed through parallel units or bypassed to other process units.

Repair work shall include fixing and/or replacement of lengths of pipe, brackets and hangers and all appurtenances, as detailed on the drawings.

#### **EC 03.04 STILLING WELLS**

Stilling wells shall be removed together with the fixed bridge and repaired with a finish to protect the stilling well against corrosion. The diameter, material and method of fixing shall be as detailed on drawings.

#### **EC 03.05 EFFLUENT WEIRS**

Where specified, effluent weirs shall be removed and reinstalled horizontally, within tolerance, to ensure equal flow distribution through the sedimentation tank. The weirs shall be sanded and painted against corrosion before reinstallation.

#### **EC 03.06 EFFLUENT LAUNDERS AND PERIMETER WALLS**

All cracks in effluent launders shall be sealed and all algae removed from surface. The Contractor shall make temporary arrangements to accommodate the existing flow during repair work. The walls of the launder (on the perimeter of the tank) channel shall be repaired where necessary. All hand railings, cemented tiles or other barriers on the perimeter and on top of walls shall be cemented, repaired and painted.

#### **EC 03.07 SCUM WITHDRAWAL SYSTEMS**

Scum withdrawal systems at primary settling tanks shall be repaired together with the central stilling well. From the central stilling well an open chute (half pipe) shall run radially to the scum baffle. From the scum baffle the full pipe shall run to the outside of the tank to remove scum. A valve shall be connected to the far end of the pipe and will open into a scum/sludge manhole. A straining basket or screen at the open end of the valve (pipe end) shall intercept all artificial solids present in scum. A scum baffle (scum board) shall prevent scum from escaping the sedimentation tank. The circular scum baffle shall run around the sedimentation tank 300 - 400 mm from the inside of the effluent weir. The scum baffle shall be 450 - 500 mm high and submerged by at least 400 mm of its height.



Repair work shall include replacement, repair, cleaning and corrosion protection of the outlet chute; pipeline and scum baffle to form a perfect working system.

**EC 03.08      PRIMARY SEIJLING TANKS**

Where parallel tanks are used, both tanks shall be emptied and cleaned completely. The Contractor shall isolate one tank and divert all flow to other tank(s) to do repair work, which shall include cleaning of pipelines entering the sedimentation tank, desludging all components/parts of the sedimentation tank and repairing cracks and waterproofing.

Where single tanks are provided adequate provision shall be made for the decommissioning of the tank and the accommodation of the flow.

**EC 03.09      SLUDGE WITHDRAWAL SYSTEM {PRIMARY SETTLING TANKS}**

The sludge withdrawal system shall consist of a pipeline and a manually opened gate valve. The repair work shall include removing the valve, while isolating the outlet pipe by means of a flanged spade and blank flange. The gate valve shall be fully reconditioned.

**EC 03.10      SECONDARY SETTLING TANKS**

Where parallel tanks are used, both tanks shall be emptied and cleaned completely. The Contractor shall isolate one tank and divert all flow to other tank(s) to do repair work, which shall include cleaning of pipelines entering the sedimentation tank, desludging all components/parts of the sedimentation tank and repairing cracks and waterproofing.

Where single tanks are used the tank shall be decommissioned and adequate provision shall be made for temporary treatment and disposal.

**EC 03.11      ACTIVATED SLUDGE RETURN, WATER PURIFICATION SLUDGE AND HUMUS WITHDRAWAL SYSTEMS**

The activated sludge return, water purification sludge or humus withdrawal systems can consist of a pipeline and manually opened gate valve running into a sludge pump sump. The repair work shall include removing the valve, while isolating the outlet pipe by means of a flanged spade and blank flange. The gate valve shall be fully reconditioned.

Where submersible pumps are used for sludge return or humus/ water purification sludge withdrawal such pumps shall be reconditioned where specified in accordance with the requirements of Technical Specification EB: Wastewater pump systems. The electrical supply and motor control of submersible pumps shall be repaired with the pump where specified in accordance with the requirements of the relevant technical specifications.

Submersible pumps shall be switched on when a level float switch reaches a certain fixed level (medium height) in the sump. Pumps shall be stopped at a certain low level. When the same medium level is reached again, the next pump shall be switched on (duty rotation). When a still higher level is reached, a level float switch shall cause both pumps to run simultaneously in parallel (high flow conditions).

**EC 03.12      RECOMMISSIONING OF SEDIMENTATION TANKS**

Sedimentation tanks shall be re-commissioned on completion of repair work by allowing them to fill with natural flow. Initial sludge carry-over must be reduced by bringing the system into function, as described, as quickly as possible. Correct functioning must be achieved within 24 hours. A continuous low flow withdrawal of sludge (thin sludge) during commissioning that establishes down flow may aid in commissioning sedimentation tanks.

**EC04 OPERATING AND MAINTENANCE MANUALS**

The Contractor shall at the start of the Contract be given all available as-built information and operating and maintenance manuals.

The Contractor shall be responsible for the compilation of an inventory list and operating and maintenance manuals.

This shall be done in accordance with Additional Specification SB: Operating and Maintenance manuals.

**EC 05 DETAIL OF REPAIR WORK**

**EC 05.01 GENERAL**

The Engineer will demarcate any areas to be repaired and shall instruct the Contractor with regard to the repair work to be done.

**EC06 MAINTENANCE OF SEDIMENTATION TANKS**

**EC 06.01 GENERAL**

The maintenance requirements specified in the clauses below shall be the minimum requirements and shall not in any way indemnify the Contractor from maintaining the entire installation in a perfect functional condition.

Maintenance shall include any repair work, cleaning of all components, corrosion protection, replacing of non-functional components and materials, routine setting, fixing of leaks, or any other actions or rectifying measures necessary to ensure perfect operation of sedimentation tanks according to the functional specification thereof.

The Contractor shall be responsible to compile a database of information containing all test results, including his own tests to ensure correct functioning of the system, with operating conditions, to aid in improving future operation of the plant.

Remuneration for monthly maintenance of all sedimentation tanks shall be deemed included with the tendered rate for ten maintenance points of the installation of which sedimentation tanks form part.

**EC 06.02 STATIC BRIDGES**

Bridges of both primary and secondary settling tanks shall be maintained clean and protected against corrosion. The bridges shall be maintained safe to enable work and inspections.

**EC 06.03 INLET PIPEWORK**

Inlet pipework shall be kept open and functional at all times. Pipes shall be cleaned and unblocked when necessary. Pipework shall be maintained leak-free at all times.

Screens shall be cleaned regularly and the debris disposed of.

**EC 06.04      STILLING WELLS**

Stilling wells shall be kept clean on a daily basis as often as necessary to prevent the build-up of a scum layer of froth and floating debris. Scum shall be removed through the scum withdrawal chute, or manually when necessary.

**EC 06.05      EFFLUENT WEIRS**

The effluent weirs shall be kept clean and all algae or other growths shall be removed. Floating artificial solids shall be removed and prevented from escaping the sedimentation tank. Artificial solids shall be disposed of with screenings removed at the inlet works. The weirs shall be maintained in perfect functional condition.

**EC 06.06      EFFLUENT/OUTFLOW LAUNDERS**

The effluent launders shall be kept clean and all algae or other growths shall be removed. The launders shall be maintained in perfect functional condition.

**EC 06.07      SCUM WITHDRAWAL AND SCUM WITHDRAWAL SYSTEMS**

Scum shall be withdrawn every three to four hours or more often when necessary, on a daily basis. A water spray system assists in the settling of scum and floating sludge. Apart from scum withdrawal, the scum collecting in the central stilling well, as well as scum and debris stuck to the scum baffle along the inside perimeter of the sedimentation tank shall be removed spraying with water. The maintenance of sedimentation tanks shall prevent formation of scum layers.

The scum withdrawal system consisting of stilling wells, open chutes, scum baffles, pipelines, valves, screens and wash water spraying nozzles shall be maintained in a perfect functional condition.

**EC 06.08      PRIMARY SETTLING TANKS**

Settled wastewater samples shall be taken in the primary settling tank between the scum baffle and the outflow weir. The settle able solids in the water sample shall be measured by means of an Imhoff cone test, as specified in Technical Specification EJ: Wastewater quality, measurement and testing. Settled sewage shall not have a value exceeding 0.4 millilitre/litre settle able solids.

The perfect functional condition of primary settling tanks shall amongst other criteria be evaluated against this value.

**EC 06.09      SLUDGE WITHDRAWAL SYSTEM (PRIMARY SETTLING TANKS)****EC 06.09.01      Quantity of raw sludge withdrawal**

The sludge valve shall be opened slowly until fully open, to discharge sludge while the condition of the sludge is observed. When the sludge seems to clear, the valve shall be closed slowly. The operation shall be repeated after two to three minutes. Piping through settled sludge may cause water to appear clear before a sufficient volume of sludge has been withdrawn. The operation shall be repeated until the outflow remains clear after a few repetitions of the operation.

The sludge valve shall always be opened and closed very slowly to prevent the occurrence of pressure surges that disturb the settled sludge and cause rising thereof.

Sludge shall be withdrawn an hour prior to peak flow conditions in the morning (before 07:00), and again at midday and then before the maintenance personnel leave the site (around 17:00).

The frequency of sludge withdrawal shall be increased when necessitated by the high content of suspended solids in the effluent.

#### EC 06.09.02 Sludge withdrawal

Sludge shall be withdrawn 3X daily from the bottom of the primary settling tank. The sludge valve shall be opened slowly, and not completely, to discharge sludge.

The volume of sludge withdrawn from the primary settling tank shall be controlled in volumes of thickened sludge to prevent overfilling of the digesters with water.

#### EC 06.09.03 Sludge withdrawal system

The complete sludge withdrawal system comprising a sludge valve(s), gravity pipeline to a sludge sump, the sludge sump, pumping equipment and electrical cables, controls and equipment shall all be kept in a perfect functional condition to ensure that raw sludge can be withdrawn from primary settling tanks and discharged to the digesters.

#### EC 06.10 SECONDARY SEDIMENTATION TANKS

A difference shall be made between the maintenance of clarifiers (downstream of activated sludge reactors and water purification works) and humus tanks (downstream of biological trickling filters). Both types of sedimentation tanks shall be used to clarify treated wastewater and purified water.

In the case of clarifiers, the return activated sludge shall be reintroduced back into the reactor for controlling the sludge age.

In the case of humus tanks, the humus shall be withdrawn from the process and disposed of with raw sludge or directly to sludge digesters, as specified.

In the case of water purification sludge the shall be dried and disposed of with sewage sludge or at a registered landfill.

#### EC 06.10.01 Maintenance of secondary sedimentation tanks and appurtenances

The water-retaining tank structure shall be maintained together with appurtenances such as hand railings, pipework and channels.

#### EC 06.10.02 Sludge withdrawal systems

Sludge withdrawal systems for secondary sedimentation tanks include return activated sludge systems or humus withdrawal systems (humus tanks). Both systems shall be maintained to keep central sludge hoppers, pipework, valves, concrete sumps (water-retaining structures), submersible pumping equipment, electrical control equipment and cables, grating and hand railings in a perfect functional condition.

#### EC 06.10.03 Return activated sludge withdrawal rate

A sample of homogenous water between the scum baffle and the outflow weir of the secondary settling tank shall be taken to measure the content of settleable solids. Return activated sludge (RAS) shall be withdrawn twenty four hours per day. Withdrawal rates are determined for the control of biological processes and shall be

set on site. RAS: Waste water inflow ratio shall be calculated on site and thickening must be controlled so that the ratio does not exceed 1.5

EC 06.10.04 Scum withdrawal

Secondary settling tank scum, if formation of scum occurs, shall be removed / withdrawn manually by means of a net or pressurised wash water spray.

EC 06.11 **HUMUS WITHDRAWAL**

EC 06.11.01 Humus withdrawal rate

A sample of homogenous water between the scum baffle and the outflow weir of the humus tank shall be taken to measure the content of suspended solids. Based on this value, the volume of humus withdrawn daily shall be adapted. The rate of humus withdrawal (quantity and frequency of withdrawal) shall be increased until the required suspended solids content is achieved.

The humus valve shall be opened slowly until fully open, to discharge humus while the condition of the humus is observed. When the humus stream seems to clear, the valve shall be closed slowly. The operation shall be repeated after two to three minutes. Piping through settled humus may cause water to appear clear before the full volume of humus has been withdrawn. The operation shall be repeated until the outflow remains clear after a few repetitions of the operation.

The humus valve shall always be opened and closed very slowly to prevent the occurrence of pressure surges that disturb the settled sludge and cause rising thereof.

Humus shall be withdrawn an hour prior to peak flow conditions in the morning (before 07:00), and again at midday and then before the maintenance personnel leave the site (around 17:00).

The frequency of humus withdrawal shall be increased when necessitated by the high content of suspended solids in the effluent.

EC 06.11.02 **Sloughing**

The increased loading of humus tanks due to sloughing (as described in Technical Specification ED: Biological trickling filters) shall be managed as part of maintenance responsibilities. The rate of humus withdrawal shall be increased steadily when sloughing is expected or experienced.

EC 06.11.03 **Scum withdrawal**

Humus tank scum, if formation of scum occurs, shall be removed / withdrawn manually by means of a net or pressurised wash water spray.

EC07 **MEASUREMENT AND PAYMENT**

EC 07.01 **DECOMMISSIONING OF SETTLING TANKS (CLARIFIERS) AND EQUIPMENT**

Unit: number

The unit of measurement shall be the number of specified units of wastewater settling tanks and equipment (effluent launders, overflow weirs, stilling wells, pipe work,

platforms, bridges, accommodation of existing flow etc.) decommissioned and removed.

The tendered rates shall include full compensation for all labour, machinery, tools, transport and site handling necessary for the decommissioning and removal equipment in compliance with Clause EC 03.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

**EC 07.02      RECONDITIONING/REPLACEMENT AND COMMISSIONING OF  
SETTLING TANK UNITS (CLARIFIERS) AND EQUIPMENT.....Unit: number**

The unit of measurement shall be the number of specified units of equipment (effluent launders, overflow weirs stilling wells, pipe work, platforms, bridges, accommodation of existing flow etc.) reconditioned / replaced.

The tendered rates shall include full compensation for all components, materials, tools, transport, site handling and labour necessary for the complete reconditioning of wastewater inlet works units and equipment in compliance with Clause EC 03.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

**EC 07.03      DECOMMISSIONING AND REMOVAL OF RETURN  
ACTIVATED SLUDGE UNIT AND EQUIPMENT ..... Unit: number**

The unit of measurement shall be the number of specified units of wastewater inlet works equipment decommissioned and removed.

The tendered rates shall include full compensation for all labour, machinery, tools, transport and site handling necessary for the decommissioning and removal equipment.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

**EC 07.04      RECONDITIONING AND COMMISSIONING OF RETURN  
ACTIVATED SLUDGE UNITS AND EQUIPMENT ..... Unit: number**

The unit of measurement shall be the number of specified units of equipment reconditioned.

The tendered rates shall include full compensation for all components, materials, tools, transport, site handling and labour necessary for the complete reconditioning of wastewater inlet works units and equipment in compliance with Clause EA 03 (Detail of repair work) of Technical Specification EA: Wastewater inlet works.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

**EC 07.05      DECOMMISSIONING AND REPAIR/RECONDITIONING OF VALVES AND SLUICE  
GATES ..... Unit: number**

The unit of measurement shall be the number of valves and sluice gates decommissioned and repaired or reconditioned.

The tendered rate shall include full compensation for replacement of components and materials for tools, transport, site handling and labour necessary for the complete decommissioning, dismantling, cleaning, repair or reconditioning of valves and sluice gates to conform to all the specifications in EC 02 and EC 03.

EC 07.06

**INSTALLATION, TESTING AND COMMISSIONING OF VALVES AND SLUICE GATES** .....Unit: number

The unit of measurement shall be the number of valves and sluice gates installed, tested and commissioned.

The tendered rate shall include full compensation for the installation, testing, and commissioning making good all corrosion protected areas and for all other costs and actions necessary to obtain a complete working system as well as for materials, tools, transport, site handling and labour necessary to conform to all the specifications in EC 02 and EC 03.

EC 07.07

**REPAIR AND RECONDITIONING OF CLARIFIER CONCRETE STRUCTURES** .....Unit: m<sup>2</sup>

The unit of measurement shall be the are of clarifier concrete structures to be reconditioned / repaired.

The tendered rates shall include full compensation for all components, materials, tools, transport, site handling and labour necessary for the complete reconditioning/repair of the concrete structure to be repaired.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.



## TECHNICAL SPECIFICATION

### EG SEPTIC TANK FACILITIES

#### CONTENTS

EG 01	SCOPE
EG02	STANDARD SPECIFICATIONS
EG 03	INFORMATION REQUIREMENTS FOR SEPTIC TANK SYSTEMS
EG 04	DETAIL OF REPAIR AND MAINTENANCE
EG 05	RESOURCES REQUIRED
EG 06	MEASUREMENT AND PAYMENT

#### **EG 01 SCOPE**

Septic tanks (STs) are generally used as the most appropriate method of sewage disposal in rural/remote locations such as police stations. Typical problems experienced with ST facilities include:

- Inadequate capacity for the loads generated by their serviced populations, thus requiring too frequent emptying and consequent operation as conservancy tanks.
- Counter-sloping of feed sewers, causing blockages in these pipes.
- Inappropriate or broken inlet and/or outlet pipe-work (tee pieces).
- Top level of separation baffles too low, causing spillover of accumulated scum from primary to secondary compartment.
- Blocked connection between ST and disposal unit (mostly French drains - FDs).
- Blocked and/or overflowing FD, due to under-sized drain or retarded percolation.
- Uneven distribution of septic tank effluent into FD drain, caused by inappropriate slope and perforation of spreader pipe.
- Blockage of pipes and/or FDs by tree and grass roots.

#### **EG02 STANDARD SPECIFICATIONS**

##### **EG 02.01 GENERAL STANDARD SPECIFICATIONS, REGULATIONS AND CODES**

The latest edition, including all amendments up to date of tender, of the following specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

SANS 1200                      Standardized specification for civil engineering construction

##### **EG 02.02 OTHER SPECIFICATIONS**

LB                      General corrosion protection

**EG 02.03      OCCUPATIONAL HEALTH AND SAFETY ACT OF 1993**

All regulations and statutory requirements as laid down in the latest edition of the Occupational Health and Safety Act of 1993: Construction Regulations, 2003 as promulgated in Government Gazette No 25207 and Regulation Gazette No 7721 of 18 July 2003 shall be adhered to.

**EG 02.04      MANUFACTURERS' SPECIFICATIONS, CODES OF PRACTICE AND INSTALLATION INSTRUCTIONS**

All equipment and materials shall be installed, serviced and repaired strictly in accordance with the manufacturers' specifications, instructions and codes of practice.

**EG 02.05      MUNICIPAL REGULATIONS, LAWS AND BY-LAWS**

All municipal regulations, laws, by-laws and special requirements of the Local Authority shall be adhered to unless otherwise specified.

**EG03      INFORMATION REQUIREMENTS FOR SEPTIC TANK SYSTEMS**

The specifications in EG 03 are of a general nature and if not referred to in Clause EG 04: Detail of Repair and Maintenance, are not considered part of this Contract.

**EG 03.01      SPECIFIC INFORMATION REQUIREMENTS**

Specific information requirements re each ST facility include:

- Current and projected design population, incorporating appropriate design factors for domestic, public and institutional sanitation facilities (with/without detention cells).
- Dimensions and capacities of existing STs and FDs.
- ST emptying frequency and period since previous emptying event.
- Required ST and FD capacities.
- Integrity and serviceability of existing ST and FD structures and accessories (in/outlet fittings, baffle walls, rodding eyes on connecting pipes, etc.).
- Type and frequency of operational problems experienced, including resultant nuisance conditions.
- Contravention of applicable legal requirements.
- Availability and utilisation of groundwater (GW), its risk of pollution by the sanitation facility and precautions practised, such as chlorination of water supplied to users.
- Depth of GW table.
- Distance of separation between ST/FD and GW source.
- Other modes of water supply (with/without special treatment), such as Local Authority (LA) connection, surface source and carting from a remote source.

- Feasibility of connecting the water supply and/or sanitation facility to a LA-system.

EG04 IIEIA\_IL\_OF REPAIR\NO\_M\_AINtENANCE

#### EG 04.01 ALL INSTALLATIONS

The following general/repair and maintenance tasks shall be performed on all installations, whether specific problems are experienced, or not:

- Assess category in which the installation falls: Maintenance (no specific problems - largely applicable to FDs), Emergency repair and Repair (problematic cases - largely applicable to FDs), and/or Upgrading (applicable to STs or FDs, depending on design population). Measure internal length and width of tank, as well as depth from top of roof slab to top levels (TIs) of scum layer, supernatant layer and sludge layer, and to floor level (FL).
- Prepare temporary sludge disposal facility - the more appropriate of the following:
  - Drying bed/pond.
  - Direct on-site burial.
  - Carting to nearby sewage treatment works or domestic sanitary landfill site.
- Install permanent sewage by-pass facility consisting of a pre-fabricated tank of appropriate volume (c. 1m<sup>3</sup> for single dwelling, larger for communal facilities) parallel to the ST, with up- and downstream connecting pipes and plugs.
- Install rodding eyes for regular cleaning of connecting pipes, particularly those between the ST and FD.
- Using a stirrer, pump and/or bacterial aids, break up scum and sludge layers and suspend tank content to enable its pumping.
- Empty tank by means of pumping - retain seed sample for re-commissioning of tanks. Remove large settled objects, such as bricks, etc. Operate by-pass tank during emptying and re-commissioning of main tank.
- Clean connecting pipes and accessories, e.g. in/outlet tees. Remove tree and grass roots from pipes.
- Maintain acceptable aesthetic conditions re smells and spillages during the cleaning cycle.

#### EG 04.02 **INSTALLATIONS REQUIRING EMERGENCY REPAIR REPAIR AND/OR UPGRADING**

Facilities in these categories shall, in most cases, be designed as if for new installations. Appropriate design guidelines are given in:

Water Institute of Southern Africa (1988). *Manual on the Design of Small Sewage Works*.

Summaries of preliminary designs shall be submitted to the Project Manager for conceptual approval. The services of a hydro-geologist may have to be employed, particularly where the accompanying water supply is fed from GW sources.

## EG.4

In cases where the capacities of the ST and/or FD are inadequate for the flow to be treated, or where evidence of malfunctioning of the FD/disposal field is observed, the following tasks shall be carried out:

- Determine the design population/flow.
- In case of a single existing FD, install a duplicate FD and use it while the original FD is being refurbished. Thereafter, operate them alternately.
- In case of a disposal field (e.g. multiple FDs):
  - Dig an inspection hole close to the existing disposal field and characterise the soil profile to a depth of 1,2 to 1,5m below ground level.
  - Select the most feasible percolation layer and perform the prescribed percolation test in that layer.
  - Assess the percolation capacity of the existing FD/disposal field and, if necessary, the additional capacity required.
  - Increase the installed capacity of the FD/disposal field to at least 120% of its design capacity and operate the two halves of the system alternately.
- If the percolation zone of the FD/disposal field is perceived to be blocked, as evidenced by effluent seeping to the surface:
  - Remove the stone media from the drain, wash off accumulated biomass and allow the media to dry.
  - Strip a 100mm mantle of blocked soil from the sides and bottom of the drain and dispose of the spoil by on-site burial.
  - Return the stone media to the drain and replenish shortages.
- Pipework:
  - In either case (new or refurbished FD), install flow distribution pipe horizontally at correct level and with percolation holes located such that flow will be spread evenly over the length and width of the drain.
  - Install vertical inspection pipe (from floor level to 1m above ground level) to enable assessment of water level in drain.
- The ST site must at all times be maintained in a neat and acceptable condition.

**EG 04.03** Six monthly maintenance shall include the measurement and recording of sludge levels in the septic tank. Sludge removal shall be at frequencies as follows:

Population served:	10	-	30 persons	2 years
	50	-	200 persons	1 year
	200	-	500 persons	6 months
			Single Household	3 years

### **EG 04.04 OTHER MEANS OF DISPOSAL OF ST EFFLUENT**

Where geological conditions are such that ST effluent disposal by means of subsurface percolation is not feasible, the following alternative disposal methods may be considered:

- Evapo-transpiration beds, either as a stand-alone facility, or supplementary to a FD system.
- Reedbeds.
- Hydroponic systems.

EGOS

**RESOURCES REQUIRED**

- Apparatus for measuring sludge and scum layers in STs.
- Apparatus for performing percolation tests.
- Excavator.
- Sludge pump.
- Stirrer/bacterial aids for breaking up of sludge and scum layers.
- Geo-hydrologist.

**EG06**

**MEASUREMENT AND PAYMENT**

**EG 06.01**

**DESLUDGE AND GENERAL REPAIR  
OF SEPTIC TANKS.....Unit: m<sup>3</sup>**

The unit of measurement shall be the cubic metre of the capacity of the septic tanks deslugged and repaired as per the procedure described in the specifications as well as for site specific requirements to achieve a clean and operational septic tank.

The tendered rate shall include full compensation for cleaning, excavation, installation, removing of obsolete material and rubble, dealing with water logged conditions, execution of the Environmental Measurement Plan during repair, provision of backfill and temporary by-pass tanks and pipes and the disposal of sludge and surplus material. All labour shall also be included in the tendered rate.

**EG 06.02**

**REHABILITATION**

**OF FRENCH DRAIN S\_YST\_EM..... Unit : Number**

The unit of measurement shall be for the procedure described in EG 04.02 as well as for site specific requirements to achieve a clean and operational French Drain System.

The tendered rate shall include full compensation for the percolation test, the increased disposal field capacity, removal of stone media (if required), pipe work, rehabilitation of existing FD and installation of inspection pipes.

**EG 06.03**

**ALLIENATIVE METHODS TO AUGMENT THE SEPTIC TANK/  
FRENCH DRAIN TREATMENT.....Unit: Number**

The unit of measurement shall be for the construction of the component to augment the ST/FD treatment system (see EG 04.04).

The tendered shall include the full compensation for the installation or construction of the system as approved by the Engineer.

## EQ.2

The earth walls of the reed beds shall be cared for not to be overgrown by natural vegetation and all shrubs, bushes and trees shall be removed before they can cause any damage to the walls. Natural grass on the outer surface of the walls need not to be removed but shall be cut regularly and shall not be allowed to grow to a length that exceeds 100 mm. Natural grass and weeds shall not be allowed to grow onto the surface of the reed beds and it shall be removed regularly.

### EQ 02.03 OCCUPATIONAL HEALTH AND SAFETY ACT OF 1993

All regulations and statutory requirements as laid down in the latest edition of the Occupational Health and Safety Act, 1993 (Act no 85 of 1993) shall be adhered to.

### EQ 02.04 **MANUFACTURERS' SPECIFICATIONS, CODES OF PRACTICE AND INSTALLATION INSTRUCTIONS**

All equipment and materials shall be installed, serviced and repaired strictly in accordance with the manufacturers' specifications, instructions and codes of practice.

### EQ 02.05 **MUNICIPAL REGULATIONS,. LAWS AND BY-LAWS**

All municipal regulations laws, by-laws and special requirements of the Local Authority shall be adhered to unless otherwise specified.

### EQ03 **OPERATING AND MAINTENANCE MANUALS**

The Contractor shall at the start of the Contract be given all available as-built information and operating and maintenance manuals.

The Contractor shall be responsible for the compilation of an inventory list and operating and maintenance manuals.

This shall be done in accordance with Additional Specification SB: Operating and Maintenance Manuals.

### EQ04 **DETAIL OF WORK**

#### EQ 04.01 No scheduled repair work **is indicated in the schedule of quantities.**

### EQ05 **MAINTENANCE**

Maintenance of reed beds shall include all work necessary to maintain in a good condition with regard to the establishment of trees, weeds and natural grass amongst the reed growth. Invasive growths shall be removed manually and disposed of.

Reed bed outlet structures, inlet weirs and all pipe work and channels interconnecting the reed beds with other units (such as sedimentation tank outlet pipes or effluent recycle outlet channels) shall be maintained clean, neat and in a perfect functional condition.

The regular maintenance of reed bed walls with regard to erosion and the removal of bushes and trees from the walls shall form part of the maintenance work.

Remuneration for the maintenance of reed beds shall be included in the tendered rate for ten points for maintenance of the installation of which reed beds form part.

Installations shall be as defined in Additional Specification SA: General Maintenance, and on the mechanical flow diagram.

EQ06      **MEASUREMENT AND PAYMENT**EQ.01      **DIYE\_RSIQN OE FLOW\_B\_EIWEEN COMPONENTS BYI**

- a) Pumping effluent ..... Unit: m<sup>3</sup>
- b) Constructing temporary pipe lines and channels ..... Unit: m

The unit of measurement shall be the cubic metres of effluent pumped and the length of pipe lines and channels constructed.

The tendered rates shall include full compensation for all labour, machinery, tools, pumping equipment and transport necessary for the diversion of the effluent. The tendered rate shall include the provisioning and installation of a suitable water meter (accuracy 1m<sup>3</sup>) to determine the volume of effluent pumped.

EQ.02      **REPAIR AND RECONDITIONING OF REED BED CONCRETE STRUCTURES**

..... Unit: number

The unit of measurement shall be the number of specified units of reed bed concrete structures to be reconditioned/ repaired.

The tendered rates shall include full compensation for all components, materials, tools, transport, site handling and labour necessary for the complete reconditioning/repair of reed bed units in compliance with Clause EH 04.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

EQ.03      **SUPPLY, INSTALLATION AND CONSTRUCTION OF REED BED OVERFLOW AND BY-PASS STRUCTURES/PIPE SLUICES AND SLUICE FRAMES**

Sluice gates and frames, gate valves, weirs, T-pieces, Bell mouth inlets and couplings ..... Unit: number

Over flow pipes and by-pass pipe lines ..... Unit: metre

The unit of measurement shall be the number of overflow structures constructed, sluice gates and sluice frames supplied and installed. For pipe installations the unit of measurement shall be the meters of pipe installed.

The tendered rates shall include full compensation for the site handling and positioning of the equipment, including the fastening of the equipment in its designated position. The following shall also be included in the tendered rates:

- (a) Installation of the sluice gates, pipes and frames;
- (b) Overflow weirs constructed
- (c) All required installation materials, labour and consumables to render a complete and working installation.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

**EQ.04 REMOVE VEGETATION AND MOWING OF EARTH WALLS.**

..... Unit: m<sup>2</sup>

The unit of measurement shall be the area cleared of vegetation.

The tendered rates shall include full compensation for all labour, machinery, tools, and transport necessary to remove the vegetation (shrubs, bushes and trees) from the pond walls and to cut the natural grass and to dispose of it at an authorised solid waste disposal site. Any damage to the structure of the earth walls shall be repaired and the cost shall be for the contractor.

**EQ.05 REHABILITATION AND SHAPING OF EARTH WALLS.**

..... Unit: m<sup>2</sup>

The unit of measurement shall be the area ripped, shaped and compacted.

The tendered rates shall include full compensation for all labour, machinery, tools, and transport necessary to import spoilt material stored on site within free haul distance rip, shape and compact the pond walls and floor..

**EQ.06 SUPPLY AND INSTALLATION OF HDPE LINING IN REED BEDS**

..... Unit: m<sup>2</sup>

The unit of measurement shall be for the supply and installation of HDPE lining to line the specified area to render the pond a water tight structure.

The tendered rates shall include full compensation for the site handling and labour for the positioning of the lining, including the joining and sealing of the lining in its position at the over flow weirs as well as to anchor the lining at the top of the embankment. .

The joints shall be water tight.

All required installation materials, labour and consumables to render a complete and working installation shall be included in the tendered rate.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.



## TECHNICAL SPECIFICATIONS

### FD            HEATING VENTILATION AND AIRCONDITIONING SYSTEMS

#### CONTENTS

FD 01	SCOPE
FD02	STANDARD SPECIFICATIONS
FD03	VARIATIONS AND ADDITIONS TO STANDARD SPECIFICATIONS
FD04	AS-BUILT INFORMATION AND OPERATING AND MAINTENANCE MANUALS
FD05	TRAINING OF OPERATIONS FOR THE OPERATION OF THE INSTALLATION AND EQUIPMENT
FD 06	LOGGING AND RECORDING PROCEDURES
FD07	TESTS AND INSPECTIONS ON COMPLETION OF REPAIR WORK
FD 08	QUALITY ASSURANCE SYSTEM
FD09	COMMISSIONING AND RECOMMISSIONING OF PLANT AND INSTALLATION
FD10	GUARANTEE OF INSTALLATION AND EQUIPMENT
FD 11	MAINTENANCE TOOLS AND SPARES
FD12	REPAIR WORK TO INSTALLATION SYSTEMS AND EQUIPMENT
FD 13	MAINTENANCE TO INSTALLATION AND EQUIPMENT

#### FD 01            SCOPE

This specification covers the general repair and maintenance of heating, ventilation and air-conditioning systems, which include the following:

- (a) Room air-conditioning units with air cooled condensers
- (b) Refrigeration pipework
- (c) Fans and attenuators
- (d) Electric motors
- (e) Air filters
- (f) Duct work
- (g) Air terminals
- (h) Noise and vibration
- (i) Painting and cleaning
- (k) Labelling and identification.

This specification shall form an integral part of the repair and maintenance contract document, and shall be read in conjunction with the additional and particular specifications compiled as part of this document.

This specification shall act as a guideline to the Particular Specification and, in the event of any discrepancies between the Technical Specification and the Particular Specification, the latter shall take precedence.

The Contractor shall at all times adhere to this specification, unless otherwise specified in the Particular Specification.

**FD02      STANDARD SPECIFICATIONS****FD 02.01      GENERAL STANDARD SPECIFICATIONS, REGULATIONS AND CODES**

The latest edition, including all amendments up to date of tender of the following specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

**FD 02.01.01      SABS and other specifications and codes**

<b>SASS 046</b>	Copper tube manufacturing code of practice
<b>SASS 0400</b>	The applications of building regulations
<b>SASS 0103</b>	The measurement and rating of environmental noise with respect to annoyance and speech communication
<b>SASS 0139</b>	The prevention, automatic detection and extinguishing of fire in buildings
<b>SASS 0140</b>	Identification colour marketing
<b>SASS 0142-1</b>	Code of practice for the wiring of premises
<b>SASS 0147</b>	Refrigerating systems, including plants associated with air-conditioning systems
<b>SASS 0173</b>	Installation, testing and balancing of duct work
<b>SASS 630</b>	Decorative high-gloss enamel paint for interior and exterior
<b>SASS 763</b>	General coating thickness
<b>SASS 1238</b>	HVAC duct construction standards
<b>Act 103</b>	National Building Regulations and Building Standard Act, 1977 (Act No 103 of 1977) as amended

**FD 02.01.02      Department of Public Works Specifications**

<b>OWG 371</b>	Specification of materials and methods to be used
<b>STD.PWD.VIII -</b>	Standard specification for refrigeration services

**FD 02.01.03      Occupational Health and Safety Act of 1993**

All regulations and statutory requirements as laid down in the latest edition of the Occupational Health and Safety Act of 1993: Construction Regulations, 2003 as promulgated in Government Gazette No 25207 and Regulation Gazette No 7721 of 18 July 2003 shall be adhered to.

**FD 02.01.04      Manufacturers' specifications, codes of practice and installation instructions**

All equipment and materials shall be installed, serviced and repaired strictly in accordance with the manufacturers' specifications, instructions and codes of practice.

**FD 02.01.05      Municipal regulations, laws and by-laws**

All municipal regulations, laws, by-laws and special requirements of the Local Authority shall be adhered to unless otherwise specified.

**FD 03      VARIATIONS AND ADDITIONS TO STANDARD SPECIFICATIONS**

The following additional general specifications and requirements shall be read in conjunction with this specification and shall be adhered to unless otherwise specified in the Particular Specification.

## FD 03.01

**GENERAL REPAIR AND INSTALLATION REQUIREMENTS**

- (a) All materials and equipment supplied and installed shall be of new high quality, design and manufactured to the relevant specifications, suitable for providing efficient, reliable and trouble-free service.
- (b) All work shall be executed in a first-class workman-like manner by qualified tradesmen.
- (c) All equipment, component parts, fittings and materials supplied and/or installed, shall conform in respect of quality, manufacture, test and performance to the requirements of the applicable current SABS specifications and codes, except where otherwise specified or approved by the Engineer in writing.
- (d) All materials and workmanship which, in the opinion of the Engineer, is inferior to that specified for the work will be condemned. All condemned material and workmanship shall be replaced or rectified as directed and approved by the Engineer.
- (e) The Contractor shall submit a detailed list of the equipment and material to be used to the Engineer for approval before placing orders or commencing installation.
- (f) All new equipment, materials and systems shall be installed and positioned such as to not impede on access routes, entrances and other services. The Contractor shall coordinate these items taking other services and equipment into account.
- (g) All control equipment and serviceable items shall be installed and positioned such that they will be accessible and maintainable.
- (h) The Contractor shall make sure that all safety regulations and measures are applied and enforced during the repair and construction periods to ensure the safety of the public and User Client.
- (i) Repair work shall be programmed in accordance with Additional Specification SC: General Decommissioning, Testing and Commissioning Procedures, to ensure the shortest possible down-time of any service and the least inconvenience to the User Client and public. The Contractor shall make sure that the necessary notifications and notices are timeously put into place for these activities.

## FD 03.02

**TESTING OF REFRIGERATION PIPING AND EQUIPMENT**

- (a) All new refrigerant pipe installations shall be thoroughly tested to be sure that they are absolutely tight. Nitrogen must be used to pressure test the system at 1,5 times the working pressure. A pressure-reducing valve must be used to set the test pressure. A leak test must be carried out on the entire system.
- (b) All new refrigerant pipe installations shall be vacuum pumped by means of a suitable vacuum-pump. An absolute pressure of 2500 micron must be reached. Allow the system to stand under vacuum for a minimum of 12 hours. If no noticeable rise in pressure has taken place after 12 hours, the system may be charged.
- (c) The dryness of the refrigeration system shall be indicated by an approved moisture indicator.
- (d) Should moisture be present, the system shall be leak tested and the leak repaired. Should no leak be present, the system shall be flushed with dry nitrogen and vacuum pumped again as described above.

- (e) If the completed system complies with all the Specifications and passes the test and inspection, it can be approved and the Contractor may be instructed to recharge the system with the correct refrigerant and refrigerant charge.
- (f) Under no circumstances shall the refrigerant piping/installation be purged.

#### FD 03.03 REFRIGERANTS

- (a) No CFC refrigerant shall be used in new installations.
- (b) Equipment still running on CFC shall be maintained until such time that a leak occurs or the system has to be decanted. The system shall then be converted to a compatible HCFC or HFC as described in the Montreal Protocol and recommended by the compressor manufacturer.
- (c) Any CFC refrigerant that has to be discharged, shall be decanted by means of an approved reclaiming system, and not discharged to the atmosphere. Should the Contractor not comply with this requirement, full action shall be taken contractually and statutory against him.
- (d) Any refrigeration system not supplied with three-way service valves, shall be provided with Schreuder type service valves. These valves shall be installed on both suction and discharge lines of the compressors. Tap-o-line valves shall not be fitted or used on the systems.
- (e) In the event of an electrical motor burn-out in a hermetic or semi-hermetic compressor, a burn-out drier shall be used. Purging only is prohibited. The burn-out drier shall be installed and removed as per the manufacturer's instructions.
- (f) No synthetic components or solutions shall be used to repair leaks in refrigeration piping, on coils or evaporators. Only approved gas welding shall be used. Should the leak be of such nature that repair is not possible, the item should be replaced.

#### FD 03.04 FANS AND ATTENUATORS

##### FD 03.04.01 General

- (a) Requirements under this heading apply to fans that are not integral parts of complete units supplied by recognised suppliers. Selected fans shall be such that the operating point is as close as possible to maximum efficiency.
- (b) Fan motors selected must be capable of supplying not less than 10 % above the specified air quantity without overloading.
- (c) The system resistance must be calculated and the fan selected to meet the required static pressure, taking into consideration the site altitude, system air temperature and air density at which the system duty shall be met. The selection must be submitted to the Engineer for approval before ordering the equipment.
- (d) Belt drives shall be designed for a minimum overload of 25 % and not less than two matched belts may be used. Belts shall be selected and installed according to BS 790.
- (e) Pulleys shall be of the adjustable speed taper-lock type and shall be accurately keyed to the shafts and aligned before the system is put into operation.

- (f) Belt guards shall be supplied in accordance with Occupational Health and Safety Act, No 85 of 1993. The guards shall have an expanded metal front and shall allow oiling and the use of a tachometer without removal of the guard.
- (g) Bearings shall be selected for a minimum life expectancy of 200 000 hours at the given duty.
- (h) Lubrication points shall be readily accessible and shall be extended to the outside to permit lubrication without removal of the fan. Fan shafts shall be suitably protected from rust and corrosion.

#### FD 03.04.02 Axial flow fans

- (a) Axial flow fans shall be in-line direct-driven type with the motor mounted inside the fan housing.
- (b) Fans shall be of the multi-bladed aerofoil type of a non-ferrous construction. The number of blades vary according to the application. The fans shall be provided with adjustable blade pitch indexed to permit field adjustment.
- (c) Fan casings shall be constructed of hot-dip galvanized mild steel with a minimum thickness of 3 mm and mild steel galvanized flanges on each side drilled for connections to matching flanges on ducting.

#### FD 03.04.03 Sound JlttenuatQJ'S

- (a) Sound attenuators shall be installed in the positions indicated on the drawings and shall be selected to provide the noise criteria levels as specified. All sound attenuators shall be products of an accredited manufacturer who publishes selection data on these products. Data shall be submitted to the Engineer for approval before ordering.
- (b) Metalwork shall be galvanized steel and acoustic insulation shall be non-combustible material, properly bonded and covered so as not to permit particles to be eroded by air moving over it.
- (c) Sound absorbing lining material shall have a density not less than 48 kg/m<sup>3</sup> and thickness of not less than 50 mm.

#### FD 03.05 **CANOPIES AND GREASE ELIMINATORS**

- (a) Kitchen canopies shall be connected to the extract fan by means of cuts of which the joints and seams are of the welded or soldered construction and shall be watertight. Cleaning openings shall be provided at such intervals on the ducting that the inside of the ducting can be reached for cleaning purposes. The fan shall be provided with a cleaning access door, as well as a drain point at the bottom.
- (b) Fire dampers, operated with fusible links, shall be provided in each air outlet connection and shall form an integral part of the canopy construction.
- (c) Lights shall be fitted into the canopy by the manufacturer. Access to the tube for tube replacement shall be through the face of the fittings without the use of tools.
- (d) Grease filters shall contain a series of vertical baffles to change the direction of the air flow and efficiently divert grease particles out of the air stream by centrifugal action. Each filter bank shall contain a condensate trough and removable grease storage container.

**FD 03.06 ELECTRIC MOTORS**

- (a) All electric motors shall be of one make, unless integral with the equipment, and shall not operate in excess of 1500 r/min unless previously approved by the Engineer for specific reasons. Motors, unless otherwise specified, shall be 380 volt, three-phase, 50 hertz for all sizes from and including 0,37 kW upwards. Smaller motors may be 220 volt, single-phase, 50 hertz.
- (b) All motors shall be totally enclosed, fan-cooled and have metric frame dimensions. Motors shall be quiet in operation to the full acceptance of the Engineer.
- (c) Three-phase motors shall all be squirrel cage induction type, special high torque motors being used on high inertia loads such as centrifugal fans, where otherwise excessively large motors, necessary to overcome driven equipment inertia, cause operation BHP to be less than 70 % of motor nameplate kW.
- (d) Starting methods for three-phase motors shall be as follows:
 

Motors up to 5,5 kW	DOL
Above 5,5 kW	Star-delta started, provided that the starting current does not exceed three times the full load amps.
- (e) Single-phase motors shall be capacitor started, induction run type with built-in manual reset overload protection.
- (f) Nameplate rating of electric motors shall be at least 15 % larger than the required driven equipment brake drive losses duly accounted for, on motors below 15 kW. On larger motors a 10 % margin shall suffice.
- (g) All switch panels shall have a phase failure and low voltage protection with automatic reset adjustable to a maximum period of 10 minutes.

**FD 03.07 DUCTWORK**

- (a) This specification covers the air distribution system as shown on the drawings. Duct work shall be manufactured in accordance with the standard specification for air-conditioning duct work, SASS 1238. Duct work shall be erected in accordance with the code of practice for the installation, testing and balancing of duct work, SASS O173.
- (b) Fittings such as elbows, parallel flow branches, branch connections, off-sets and transitions shall be manufactured and installed in accordance with the SMACNA standards.
- (c) All ducting shall be sufficiently airtight to ensure economical and quiet performance of the system, and joints shall be suitably sealed in accordance with the relevant SMACNA standard with suitable non-combustible filler compound.
- (d) The Contractor shall provide all hangers and supports which are to be hot-dip galvanized after fabrication to SASS 193. No explosive fasteners to the building structure shall be allowed, only approved expanding bolts or clamps are permissible.
- (e) The duct work shall be connected to the air terminals by means of flexible ducting. Flexible ducting shall be coated fibreglass fabric with a mineral base. Flexible ducting shall be installed with "easy" bends of not less than one duct diameter centre line and shall be supported to SMACNA specification to ensure

that the ducting does not kink. The length of the flexible duct shall be kept to a minimum and shall not exceed lengths of 1200 mm.

#### FD 03.08 AIR TERMINALS

- (a) Air distribution shall be effected by means of the supply air grilles as indicated on the drawing. The finish of the grilles shall be epoxy powder-coated, the colour of which shall be advised and approved by the Engineer. Supply air grilles shall be of the double deflection type, consisting of two rows of individually adjustable aerofoil section vanes, front vanes horizontal rear vanes vertical, all vanes housed in a surrounding fixing flange with neat mitred joints in the corner.
- (b) Supply air grilles shall be of steel construction and shall be provided with burglar bars. The inner section will be only accessible from above and the face plate of the grille is fixed from above. No screws or fixing devices are accessible from below.
- (c) Supply grilles are supplied with a plenum box with spigot and connected to the spigot on the ducting by means of flexible ducting.
- (d) Transfer grilles shall be of steel construction and be provided with burglar bars. Standard door grilles may be installed with a burglar bar assembly in between.

#### FD 03.09 AIR FILTERS

##### FD 03.09.01 General

- (a) Provide and install air filters in the positions as indicated on the drawings.
- (b) Filters shall be standard products of a reputable manufacturer regularly engaged in the manufacture of the particular filter. The manufacturer shall submit evidence to the satisfaction of the Engineer that the filters have been tested by an independent authority and that they meet the minimum arrestance, efficiency and dust holding capacity.
- (c) Filters shall be tested in accordance with ASHRAE test standard 52 - 76.
- (d) A Megnahelic gauge calibrated from zero to 500 Pa shall be installed, connected with copper tubing to static pressure taps complete with isolating valves.

##### FD 03.09.02 Primary filters

- (a) Primary filters shall, unless otherwise stated, be washable on woven polyester material, pleated to provide an extended surface with a dust spot efficiency of minimum 40 % and an arrestance of 85 %.
- (b) Media shall be firmly held in place by rustproof wire screens to maintain pleat strength and spacing.
- (c) Media and support screens shall be continuously bonded into aluminium support.
- (d) Frames shall be folded to form a robust media support frame. The bonding between media and frame shall be continuous to prevent leakage.
- (e) Each filter shall be provided with a factory made holding frame, constructed of not less than 1,0 mm thick galvanized mild steel provided with suitable seals and quick release spring type clips to securely hold the filter cell in place without permitting leakage of air.



- (f) The holding frames of multiple cell filter banks shall be suitably joined and sealed so as to prevent leakage of air between the frames.

#### FD 03.10 LABELLING AND IDENTIFICATION

All equipment shall be labelled and identified using black Traffolite labels with 10 mm high white lettering on the labels. Labels will be secured using epoxy base glue.

The identification number used on these labels shall correspond with the equipment number on the complete inventory list.

#### FD 03.11 NOISE AND VIBRATION

- (a) Particular care shall be taken in the selection, application and installation of all equipment used to ensure that the equipment will operate below the required noise level for public areas of NC 35 and with the least vibration possible, all to the satisfaction of the Engineer.
- (b) Equipment shall be mounted on vibration isolators of the correct type and selection depending on deflection requirement and vibrating frequency.
- (c) Anti-vibration connections shall be used on duct work where it joins vibrating equipment such as fans and air-conditioning units.
- (d) Suitable sound attenuating devices shall be incorporated within the duct work to reduce airborne noise to acceptable levels as specified.
- (e) The subcontractor shall provide sound level data to the Engineer on the completion of the installation detailing the noise levels in NC level for each separate area. No measurement shall be taken closer than 1 metre from any outlet.

#### FD 03.12 PAINTING AND CLEANING

- (a) No untreated metal surfaces shall be allowed on the project. Items which are not galvanized or similarly protected against rust and corrosion shall be painted as detailed below. No equipment, hangers, brackets, etc, shall be delivered to site in unprotected condition; they shall be factory coated with an approved zinc-rich prime coat before being despatched.
- (b) Painting shall comprise the following consecutive processes. Thoroughly clean, descale and degrease all surfaces, apply one coat of approved zinc-rich primer and one coat of universal undercoat, and finish off with two coats of quality high-gloss enamel. Final finish shall be to the full approval of the Engineer.
- (c) Items with galvanized finish, such as cable trays, need not be painted but shall be properly cleaned with suitable galvanized iron cleaning fluid. Where galvanized finish is painted, it shall be primed with a calcium plumbate primer.
- (d) It is not a requirement to paint duct work, conduits or pipework installed in roof voids and shafts, where they are not visible, if they are galvanized. Items as mentioned above shall be properly cleaned and painted as specified above.
- (e) Visible sections of the inside of ducting through grilles shall be painted matt black after degreasing and priming as specified above.
- (f) Plant and equipment shall be painted with the relevant colour in accordance with SABS.



**FD 03.13 SELF-CONTAINED AIR-CONDITIONING UNITS**

- (a) The self-contained packaged unit shall be a fully catalogued product and documentation shall include performance curves and selection tables.
- (b) Self-contained room air-conditioning units consist of unit casing, compressor, evaporator and fan, condenser and fan, refrigerant pipework with expansion device and the relevant controls. The condenser unit shall form an integral part of the unit or be separate for split applications.
- (c) Unit casings shall be of sheet metal construction with a baked enamel finish to give a corrosion resistance. Units shall be suitably insulated to ensure quiet operation.
- (d) Evaporator fans shall be of the double inlet centrifugal type with integral motor or belt-driven. The fan assembly shall be isolated from the unit by means of rubber mounts and the unit shall operate without vibration.
- (e) Condensate trays shall be manufactured of non-corrosive materials and shall be insulated and condensate shall be piped to the nearest drain point.
- (f) Washable WP 77 filters shall be provided and installed behind the inlet grille and shall be easily removable.
- (g) Compressors shall be of the hermetically sealed dome type with crankcase heaters and suitable vibration isolators.
- (h) Condenser coils shall be copper tubes with aluminium fins for inland use. Condenser fans shall be propeller fans or of the centrifugal type.
- (i) Refrigerant piping shall be installed and repaired as specified in FD 03.

**FD04 AS-BUILT INFORMATION P&ID OPEBATING AND MAINTENANCE MANUALS**

The Contractor shall be responsible for the compilation of an inventory list and operating and maintenance manuals and system data sheets.

This shall be done in accordance with Additional Specification SB: Operating and Maintenance Manuals.

The Contractor shall allow for the required equipment and facilities to establish the correct as-built information.

All information shall be recorded and reproduced in electronic format, as well as three sets of hard copies to be supplied to the Department.

Over and above what is specified in Additional Specification SB: Operating and Maintenance Manuals, the operating and maintenance manual to be compiled shall be structured to include at least the following:

- (a) System description  
Complete system description and the working of the plant.
- (b) Commissioning data  
Complete commissioning, test and inspection data of plant.
- (c) Operating data

- (i) Plant running check list and frequency of servicing required;
  - (ii) Safety precautions to be implemented;
  - (iii) Manual and automatic operation;
  - (iv) Maintenance duties and logging required;
  - (v) Lubricating oils and service instructions;
  - (vi) Pre-start checklist for each system;
  - (vii) Starting and stopping procedures.
- (d) Mechanical equipment
- (i) Description of all major items with the make, model number, names, addresses and telephone numbers of the suppliers, manufacturers or their agents;
  - (ii) Design capacities of all equipment, including selection parameters, selection curves, capacity tables, etc;
  - (iii) Manufacturers' brochures and pamphlets;
  - (iv) Schedule of spares with part numbers recommended to be held as stock.
- (e) Maintenance instructions
- (i) Schedule of maintenance particulars, frequency of services and replacements;
  - (ii) Trouble-shooting guide;
  - (iii) Part number of all replacement items and spares;
  - (iv) Capacity curves of pumps, fans and compressors;
  - (v) Serial numbers of all items of equipment.
- (f) Electrical equipment
- (i) Schedule of equipment, indicating manufacturer, type, model number, capacity and addresses and telephone numbers of suppliers;
  - (ii) Maintenance instructions;
  - (iii) Manufacturers' brochures and pamphlets;
  - (iv) Complete as-built circuit diagrams and diagrammatic representation of interconnections of all electrical equipment.
- (g) Instrumentation and control
- (i) Description of each control system;
  - (ii) Schedule of control equipment indicating manufacturer, type, model number, capacity and addresses and telephone numbers of suppliers;
  - (iii) Maintenance instructions;
  - (iv) Manufacturers' brochures and pamphlets.
- (h) Drawings
- (i) Paper prints of all as-built mechanical and electrical drawings;
  - (ii) Wiring diagrams framed behind glass shall be mounted adjacent to each relevant control panel.

## **FOOS      LOGGING AND RECORDING PROCEDURES**

The Contractor shall under this repair and maintenance contract institute a logging and recording system as part of his maintenance control plan as defined in Additional Specification SA: General Maintenance. This shall consist of a log and record book which shall be utilised to log and record all operations, faults, system checks, breakdowns, maintenance visits, inspections, etc.

The logbook shall be kept in a safe place at the maintenance section and shall only be utilised by the boiler house supervisor, the Contractor and the Engineer. A copy of the monthly entries and recordings into this logbook shall be submitted by the Contractor together with this monthly report to the Engineer.

The logbook shall be structured to include at least the following:

- (i) Daily inspection and maintenance actions;
- (ii) Monthly inspection and maintenance actions;
- (iii) Six-monthly inspection and maintenance actions;
- (iv) Breakdown reports.

The Contractor shall also institute an attendance register, which shall be kept in a safe place at the maintenance section. This register shall be completed by all persons visiting the relevant plants, including:

- (a) Contractor and maintenance personnel;
- (b) Inspectors;
- (c) User Client and associates;
- (d) Engineer.

This register shall state the date, time-in, time-out, name, company and reason for visit. A copy of the register shall be submitted by the Contractor together with his monthly report.

On completion of repair work and/or the installation of new equipment the plant and equipment shall be put into operation after all tests and adjustments have been carried out to the satisfaction of the Engineer. Where new plant is installed the Contractor shall run and operate the system for a period of time specified by the Engineer and train the staff of the User Client to operate and maintain the system. This operation shall be done strictly in accordance with Clause SC 11 of the Additional Specification SC: General Decommissioning, Testing and Commissioning Procedures.

Logging of the operation of the installations shall commence immediately upon start-up.

The Contractor shall submit a full commissioning report as per attached commissioning data sheet.

## **FOOS TESTS AND INSPECTIONS ON COMPLETION OF REPAIR WORK**

On completion of repair work the Contractor shall prior to recommissioning test the plant and its equipment. This operation shall be done strictly in accordance with Clause SC 08 of Additional Specification SC: General Decommissioning, Testing and Commissioning Procedures.

Except where otherwise provided in the Contract, the Contractor shall provide labour, materials, power, fuel, accessories and properly calibrated and certified instruments necessary for carrying out such tests. Arrangements for these tests shall be made by the Contractor and he shall give at least 72 hours written notice to the Engineer before commencing the test.

In the event of the plant or installation not passing the test, the Employer shall be at liberty to deduct from the Contract amount all reasonable expenses incurred by the Employer or the Engineer attending the repeated test.

Whenever any installation or equipment is to be operated for testing or adjusting as provided for above, the Contractor shall operate the entire system for as long a period as may be required to prove satisfactory performance at all times in the occupied space served by that system for up to twenty-four hours a day continuously until the certificate of practical completion of repair work is handed over.

The Contractor shall provide all labour and supervision required for such operation and the Department may assign staff as observers, but such observation time shall not be counted as instruction time.

After complete installation of the system all equipment shall be tested, adjusted and readjusted until it operates to the satisfaction and approval of the Engineer.

The Contractor shall submit certificates of tests carried out to prove the performance of all equipment, as well as certificates obtained from all the relevant authorities and statutory bodies, etc.

The Contractor shall only utilise Departmental approved inspection authorities for all inspections and tests to be conducted. This will be done and approved in writing among the relevant parties.

**FD 07**      **QUALITY ASSURANCE SYSTEM**

The Contractor shall institute an approved quality assurance (QA) system, which shall be submitted to the Engineer for his approval. The records of this QA system shall be kept throughout the duration of the Contract and be submitted to the Engineer at regular intervals as required.

**FD0S**      **COMMISSIONING AND RECOMMISSIONING OF PLANT AND INSTALLATION**

**FD 08.01**      **GENERAL**

On completion of repair work and/or the installation of new equipment the plant and equipment shall be put into operation after all tests and adjustments have been carried out to the satisfaction of the Engineer. Where new plant is installed the Contractor shall run and operate the system for a period of time as specified by the Engineer and train the staff of the User Client to operate and maintain the system. This operation shall be done strictly in accordance with Clause SC 11 of Additional Specification SC: General Decommissioning, Testing and Commissioning Procedures.

Logging of the operation of the installations shall commence immediately upon start-up.

The Contractor shall submit a full commissioning report as per attached commissioning data sheet.

**FD 08.02**      **RECOMMISSIONING OF PLANT AND ANCILLARY EQUIPMENT**

On completion of repair work the Contractor shall recommission the plant and its equipment. This operation shall be done strictly in accordance with Clause SC 11 of Additional Specification SC: General Decommissioning, Testing and Commissioning Procedures. This operation shall also be carried out strictly in accordance with the manufacturer's specification and shall be witnessed by the Engineer.

Recommissioning checks to be carried out shall be categorised under the following headings:

- (a) Mechanical checks
- (b) Electrical and control checks.

On completion of repair work the Contractor shall recommission the plant and its ancillary equipment. This operation shall be done strictly in accordance with the manufacturer's specification and shall be witnessed by the Engineer. This shall include but not be limited to the following:

- (a) All required recommissioning mechanical checks
  - (i) Check system for leaks;
  - (ii) Check rotation of all fans;
  - (iii) Check mountings of all equipment.
- (b) All required recommissioning electrical and control checks
  - (i) Check all wiring connections for tightness and repair any hot connections.
  - (ii) Check that all electrical equipment have been properly reconnected in accordance with the manufacturer's specification.
  - (iii) Perform and record all required electrical insulation tests on equipment.
  - (iv) Check and test all controls with main circuits isolated.
  - (v) Check all motor-driven equipment for correct rotational directions.
  - (vi) Check and test the operation of all indication and warning lights.
  - (vii) Check, set, record and readjust all equipment control and set points in accordance with manufacturer's specification.
  - (viii) Run all motor-driven equipment for a period to ensure free movement and correct operation, feed pumps only to be operated for a short interval to check rotation.

#### **FD 08.03 COMMISSIONING AND\_COMPLETION\_Of\_BEPAIRS**

On completion of the recommissioning checks the Contractor shall proceed with the commissioning. This operation shall be done strictly in accordance with Clause SC 11.02 of Additional Specification SC: General Decommissioning, Testing and Commissioning Procedures. This operation shall also be carried out in accordance with the manufacturer's specification and shall include but not be limited to the following for the different types of equipment:

##### **FD 08.03.01 Air-conditioning unit**

- (a) Check evaporator and condenser pressures and superheat.
- (b) If the unit needs charging, find leak, decant, repair leak and recharge unit.
- (c) Check fans, fan speed control and fan motors.
- (d) Check entering and leaving air temperatures over evaporator coil.
- (e) Check operation of all safeties:
  - (i) LP cut-out pressure
  - (ii) HP cut-out pressure
  - (iii) Low on-coil thermostat
  - (iv) Set point of oil pressure safety
  - (v) Oil pressure trip.
- (f) Check anti-recycle timer.
- (g) Check all running amps of fans and compressors.
- (h) Check compressor unloading mechanism if applicable.
- (i) Complete commissioning data sheet.

**FD 09      GUARANTEE OF INSTALLATION AND EQUIPMENT**

The Contractor shall provide and obtain guarantees from the manufacturer(s) and/or supplier(s) to the effect that each piece of new equipment, supplied and installed under the repair contract, will comply with the required performance and will function as part of the complete system.

All new equipment, including the complete new installations and the systems as a whole, shall be guaranteed for a period of 12 (twelve) months commencing on the day of issue of a certificate of completion for repair work of the installation.

**FD 10      REPAIR WORK TO INSTALLATION S YSTEMS AND EQUIPMENT****FD 10.01      GENERAL**

At the start of the repair and maintenance contract all the systems, installations and equipment shall be repaired as specified in the Particular Specification. This repair work shall include but not be limited to the specified Particular Specification details.

All repair work shall be executed using approved materials and equipment suitable to the systems and/or installations they serve. The said repair work shall be executed in accordance with the relevant codes of practice, standard, regulations, municipal laws and by-laws, manufacturer's specifications and codes of practice and all additional and particular specifications included in this document.

The repair work items shall be listed in tabular form in the Particular Specification with all relevant details, such as capacity, size, manufacturer, model number, etc.

All repair work shall be executed within the approved period for repairs to be agreed at the start of the Contract period. All new equipment, materials and systems shall be furnished with a written guarantee of a defects liability period of 12 months from date of issue of a certificate for completion of the repair work. These guarantees shall be furnished in favour of the Department of Public Works. On completion of the required and specified repair work the systems, installations and equipment shall be commissioned and handed over to the satisfaction of the Engineer.

Repair work items shall be categorised for the following installations:

- (a) Self-contained air-conditioning units.

**FD 10.02      AIR-CONDITIONING UNITS**

- (a) Clean air intake screen.
- (b) Replace filters.
- (c) De-rust, neutralise and touch up paintwork.
- (d) Replace canvas collars.
- (e) Clean housing, ensure all panels are properly secured and door panels close properly.
- (f) Check setting and operation of all pressure switches, reset if required.
- (g) Check setting and operation of all safety switches, ie LP and HP switches, oil pressure switch.
- (h) Check setting and operation of thermostats.
- (i) Check timers and reset if required.
- U) Check operation of seven-day timer.
- (k) Check running current of fans and compressor and settings and operation of overloads.
- (l) Check tightness of all electrical terminals.

- (m) Ensure operation of local and remote isolators.
- (n) Check condition of all cables and whether cables are neatly strapped and reposition and strap if required.
- (o) Ensure correct operation of emergency stop.
- (p) Carry out a leak test on all refrigeration piping and components inclusive of evaporator and condenser.
- (q) All leaks shall be repaired. Should a leak on a component be of such a nature that it cannot be repaired, the component shall be replaced. The procedure to follow is as set out in FD 03.
- (r) The superheat setting of the thermostatic expansion valve shall be checked and adjusted if required (setting approximately 8 °C).
- (s) The filter dryer shall be replaced.
- (t) Check compressor vibration mounts.
- (u) Test oil acidity.
- (v) Check refrigerant charge sight glass being clear or flashing.
- (w) Check moisture indication being dry.
- (x) Clean condensate tray and test drainage operation.
- (y) Clean evaporator and condenser blades and check unbalance.
- (z) Replace suction line insulation.
- (aa) Check all service valves for full operation, replace caps if missing.

## **FD 11 MAINTENANCE TO INSTALLATION AND EQUIPMENT**

### **FD 11.01 GENERAL**

Monthly maintenance responsibilities for each installation including all units and components as specified, shall commence with commencement of the Contract. A difference shall be made in payment for the maintenance prior to and after practical completion of repair work.

Maintenance responsibilities of the completed installation shall commence upon the issue of a certificate of practical completion for repair work, and shall continue for the remainder of the 36-month contract period.

This part of the Contract shall include:

- (a) Routine preventative maintenance;
- (b) Corrective maintenance; and
- (c) Breakdown maintenance;
- (d) Cleaning of filters,

as defined in Additional Specification SA: General Maintenance, for the specified installations described under FD 01 of this specification.

The maintenance work to be performed and executed shall be done strictly in accordance with Additional Specification SA: General Maintenance, and as specified in Particular Specification PFD and this specification.

The said maintenance work shall be executed in accordance with the relevant codes of practice, statutory regulations, standards, regulations, municipal laws and by-laws and the manufacturers' specifications and codes of practice.

The maintenance schedules and frequency shall be developed under the maintenance control plan to be instituted by the Contractor, as specified in Additional Specification SA: General Maintenance.

All new equipment, components and materials supplied and installed under the maintenance contract shall be furnished with prescribed manufacturer's guarantees.



## FD.1

The maintenance work and items are to be categorised by the Contractor for each maintenance activity under the following headings:

- (a) Self-contained air-conditioning units.

The Contractor shall be remunerated monthly, based on his performance, for maintaining the complete installation in a perfect functional condition.

### FD 11.02 **DEFINITION AND QUALIFICATION OF ACTIONS**

#### FD 11.02.01 **Daily\_ maintenance actions**

Daily actions are the responsibility of the User Client. These checks are to be performed by staff responsible of the facility. The self-contained air-conditioning units and ventilation systems should run during working hours and/or continuously. The status of these systems can thus be monitored by observation on a daily routine.

- (a) Air-conditioning units:

- Does the unit perform and maintain temperature?
- Is the temperature in the areas concerned satisfactory?
- Is the condensate drain working properly?

These daily checks shall be logged at the facility, ie by the kitchen manager and the maintenance personnel.

#### FD 11.02.02 **Monthly maintenance actions**

TABLE FD 11.02.02/1: AIR-CONDITIONING UNIT

REFERENCE NUMBER	ACTION
S-1	Clean filters, replace if required
S-2	Inspect air intake and discharge for blockages
S-3	Check all refrigerant, drainage pipes for damaged and leaks
S-4	Check sightglass: clear or flash gas
S-5	Carry out visual inspection of condenser coil for blockages and correct operation of fans
S-6	Carry out visual inspection of evaporator coil for blockages and correct operation of supply fan
S-7	Check enclosure for damages
S-8	Check electric motor running temperatures
S-9	Check electric connections for tightness
S-10	Test thermostat and control operation
S-11	Clean condensate tray and test drainage for proper operation
S-12	Check cooling and heating cycle

Note: The monthly actions shall include the activities of the daily maintenance actions.



## FD 11.02.03 Annual maintenance actions

TABLE FD 11.02.03/1: AIR-CONDITIONING UNITS

REFERENCE NUMBER	ACTION
S-1	Clean filters, replace if required
S-2	Inspect air intake and discharge for blockages
S-3	Check all refrigerant, drainage pipes for damages and leaks
S-4	Check sight-glass: clear or flash gas
<b>S-5</b>	Carry out visual inspection of condenser coil for blockages and correct operation of fans
<b>S-6</b>	Carry out visual inspection of evaporator coil for blockages and correct operation of supply fan
<b>S-7</b>	Check enclosure for damages
<b>S-8</b>	Check electric motor running temperatures
<b>S-9</b>	Check electric connections for tightness
<b>S-10</b>	Test thermostat and control operation
S-11	Clean condensate tray and test drainage for proper operation
<b>S-12</b>	Check filter/dryer
<b>S-13</b>	Check superheat and functioning of expansion valve
<b>S-14</b>	Check operation of HP and LP switch
<b>S-15</b>	Check operation of controllers
<b>S-16</b>	De-rust, neutralise and touch up paint work
<b>S-17</b>	Check cooling and heating cycle
<b>S-18</b>	Clean evaporator and condenser coil chemically
<b>S-19</b>	Clean all filter frames and seals
<b>S-20</b>	Check fan motor and compressor current
<b>S-21</b>	Check and test overload settings
<b>S-22</b>	Lubricate all bearings

Note: The above annual actions include the activities of the monthly maintenance actions.

## PARTICULAR SPECIFICATIONS

### PFD HEATING VENTILATION AND AIR CONDITIONING SYSTEM

#### CONTENTS

PFD 01	SCOPE
PFD02	GENERAL DESCRIPTION OF INSTALLATIONS
PFD03	TECHNICAL DETAILS OF INSTALLATION
PFD04	DETAILS OF REPAIR WORK
PFD05	DETAILS OF MAINTENANCE WORK

#### **PFD 01** **SCOPE**

- (a) This specification encompasses all aspects regarding the particulars of the repair and maintenance work to the Heating Ventilation and Air-conditioning systems at various Ports of Entry. This particular Specification shall be read in conjunction with the Technical Specification FD: Heating, Ventilation and air-conditioning systems and all additional and technical specifications compiled as part of this document, and in particular the following Additional specifications.

SA: General Maintenance

SB: Operating and Maintenance Manuals

SC: General Decommissioning, Testing and Commissioning Procedures

The intended service, repair and maintenance work to this installation will restore the existing installation to a safe, efficiently functional system that complies with all statutory regulations and applicable standards, in the process repairing all defects and shortfalls. On completion of the repair work, the equipment shall be maintained and serviced by the Contractor for the remainder of the 36-month Contract period.

The installations which have to be repaired and maintained under this Contract includes the following equipment and is referred to as Installation B9, C7, 07 & E6:

- (1) Ninety Seven (97) of existing split, wall and window unit air conditioning units in various buildings at Mahamba Port of Entry
- (2) Twenty Eight (28) of existing split unit air conditioning units at Emahlathini Port of Entry
- (3) Eighteen (18) of existing split unit air conditioning units in various buildings at Bothashoop Port of Entry

**PFD 02 GENERAL DESCRIPTION OF INSTALLATIONS**

The split unit air conditioning units are inside the offices and at the residential area for a cooler working condition for workers, residents, public and the electronic equipment. (Heating detail not provided).

**PFD03 TECHNICAL DETAILS OF INSTALLATION**

At the time of this document the existing installation consisted of the equipment and plant as listed below with their relevant technical detail.

**PFD 03.01 AIR CONDITIONING UNITS:**

<b>Installation ID:</b>	<b>Type 1</b>	<b>Type2</b>	<b>Type3</b>	<b>Type4</b>
<b>Equipment Details</b>	44 of	2 of	66 of	1 of
Manufacturer	<b>LG</b>	<b>LG</b>	<b>LG</b>	Carrier
Type	<b>High Wall Split Unit</b>	<b>High Wall Split Unit</b>	<b>High Wall Split Unit</b>	<b>High Wall Split Unit</b>
<b>Model</b>	<b>LS-T266 CEL LS-NC2665DMO LSUC2665DMO</b>	<b>LST-186ABL HSUC1865DA4 LSNC1865DMO</b>	<b>LS-R126 CEL LS-R126AAL LSUH1264DM</b>	<b>38QCE012708</b>
Cooling ( Btu/h)	<b>26000</b>	<b>18000</b>	<b>12000</b>	<b>12000</b>
Cooling power (Watt)	<b>2700W</b>	<b>1860W</b>	<b>1260W</b>	<b>1260W</b>
Cooling Amps	<b>12.8</b>	<b>9.2</b>	<b>5.8</b>	<b>6.0</b>
<b>Installation ID:</b>	<b>Types</b>	<b>Type6</b>	<b>Type7</b>	<b>Type8</b>
<b>Equipment Details</b>	2 of	4 of	2 of	2 of
Manufacturer	Totaline	Defy Silhouette	TCL	Dunham Bush
Type	High Wall Split Unit	Wall unit	High Wall Split Unit	High Wall Split Unit
Model	AS-09HR4FMC	<b>N/A</b>	TAC-09CHS/E	
Cooling ( Btu/h)	9000	N/A	9000	12000
Cooling power (Watt)	900	<b>N/A</b>	N/A	1260W
Cooling Amps	4.2	<b>N/A</b>	4.2	5.8
<b>Installation ID:</b>	<b>Type9</b>	<b>Type 10</b>	<b>Type 11</b>	<b>Type 12</b>
<b>Equipment Details</b>	16 of	2 of	1 of	2 of
Manufacturer	National/ LG	Shining	LG	LG
Type	Wall unit	KFR-70W	Cassette Unit	Cassette Unit
Model	<b>N/A</b>	N/A		
Cooling ( Btu/h)	<b>N/A</b>	N/A	18000	12000
Cooling power (Watt)	<b>N/A</b>	7000W	1860W	1260W
Cooling Amps	N/A	N/A	9.2	5.8

**PFD 04      DETAILS OF REPAIR WORK**

**PFD 04.01      GENERAL D\_ESCR\_IPTION OF REPAIR WORK**

**PFD 04.01.01**      The Contractor shall at the start of the Repair and Maintenance Contract inspect the items, systems, equipment, components and installations listed below. This inspection shall include the establishing of any defects, leaks, conditions, damages, shortfalls, structural soundness, repairs required, details of existing equipment, suitability of equipment for the purpose it serves, etc. The Contractor shall report back to the Engineer in writing on all the above and the following items. No repair work shall commence prior to approval by the Engineer:

- (a)    Air-conditioning units;
- (b)    Support and bracketing system;
- (c)    Drainage installations to equipment;
- (d)    Electrical supply, wiring to and control of equipment.

**PFD 04.01.02**      The general scope of repair work to this installation shall at least include, but not be limited to the following. Any items, components, installations and systems not detailed in the Particular Specification shall be repaired and/or replaced if found to be defective and/or inoperative.

- (a)    All statutory inspections required for steam-driven equipment shall be inspected, tested and certified by an approved third party inspection authority where required by the Occupational Health and Safety Act as amended;
- (b)    Dismantling, stripping, overhauling, repair, service, reassembling, testing and commissioning of all equipment that form part of this installation;
- (c)    Implementation of a maintenance control plan;
- (d)    Supplying as-built information and drawings, as well as operating and maintenance manuals for all equipment that form part of this installation.

**PFD 04.02      DETAILS OF REPAIR WORK TO EQUIPME N J**

The following work shall form part of the repair work the heating, Ventilation and Air Conditioning Systems. This work shall be done in accordance with the relevant regulations, codes of practice, specifications and Technical specification FD: Heating ventilation and air conditioning, as set out in this document. The following work shall be included.

**PFD 04.02.01      Air-Conditioning Units**

- (a)    Clean air intake screen.
- (b)    Replace filters
- (c)    De-rust, neutralise and touch up paintwork
- (d)    Replace canvas collars

#### PFD. 4

- (e) Clean housing, ensure all panels are properly secured and door panels close properly. Replace panel seals.
- (f) Check setting and operation of all pressure switches, reset if required.
- (g) Check setting and operation of all safety switches, i.a. LP&HP switches, oil pressure switch.
- (h) Check setting and operation of thermostats.
- (i) Check timers and reset if required.
- u) Check operation of seven-day timer.
- (k) Check running current of fans and compressor and settings and operation of overloads.
- (l) Check tightness of all electrical terminals.
- (m) Ensure operation of local and remote isolators.
- (n) Check condition of all cables and whether cables are neatly strapped and reposition and strap if required
- (o) Ensure correct operation of emergency stop.
- (p) Carry out a leak test on all refrigeration piping and components inclusive of evaporator and condenser.
- (q) All leaks shall be repaired. Should a leak on a component be of such a nature that it cannot be repaired, the component shall be replaced. The procedure to follow is as set out in section FD 03.02
- (r) The superheat setting of the thermostatic expansion valve shall be checked and adjusted if required (setting approximately 8°C).
- (s) The filter dryer shall be replaced.
- (t) Check compressor vibration mounts.
- (u) Test oil acidity.
- (v) Check refrigerant charge sight glass being clear or flashing.
- (w) Check moisture indication being dry.
- (x) Clean condensate tray and test drainage operation.
- (y) Clean evaporator and condenser fan blades and check unbalance.
- (z) Replaced suction line insulation.
- (aa) Check all service valves for full operation, replaced caps if missing.

## PFD.5

- PFD 04.02.02      Extract/Ventilation Fans:
- (a) De-rust, neutralise and touch up paintwork.
  - (b) Check tightness of all securing bolts.
  - (c) Check bearings of fan motors and lubricate.
  - (d) Clean fan-blades and check for unbalance.
  - (e) Check fans, speed control and fan motor.
  - (f) Check running amps of fan.
  - (g) Reseal penetrations through the wall.
  - (h) Check controls and wiring of the fans.
  - (i) Replace filters.

### **PFD 05.01      HEATING VENTILATION AND AIRCONDITIONING SYSTEM REPAIR WORK: MEASUREMENT AND PAYMENT**

<u>Item</u>	<u>Unit</u>
PFD      05.01.01 <b>Service AC units</b>	No

The unit of measurement shall be the number of AC units serviced.

The tendered rate shall include full compensation for the servicing of the units as per Manufacturer's instructions, cleaning of filters, evaporator coils, condenser coils, housing, checking of all switches, thermostat and compressors as described in clause PFD 04.02.01.

<u>Item</u>	<u>Unit</u>
PFD      05.01.02 <b><u>Replace AC temp controller</u></b>	No

The unit of measurement shall be the number of defective controllers replaced.

The tendered rate shall include full compensation for the removal of the defective controller, the supply and installation of the new controller as well as testing.

## TECHNICAL SPECIFICATION

### FN            CLEAR-WATER PUMP SYSTEMS

#### CONTENTS

FN 01	SCOPE
FN 02	STANDARD SPECIFICATIONS
FN 03	AS-BUILT INFORMATION AND OPERATING AND MAINTENANCE MANUALS
FN 04	PUMP DESIGN AND REQUIREMENTS
FN 05	MOTOR DESIGN AND REQUIREMENTS
FN 06	WORKING VOLTAGE AND SUPPLY SYSTEMS
FN 07	PROTECTION AND CONTROL DEVICES
FN 08	DETAIL OF WORK
FN 09	TESTING AND COMMISSIONING
FN 10	MAINTENANCE
FN 11	MEASUREMENT AND PAYMENT

#### FN 01            SCOPE

This specification covers maintenance and servicing of pumping equipment, motor control devices and low-voltage cables. The function of clear-water pump systems shall be the delivery of water at a specified flow rate and head to the required location.

This specification shall form an integral part of the maintenance and servicing contract document and shall be read in conjunction with portion 3: Additional Specifications included in this document.

This specification shall act as a guideline to the Particular Specification and, in the event of any discrepancies between the Technical Specification and the Particular Specification, the latter shall take precedence.

#### FN 02            STANDARD SPECIFICATIONS

##### **FN 02.01            GENERAL STANDARD SPECIFICATIONS, REGULATIONS AND CODES**

The latest edition, including all amendments up to date of tender, of the following specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

BS 5316, Part 1	Acceptance tests for centrifugal, mixed flow and axial pumps
<b>SABS 948</b>	Three-phase induction motors
<b>SANS 1222</b>	Enclosures for electrical equipment (classified according to the degree of protection that the enclosure provides)
<b>BS 4999</b>	General requirements for rotating electrical machines
BS 1486, Part 2	Heavy duty lubrication nipples
ISO 281/1	Rolling bearings - dynamic load ratings and rating life

**FN 02.02 OCCUPATIONAL HEALTH AND SAFETY ACT OF 1993**

All regulations and statutory requirements as laid down in the latest edition of the Occupational Health and Safety Act of 1993: Construction Regulations, 2003 as promulgated in Government Gazette No 25207 and Regulation Gazette No 7721 of 18 July 2003 shall be adhered to.

**FN 02.03 MANUFACTURERS' SPECIFICATIONS, CODES OF PRACTICE AND INSTALLATION INSTRUCTIONS**

All equipment and materials shall be installed, serviced and repaired strictly in accordance with the manufacturers' specifications, instructions and codes of practice.

**FN 02.04 MUNICIPAL REGULATIONS, LAWS AND BY-LAWS**

All municipal regulations laws, by-laws and special requirements of the Local Authority shall be adhered to unless otherwise specified.

**FN 03 AS-BUILT INFORMATION AND OPERATING AND MAINTENANCE MANUALS**

The Contractor shall at the start of the Contract be given all available as-built information and operating and maintenance manuals.

The Contractor shall be responsible for the compilation of an inventory list and operating and maintenance manuals.

This shall be done in accordance with Additional Specification SB: Operating and Maintenance Manuals.

**FN04 PUMP DESIGN AND REQUIREMENTS**

- (a) The pump shaft shall be manufactured from stainless steel and shall be sealed where it enters the casing with double mechanical face seals.
- (b) The impeller shall be suitable for pumping the type of clear water as specified in Clause FN\_ 08 (Detail of work) of this specification.
- (c) The impeller shall be manufactured from stainless steel or, in the case of other materials, it shall be coated with an approved material resistant to abrasion and corrosion prevalent to the conditions under which the impeller shall operate. For pumps rated below 2 kW non-metallic impellers may be utilised.
- (d) The impeller shall be statically, dynamically and hydraulically balanced. No holes may be drilled in the impeller to balance it with regard to mass distribution.
- (e) Only permanently sealed ball or roller bearings shall be installed.
- (f) Bearings shall have a B-10 life rating of 100 000 hours.
- (g) The pump shall be a currently catalogued product.
- (h) Performance curves shall be based on a reproducible and certified test carried out in an approved testing facility, such as the SABS.
- (i) The flow rate at break-off point of the curve for the impeller selected shall be at least 1,5 times that of the maximum flow rate specified.



- U) The head at zero delivery of the curve of the impeller selected shall be at least 1,2 times the maximum head in the pump's operational range.
- (k) Each pump shall be clearly labelled. The label shall be a 0,5 mm thick stainless steel plate of dimensions 100 mm x 50 mm. The label shall be fixed to the pump exterior with an approved adhesive or other method after the completion of corrosion protection on the pump. It may be bent to follow the shape of the pump exterior but shall not be bent to accommodate sharp folds. Under no circumstances shall the stainless steel plate of the label influence, damage or otherwise have a detrimental effect on the corrosion protection system. The label shall include the following information:
  - pump rates
  - pump head
  - power required
  - NPSH (r) rotational speed
  - impeller detail.
- (l) All new submersible pumps shall be supplied with a length of power cable to suit the installation shown on the drawings.
- (m) All new pumps shall be fitted with double flush mechanical seals, which shall be included in the cost of the pumps. The pump shafts shall be hardened and accurately ground where the seal bears on the shaft. The rotating seal face shall be mounted on a flexible member, sealing on the shaft as well. The flexible member shall be manufactured from rubber, PTFE or equivalent material suitable for the operating environment.
- (n) Centrifugal pumps shall comply with relevant and applicable items under the clause on technical requirements regarding all pump types, as well as the following:
  - (i) Preference shall be given to pumps of the self-regulating type and where the power consumption characteristic is such that the power consumption decreases with an increase in delivery to beyond a certain limit, thus ensuring that the motor is not overloaded in the event of a large reduction in pumping head.
  - (ii) The casing for centrifugal pumps shall be horizontally or vertically split to allow removal of parts.
  - (iii) The efficiency of the pump shall not be less than 95 % of its maximum efficiency at the selected operating point, where the latter shall not be less than 80 %.

#### **FN 05 MOTOR DESIGN And REQUIREMENTS**

- (a) Electric motors shall comply with the requirements of SASS 948
- (b) Imported motors forming an integral part of the pump shall be submitted to the South African Bureau of Standards to be tested in accordance with the requirements of SASS 948.
- (c) All motors shall be standard catalogue models and shall be readily available.
- (d) All motors shall, where possible, be from the same manufacturer and shall have the same interchangeable frames. Variations in type and size shall, where possible, be limited to make stocking a variety of special spares unnecessary.
- (e) All motors shall have dynamically balanced rotors supported by maintenance-free, sealed-for-life ball bearings.

#### FN.4

- (f) All motors shall be suitably coated to ensure the satisfactory operation of the motor under the specified class of service.
- (g) All terminal boxes shall be waterproof and suited for submersion up to the depth as specified for the pumps.
- (h) An adequate length of waterproof cable, purpose-made for submerging, shall be supplied with each submersible motor. The coupling of this cable to the normal power-distribution cable, which usually is of the PVC type with steel-wire armour, shall be placed at least 1,0 m above the maximum water level by means of a purpose-made, weatherproof, outdoor junction box. The submerged cable shall be supported to minimise any movement of the cable, which result from turbulence caused by the operation of the equipment or the flow of the water.
- (i) Thermistor protection or Klaxon type temperature switches shall be provided for submersible motors.
- 0) Seal monitors shall be provided for submersible motors, together with the required seal monitor relays. The cost for the seal monitor relays shall be deemed to be included in the rates tendered for the equipment.

#### **FN 06      WORKING VOLTAGE AND SUPPLY SYSTEMS**

The motors shall be capable of operating within  $\pm 10\%$  of the nominal supply voltage without risk of damage. All motors shall be suitable for operating continuously at the specified three-phase voltage system under actual service conditions, including the  $\pm 10\%$  voltage tolerance, without exceeding the specified temperature rise determined by the resistance on a basic full load heat run.

All motors shall be capable of operating continuously under actual service conditions at any supply frequency between 48 and 51 Hz together with any voltage between  $\pm 5\%$  of the nominal supply voltage.

The slip-in speed of any motor at 80 % of the nominal voltage at 50 Hz shall not exceed a percentage agreed on by the Engineer, and the motors shall be capable of operating at this voltage for a period of five minutes without deleterious heating.

#### **FN 07      PROTECTION AND CONTROL DEVICES**

Submersible pumping equipment shall have float switches to switch the pump motor on and off, according to the level of the liquid. Switches shall operate freely and not be hindered by cables or other switches and shall switch off at a level where no damage to the pump or motor will occur.

Three level switches shall operate a pump control system:

- (a) Level switch one shall switch off pumps at low level;
- (b) Level switch two shall switch on one pump at an intermediate level, to draw the liquid down to level 1. When the level again rises to where level switch two was switched on, the pump duty shall rotate and start the motor parallel to the one which ran the first time;
- (c) Level switch three shall switch on both pumps to run in parallel at a high level.

In the event of a pump failing to start, the other pump must automatically be restarted.

Pumps shall be operated in both manual and automatic modes.

**FN 08      DETAIL OF WORK****FN 08.01      GENERAL**

The Contractor shall investigate and inspect all areas of the installation to confirm the extent of the servicing work required and shall report to the Engineer. The Engineer will thereafter demarcate any areas to be serviced and shall instruct the Contractor with regard to the repair work to be done.

**FN 08.02      TESTING EQUIPMENT**

All electrical and mechanical equipment shall be checked at the start of the Contract to establish which items need to be repaired, reconditioned or replaced.

**FN 08.03      BULK WATER PUMP SYSTEM**

The electric motors and pumps were in perfect working order at the time of the tender. Only the maintenance specification will be applicable to the pump including its motor.

The following submersible raw water pumps shall be serviced and maintained under this contract:

- Two submersible raw water pumps at the existing Emahlathini Border Control Port of Entry river sump area. One duty pump and one stand-by pump, which will alternate as specified in FN 08.06.

**FN 08.04      WATER TREATMENT WORKS PUMPS**

The water treatment works pump system consists of two Pentax pumps with electric motors.

The details are as follows:

- |     |           |                                 |
|-----|-----------|---------------------------------|
| (a) | 1 x Pump: | PENTAX (SRENDOLA-VI-ITALY)      |
|     | Type:     | CM 40/750 No A                  |
|     | Umin:     | 100/600                         |
|     | Hm:       | 50/35                           |
|     | kW:       | 5.5                             |
|     | Hp:       | 7.5                             |
|     | R.P.M.:   | 2840                            |
|     | Hz:       | 50                              |
|     | IP:       | 44                              |
| (b) | 1 x Pump: | PENTAX (VERONELLA (VR) - ITALY) |
|     | Type:     | CM 40/160 A                     |
|     | Umin:     | 100/600                         |
|     | Hm:       | 38/27                           |
|     | kW:       | 4                               |
|     | Hp:       | 5.5                             |
|     | R.P.M.:   | 2840                            |
|     | Hz:       | 50                              |
|     | IP:       | 44                              |

## FN 08.05      **MOTOR CONTROL CENTRE**

- (a) The inside and outside of all surfaces of the motor control centre must be thoroughly cleaned and metal surfaces treated for rust and corrosion and repainted to specification.
- (b) Float switches for level sensing shall be checked. Missing, damaged or faulty switches shall be replaced with new switches of similar and equal type. The switches must be installed and supported on suitable brackets to prevent the cables and switches from tangling, due to the inflow of the sewage water.
- (c) Check and tighten all terminations of all equipment.
- (d) Clean out all switchgear and equipment properly to remove dust and spider webs.
- (e) Dismantle and clean all moving parts and contacts of magnetic contactors and starters, reassemble, check overload trip units and adjust correctly. Test for correct functioning on completion of repair work.
- (f) Replace any damaged ammeters, switches and lamps on the control with parts similar and equal to the existing types on the panel.
- (g) Wiring diagrams of all electrical panels and MCC panels shall be compiled.

## FN 08.06      **MOTOR CONTROL CENTRE (RAW WATER PUMPS)**

- (a) The existing motor control centre for the control of the raw water pumps is situated at the standby power generator/LV building near the police building. The existing motor control centre shall be replaced to comply with the following requirements:
- (b) The new replacement motor control centre for the raw water pumps shall be wired to comply with the requirements as set out in this clause.
- (c) The power supply cable from the MCC to the two pumps at the sump shall be tested for conformity to be re-used for the supply of the two new pumps. In the event that the cable might not pass such testing by the Contractor, the Contractor shall inform the Engineer in writing. The Engineer will instruct the Contractor with regard to a new cable to be installed. *Remuneration, in the event of a new power supply cable being required from the MCC to the sump, will be measured under the re-measurable electrical repair quantities and must **not** be included in the payment item for the replacement and equipping of the Motor Control Centre.*
- (d) Provide an engraved label on the door of the MCC with the relevant MCC number on. The label shall be secured with screws and nuts.
- (e) New float control switches (2 off) shall be supplied, delivered and installed in the raw water balancing tank (situated at the water treatment works - approximately 400 m away from the raw water MCC for the level sensing functions, as follows (remuneration for the float control switches included in this payment item for the motor control centre):
  - When the raw water balancing tank is 50% full, one pump shall start to fill the tank until it is full
  - When the raw water balancing tank is full, the pump shall switch off

- A censing cable shall be installed between the level censing devices at the water treatment works and the MCC. *Remuneration for the censing cable required from the MCC to the water treatment works will be measured under the re-measurable electrical repair quantities and must not be included in the payment item for the replacement and equipping of the Motor Control Centre Work will be directed on site by the Engineer, based on the availability of sleeves, need for excavation etc.*
- (f) Switchgear and equipment shall be installed in the MCC to:
- Automatically regulate the start and stop of pumps as set out in (e)
  - Indicate which pump is running
  - Indicate a pump that has tripped
  - Indicate the time each pump has been operating since new (hour meters)
  - Alternate pumps after every start - stop pump cycle
  - Manually override the alternating of pumps and select either pump manually
  - Start/stop either pump manually.
- (g) Test for correct functioning on completion of electrical repair work.
- (h) Emergency stop buttons shall be installed at the pump sump in all weather box for emergency stop functions.

**FN 08.07**

**MOTOR CONTROL CENTRE (WATER TREATMENT WORKS)**

- (a) The inside and outside of all surfaces of the motor control centre must be thoroughly cleaned and metal surfaces treated for rust and corrosion and repainted to specification.\
- (b) The electrical connections inside the MCC need to be re-wired.
- (c) Switchgear and equipment shall be installed in the MCC to:
- Automatically regulate the start and stop of pumps
  - Start/stop either pump manually.
  - Indicate which pump is running
  - Indicate a pump that has tripped
  - Hour meters to indicate the time each pump has been operating since new.
- (d) The float control switches for the level sensing functions are working at the time of the tender and shall only be maintained by the Contractor.
- (e) Provide an engraved label on the door of the MCC with the relevant MCC number on. The label shall be secured with screws and nuts.
- (f) Check and tighten all terminations of all equipment.
- (g) Properly clean out all switchgear and equipment from dust and spider webs.
- (h) Dismantle and clean all moving parts and contacts of magnetic contactors and starters, re-assemble. Check overload trip units and adjust correctly. Test for correct functioning on completion of electrical repair work.

**FN 09      TESTING AND COMMISSIONING****FN 09.01      TEST TO BE PERFORMED**

- (a) All pumping equipment shall be subject to the commissioning tests as described in the applicable specification.
- (b) At least one of each type or size of pump supplied, repaired or reconditioned, shall be subject to a delivery flow rate test. The Contractor shall supply flow rate or volumetric flow testing facilities.
- (c) The operating point of each pump shall be determined.
- (d) Efficiency tests shall be performed.
- (e) NPSH tests shall be performed.

**FN 09.02      PUMP OPERATING POINT**

During the day 1 commissioning tests the pump operating point shall be determined by observing the following:

- (a) pump delivery and suction pressures, and
- (b) electric motor power consumption.

If no efficiency tests are required, then the motor power consumption shall be calculated from the voltage and current measurements obtained during the commissioning test.

The Contractor shall supply the necessary adaptors, fittings and pressures gauges to measure the suction and delivery pressures. If no gauge fittings exist on the suction side, then the suction pressure conditions will be calculated from the system properties.

**FN 09.03      FLOW RATE (DELIVERY), EFFICIENCY AND NPSH TESTS**

- (a) Testing shall be done in accordance with BS 5316 Part 1, class C tests.
- (b) Power consumption of electric motors shall be as determined by the three-wattmeter method where efficiency tests are required in the detail specification.

**FN 09.04      TEST CONDITIONS**

- (a) All tests shall be performed in situ.
- (b) The pumped medium or liquid shall be water.

**FN 09.05      ADDITIONAL TESTS**

Additional tests may be specified in the detail of work.

**FN 10 MAINTENANCE****FN 10.01 GENERAL**

All pumping equipment and systems shall be serviced and repaired, following practical completion of the installation of which it forms part, to maintain it in perfect functional condition.

Maintenance shall be carried out and shall include routine preventative maintenance according to the manufacturer's specification to be set out in the operating and maintenance manual, as well as unforeseen repairwork or replacement.

The remuneration for monthly maintenance of pumping equipment and systems shall be deemed included in the tendered rate for 10 points of the installation of which the system forms part. Installations are specified in Additional Specification SA: General Maintenance, and illustrated in detail on the mechanical flow diagram.

**FN 10.02 ROUTINE PREVENTATIVE MAINTENANCE**

The routine preventative maintenance work to be carried out shall include but not be limited to the items listed in table FN 10.2/1 below.

These actions and findings shall be logged and reported on the relevant approved schedules and reports.

TABLE FN 10.02/1

NO	ROUTINE PREVENTATIVE MAINTENANCE OF CLEAR-WATER PUMP SYSTEMS	MAINTENANCE FREQUENCY
1	Clean inlet sump	Six-monthly
2	Visually inspect and report on complete systems	Monthly
3	Check, service, repair and clean all pumps	Six-monthly
7	Check, service, repair and clean all motor control centres and level sensing devices.	Six-monthly
4	Corrosion protect pumps, motors and surface piping	As required
5	Check, inspect, report and repair all leaks	Monthly
6	Check and lubricate moving parts	Six-monthly

**FN 11 MEASUREMENT AND PAYMENT****FN.01 SUPPLY AND DELIVERY OF PUMPING EQUIPMENT**

Unit: number

The unit of measurement shall be the number of pumping equipment units supplied and delivered.

The tendered rates shall include full compensation for the design, manufacture, corrosion protection, patent rights, pre-delivery testing and test certificates, transport for delivery to site and off-loading, including all handling of the equipment. The equipment shall include the following:

- (a) The pump and motor as an integrated unit
- (b) Electrical power cable.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

**FN.02****INSTALLATION, TESTING AND COMMISSIONING OF PUMPING EQUIPMENT**

Unit: number

The unit of measurement shall be the number of pumping equipment units tested and commissioned.

The tendered rates shall include full compensation for the site handling and positioning of the pumping equipment, including the fastening of the equipment in its designated position. The following shall also be included in the tendered rates:

- (a) Installation of the guide rails and sealing frame;
- (b) Coupling of all required pipes flanges, including all required gaskets, nuts, bolts and washers;
- (c) Routing and fastening of the power cable up to the isolator box;
- (d) All required installation materials, labour and consumables to render a complete and working installation.

The tendered rates shall also include full compensation for all preliminary tests, delivery and efficiency tests if required and commissioning tests. Commissioning tests shall comply with the section dealing with testing and commissioning. Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

**FN.03****DECOMMISSIONING AND REMOVAL OF PUMPING EQUIPMENT**

Unit: number

The unit of measurement shall be the number of pumping equipment units decommissioned and removed.

The tendered rates shall include full compensation for all labour, machinery, tools, transport and site handling necessary for the decommissioning and removal of pumping equipment.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

**FN.04****RECONDITIONING OF PUMPING EQUIPMENT**, Unit: number

The unit of measurement shall be the number of pumps and motors reconditioned.

The tendered rates shall include full compensation for replacement of components and materials, and for tools, transport, site handling and labour necessary for the complete reconditioning of pumping equipment to conform to all the specifications in Clauses FN 04: Pump design and requirements, and FN 05: Motor design and requirements.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.



**FN.05      REPAIR OF PUMPING EQUIPMENT ..... Unit: number**

The unit of measurement shall be the number of pumps and motors repaired.

The tendered rate shall include full compensation for supply of an identification label, resetting the spacer between impeller and back plate and ensuring that impeller rotates freely, as well as cleaning and corrosion protection and installing a new hoisting chain.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

**FN.06      SUPPLY OR RECONDITIONING OF MCC BOARDS OR OTHER  
ELECTRICITY BOARDS ..... Unit: number**

The unit of measurement shall be the number of MCC boards or other electricity boards supplied of existing boards reconditioned.

The tendered rates shall include full compensation for supply and replacement of components and materials and for tools, transport, site handling and labour necessary for the complete reconditioning of all components of the board or supply of all components to provide a fully functional MCC board.

Separate items will be listed in the Schedule of Quantities for different types and sizes of equipment.

**FN.07      COMPILATION OF WIRING DIAGRAMS ..... Unit: number**

The unit of measurement shall be the number of wiring diagrams compiled.

The tendered rates shall include full compensation for drawing, printing, computer time and any other associated costs necessary for the compilation of a wiring diagram.

**FN.08      SUPPLY AND DELIVERY OF PIPEWORK, VALVES, FITTINGS, SPECIALS AND  
ANCHORING ..... Unit: sum**

The unit of measurement shall be the sum for the pipework, valves, fittings, specials and anchoring complete as detailed in section FN0S.04.02 items (a) to (g) and on drawing 048175/4/B.

The tendered rate shall include full compensation for the design, manufacture, procurement, corrosion protection, storage, transport for delivery to site and off-loading including all handling of the complete section of pipework or pipework reticulation specified, which shall include the pipes, fittings, fixing equipment, drainage valves, manual isolation valves, reducers, flanges, welding, nozzles and appurtenances to ensure a complete operational system.

FN.09

**INSTALLATION, TESTING AND COMMISSIONING OF PIPEWORK, VALVES, FITTINGS AND SPECIALS..... Unit: sum**

The unit of measurement shall be the sum for installation and testing of the pipework, valves, fittings, specials and anchoring detailed in section FN08.04.02 items (a) to (g) and on drawing 048175/4/B.

The tendered rate shall include full compensation for the installation and flushing of the pipework to provide a complete working system as detailed in the standard and detail specifications. The cost for handling of equipment, fixing of pipework, coupling of flanges and all installation materials and labour shall be included in the tendered rates.

The tendered rate shall include full compensation for all field testing, including re-testing where required and the contractor shall provide all instrumentation, tools, equipment and labour at no extra cost to perform the following:

- Testing of welds
- Testing of linings and coatings
- Hydraulic or pneumatic field-testing.

The pipe work system shall be tested as a whole together with the appurtenant pumps, valves, etc.

## TECHNICAL SPECIFICATION

HA MV SWITCHGEAR SYSTEMS

## CONTENTS

HA01	SCOPE
HA02	STANDARD SPECIFICATIONS, REGULATIONS, CODES AND ADDITIONAL SPECIFICATIONS
HA03	AS-BUILT INFORMATION AND OPERATING AND MAINTENANCE MANUALS
HA04	TEST AND INSPECTION FOLLOWING COMPLETION OF REPAIR WORK
HA05	LOGGING AND RECORDING PROCEDURES
HA06	MAINTENANCE TOOLS AND SPARES
HA07	QUALITY ASSURANCE SYSTEM
HA08	RE-COMMISSIONING OF INSTALLATION
HA09	REPAIR WORK TO INSTALLATIONS
HA10	INSTALLATION MAINTENANCE
HA 11	MEDIUM VOLTAGE SWITCHGEAR: TECHNICAL DETAILS
HA12	SUBSTATION BUILDING AND YARD: TECHNICAL DETAILS

HA01 SCOPE

<b>HA 01.01</b>	This specification comprises all aspects regarding the repair and maintenance of Medium voltage switchgear, Substation building and yard.
<b>HA 01.02</b>	This specification shall form an integral part of the repair and maintenance contract document and shall be read in conjunction with Part C, the Additional Specification included with this document.

HA02 STANDARD SPECIFICATIONS, REGULATIONS AND CODES

<b>HA 02.01</b>	The latest edition, including all amendments up to date of tender of the following specifications, publication and codes of practice shall be read in conjunction with the specification and shall be deemed to form part thereof.
<b>HB 02.02</b>	<b>SANS Specifications</b> <ul style="list-style-type: none"> <li>♦ SANS 1195</li> <li>♦ SANS 172</li> <li>♦ SANS 763</li> <li>♦ SANS 555</li> <li>♦ SANS 1091</li> </ul>
<b>HB 02.03</b>	<b>BSI Specifications</b> <ul style="list-style-type: none"> <li>♦ BSI 5463</li> <li>♦ BSI 159</li> <li>♦ BSI 223</li> <li>♦ BSI 2562</li> <li>♦ BSI 2692</li> <li>♦ BSI 88</li> <li>♦ BSI 5227</li> <li>♦ BSI 729</li> <li>♦ BSI 148</li> <li>♦ BSI 5253</li> </ul>

- ♦ BSI 5463
- ♦ BSI 142

HA 02.04	<u>Occupational Health and Safety Act of 1993 (OHS-Act)</u>
HA 02.05	Manufacturer's Specifications and maintenance instructions
HA 02.06	Additional requirements

Equipment and material installed shall be new and unused.  
Air and Oil switches, MV and LV switches and Protective relays shall bear the SANS stamp. The Contractor shall ensure that all safety regulations and measures are applied and enforced during repair and maintenance work.

### **HA03                      AS-BUILT INFORMATION AND OPERATING AND MAINTENANCE MANUALS**

**HA 03.01**                      Procurement of available as-built information. At the commencement of the contract, the Contractor shall obtain all available as-built documentation.

The Contractor shall be responsible for the verification of the correctness of all such information. The Contractor shall, in the probable case of non-availability and correctness of such information be responsible for the compilation of a complete set of as-built drawings, inventory list and Operating and Instruction Manuals.

This shall be done in accordance with the Additional Specification SB-Operating and Maintenance manuals.

The Contractor shall allow for the required tools and equipment to establish the correct as-built information.

All information shall be recorded and reproduced in electronic format as well as supplying the Engineer with three sets of hard copies.

**HA 03.02**                      Over and above what is specified in the Additional Specification - SB Operating and Maintenance manuals, the Operating and Maintenance Manual to be compiled shall be structured and shall at least include the following:

- ♦ System Description

- ▶ Complete system description of the distribution system. This shall be done for each substation individually. The system description shall contain detailed information regarding the supply configuration (substation, cabling, distribution kiosks, pole mounted switchgear), the system configuration (switchgear, cabling, metering, batteries) and the switchgear detail as well as the earthing and lightning protection arrangement.

- ♦ Commissioning Data

- ▶ Complete commissioning, test and inspection data of the MV switchgear.  
This shall be done for each substation installation individually.

- ♦ Operating data

- ▶ Safety precautions to be implemented.
- ▶ Operating of MV system : Switchgear, relays, battery and charger sets.

- ◆ Maintenance instructions
  - ▶ Projected frequency of fuse replacement per substation.
  - ▶ Procedure to verify operation of circuit breaker - controlled circuits.
  - ▶ Trouble shooting diagram.
  - ▶ Equipment details, including manufacturer's brochures / pamphlets, order numbers and list of components.
  - ▶ Schedule of serviceable components of medium voltage switchgear.
  - ▶ Hoisting equipment specification, if applicable.

#### **HA04 TEST AND INSPECTI ON FOLLOWING COMPLETION OF REPAIR WORK**

**HA 04.01** It is the responsibility of the Contractor to provide all labour, accessories and properly calibrated and certified measuring instruments necessary to record the following parameters:

- ▶ phase voltages
- ▶ current per phase
- ▶ earthing resistance testing
- ▶ contact resistance per phase

The Contractor is responsible for the arrangement of such tests. He shall give at least 72 hours notice to the Engineer prior to the test date.

#### **HA05 LOGGING AND RECORDING PROCEDURES**

**HA 05.01** The Contractor shall as part of this Contract institute a Recording system as part of his Maintenance Control Plan as defined in the Additional Specification SA - General Maintenance. This shall consist of a Record book which shall be utilised to log and record all faults, system checks, services, overhauls, breakdowns, maintenance visits, inspections, etc.

**HA 05.02** The logbook shall be stored in a safe place inside the main substation and shall only be utilised by the Contractor and the Engineer. A copy of the monthly entries and recordings into this logbook shall be submitted by the Contractor together with his monthly report to the Engineer.

This logbook shall be structured to at least include the following:

- ▶ Monthly medium voltage Switchgear inspection and maintenance actions
- ▶ Bi-annual inspection and testing of medium voltage switchgear
- ▶ Annual earthing test report
- ▶ Breakdown / call out reports.

#### **HA06 MAINTENANCE TOO LS AND SPARES**

**HA 06.01** On commencement of the Repair and Maintenance Contract, the Contractor shall compile an inventory of the existing Tools and Spares in the presence of the Engineer. Any deficiencies or short fall or damaged Tools and Spares shall be replaced with new equipment / material, as part of the contract.

**HA 06.02** The Tools and Spares shall be kept safe in a lockable store room on site. The Contractor shall provide his own lock for the designated store room. The inventory of the Tools and Spares shall be verified on a monthly basis. Any short fall shall be replaced by the Contractor as part of his responsibility under this contract.

**HA 06.03** The Tools and Spares shall at least include the following :

Medium voltage switchgear operating tools.

MV fuses rated 25A 12kV 40kA.  
Cut out fuse element 10A & 20A

#### **HA07 QUALITY ASSURANCE SYSTEM**

- HA 07.01** Following formal approval of his Quality Assurance system by the Engineer, the Contractor shall implement the approved QA system.
- HA 07.02** Records of this QA system shall be kept throughout the duration of the contract and shall be submitted to the Engineer as required.

#### **HA08 RE-COMMISSIONING OF INSTALLATION**

- HA 08.01** On completion of the repair work, the MV installations shall be put into operation.

#### **HA09 REPAIR WORK TO MV INSTALLATIONS**

- HA 09.01** The various MV systems shall be repaired as measured in the bills of quantities, Installation A3, during the first period of the repair and maintenance contract.
- HA 09.02** The scope of the repair work shall include, but shall not be limited to the activities listed below.
- HA 09.03** The Contractor shall record the repair actions in tabular format before the maintenance phase commences.
- HA 09.04** Repair work shall be executed within the approved period for repairs. This period shall be agreed at the start of the contract period.
- HA 09.05** New equipment and material (e.g. batteries, relays, contacts, etc). shall be supplied with a written guarantee confirming a defects liability period of 12 months from date of hand-over. These guarantees shall be furnished in favour of the Engineer.
- HA 09.06** The maintenance phase of this contract shall commence once the repair work on the installation have been commissioned and handed over to the satisfaction of the Engineer.

#### **HA 10 MV INSTALLATION MAINTENANCE**

- HA 10.01** The various MV systems shall be maintained following the initial repair work. The maintenance contract shall run for the balance of the 36 month contract period.
- HA 10.02** The following maintenance actions will be required under this period of the contract:
- ♦ routine preventative maintenance
  - ♦ corrective maintenance
  - ♦ breakdown maintenance
- These actions are defined in the Additional Specification SA - General Maintenance.
- HA 10.03** The maintenance schedules and frequency of services and maintenance activities shall be developed under the maintenance control plan which will be instituted by the Contractor. The Contractor's responsibility in this regard is specified in the Additional Specification SA - General Maintenance.

## **HA 11                      MEDIUM VOLTAGE SWITCHGEAR : TECHNICAL DETAILS**

### **HA 11.01                      Installation descyi,ltion**

This section describes the electrical distribution network that will be repaired and maintained in terms of this contract. The network is urgently operated at 11kV.

#### **a)      Distribution Substation\_s**

The electrical distribution network includes 1 distribution substation. The substation are brick built containing 3 rooms. The MV room contains a SF6 Ring Main unit and is connected to an incoming and transformer feeder MV cable.

### **HA 11.02                      Scope of repair work**

Clean, check and service 11kV circuit breaker, replace tripping batteries, check charger and protection.

Check and repair oil leaks on cable boxes.

Recover redundant equipment not in use.

### **HA 11.03                      Repair work : Measurement and payment**

#### **Item**

#### **Unit**

- |     |   |    |
|-----|---|----|
| (a) | Service 11kV switchgear (bulk oil type) | No |
|-----|---|----|

The unit of measurement shall be the number of panels serviced.

The tendered rate shall include full compensation for the following :

#### **Truck**

Wipe down and clean carriage and circuit breaker framework.

Open circuit breaker and examine turbulators and contacts. Replace if necessary.

Clean insulation.

Clean and lubricate isolating contacts and check freedom of movement.

Remove insulating oil.

Clean tank and circuit breaker.

Replace insulating oil (Oil to SANS 1555 specification)

Replace tank gasket.

Check, clean an lubricate mechanism.

Check, clean and lubricate the lifting screw and guides of the carriage.

Check interlocks.

Check opening and closing speeds.

Record contact resistance per phase.

Lubricate carriage wheels, locating bolt and linkage.

Clean and lubricate secondary isolating contacts and check freedom of movement.

Remove rust and repaint where necessary. User rust remover, sand thoroughly and apply neutralizer. Apply primer before 2 coats of enamel paint.

#### **Fixed Panel**

Wipe down and clean externally.

Clean circuit breaker and panel compartment.

Remove all secondary fuses and clean contact surfaces.  
 Check auxiliary contacts and connections.  
 Check switches and connections in panel and CT Chamber.  
 Lubricate shutter mechanism.  
 Lubricate all hinges and handles.  
 Clean circuit and busbar orifice insulators.  
 Clean busbar chamber.  
 Clean isolating plugs and regrease.  
 Check operation of orifice shutters.  
 Check and lubricate selector gate mechanism.  
 Clean voltage transformer orifices.  
 Clean secondary and earth contacts of the voltage transformer.  
 Lubricate voltage transformer carriage.  
 Check and replace indication lamps.  
 Open, check and clean air insulated cable end boxes.  
 Remove rust and repaint where necessary. Use rust remover, sand thoroughly and apply neutralizer. Apply primer before 2 coats of enamel paint.  
 Reassemble, test and commission.  
 Close and trip manually and electrically several times.  
 Carry out thermal scan of busbars.  
 Check and repair vermin proofing.

<u>Item</u>	<u>Unit</u>
(b) Service battery and charger set.	No

The unit of measurement shall be the number of battery and charger sets serviced.

The tendered rate shall include full compensation for the following :

**Battery and charger sets**

Replacement of batteries.  
 Cleaning of connections and terminals.  
 Measure and record SG where applicable. Top up each cell.  
 Check battery capacity, with an external load.  
 Apply insulating grease to contacts.  
 Check and test battery charger operation.  
 Battery trip unit service and test.

<u>Item</u>	<u>Unit</u>
(c) Check protection relay	No

The unit of measure shall be the number of panels with relays tested.

The tendered rate shall include full compensation for the following:

**11kV panels with 3 x OC (IDMT) 1 x EF**

Current transformers ; (3 x per panel)  
 Primary injection  
 Secondary injection and all other tests  
 Protection relays per panel :  
 Testing and commissioning  
 Indication and metering  
 Interlocking and scheme  
 Control functions  
 Supervisory functions  
 General : Cleaning panels, fuse holders, relays, enclosures, instrumentation; check fuses, vermin-proofing, lubrication.



	<u>Item</u>	<u>Unit</u>
(d)	Add additional cable box oil	Litre
	The unit of measure shall be the number of litres of oil added.	
	The tendered rate shall include full compensation for ordering, supplying and adding additional oil. The oil must be as semi fluid grade of compound 'Pentrol' or equipment.	
	<u>Item</u>	<u>Unit</u>
(e)	Replace neon lamps and capacitor diverters	No
	The unit or measure shall be the number of neon lamps and capacitor diverters replaced.	
	The tendered rate shall include full compensation for the replacement of faulty neon lamps and capacitor diverters.	
	<u>Item</u>	<u>Unit</u>
(f)	Re-tape MV busbars.	No.
	The unit of measure shall be a lump sum.	
	The tendered rate shall include full compensation to re-tape the MV busbars to the bushings inside the MV panel using PVC insulation tape.	
	<u>Item</u>	<u>Unit</u>
(g)	Repair oil leak on cable box.	No
	The unit of measure shall be the number of cable boxes repaired.	
	The tendered rate shall include full compensation for the repairing of oil leaks.	

**HA 11.04                      Scoee of maintenance work**

**HA 11.04.01                Monthl**

Visual inspection of switchgear.  
 Check for oil leaks.  
 Check oil levels.  
 Recording of current and voltage readings in and signing of record book.

**HA 11.04.02                Annual**

Service all medium voltage Switchgear.  
 Record all test results in record book.

**HA 11.05                      Maintenance work :\_Measurement and Pa\_y:ment**

Refer to clause SA 06 of the Additional Specification - SA General Maintenance.

**HA 12 SUBSTATION BUILDING AND YARD****HA 12.01 Installation description**

This section describes the electrical distribution network that will be repaired and maintained in terms of this contract.

## a) Distribution S1.1b Station

Distribution substation consists of a three room brick building, containing MV switchgear, transformer and LV distribution boards all fenced in.

## b) Pole Transformer

Two pole mounted Transformers forms part of the distribution network.

**HA 12.02 Scope of Repair Work**

Open substation, clean substation, cut and replace duct covers.  
Provide framed schematic in HV switch room.  
Provide labels and markings on substations.  
Check and report on condition of building elements.

**HA 12.03 Repair Work : Measurement and Payment**ItemUnit

## (a) Substation earthing

No

The unit of measurement shall be the number of substation earths checked.

The tendered rate shall include full compensation for the following :

Measurement of earthing system earth resistance.  
Checking of earthing of all equipment.  
Secure earth termination.  
Re-tensioning of all earth connections.

ItemUnit

## (b) Substation yard and building service.

No

The unit of measurement shall be the number of substations serviced.

Check condition of substation, ventilation louvres, doors, hinges and locking mechanisms and report to site engineer for further action. Check substation for roof leaks and report to site engineer for further action.

Clean and remove all alien vegetation from the yard and apply weed killer over the entire substation area if substation yard is stoned.

General cleaning of substation interior.

<u>Item</u>	<u>Unit</u>
(c) Provide labels, notices and schematics.	No.
The unit of measure shall be the number of substations labeled.	
The tendered rate shall include full compensation for the following :	
Provide substation number.	
Mark room doors HV/TRF/LV/ESC, etc.	
Provide OHS Act notice at each substation.	
Provide a A3 laminated framed schematic in the medium voltage room.	
<u>Item</u>	<u>Unit</u>
(d) Supply duct covers.	Item
The unit of measure shall be the total sum for the replacement and cutting of covers.	
The tendered rate shall include full compensation for the following :	
a) The contractor shall manufacture and install sections of cable trench cover plates to fit the sections in substations where old cover plates have been removed. The contractor shall measure up the cable trenches and manufacture the plates to fit exactly in the required sections. The dimensions specified in this procedure shall only be used as a basis to determine the tendered rate.	
b) The cover plates shall be manufactured from mild steel chequered plate with a base thickness of 4.5mm and a chequered stud thickness of 6.1mm. Each cover plate shall have two guiding lengths of angle iron welded to the bottom of the plate. The guiding angle irons shall be welded in positions parallel to the length of the cable trench. The guiding angle irons shall be positioned at the edges of the plate, and shall form a tight fitting stop against the edges of the cable trench. The angle irons shall be mild steel with dimensions 40mm x 40mm x 3mm.	
c) Each cover plate shall be fitted with two steel lifting handles fitted at opposing ends of the plate (in line with the length of the cable trench). The handles shall be fitted through holes drilled in the plate, and shall be such that they form irremovable parts of the plate.	
d) All metal edges shall be chamfered to remove all burrs so that the cover plates can be handled without injury.	
e) Each cover plate and its handles shall be painted with a suitable anti-corrosive primer after all welding and chamfering has been completed. All metal surfaces shall be cleaned (prior to painting) and painted in accordance with the paint manufacturer's recommendations.	
<u>Item</u>	<u>Unit</u>
(e) Vermin proof cable ducts.	Item
The tendered rate shall include full compensation for opening, cleaning vermin proofing and closing of duct covers.	

<u>Item</u>	<u>Unit</u>
(f) Re-paint substation roof and gutters.	Item
Report to site engineer for further action by others.	
<u>Item</u>	<u>Unit</u>
(g) Provide MV ring schematic.	Item
The unit of measure shall be the number of MV ring schematic installed.	
The tendered rate shall include full compensation for compiling, supply and installation of a A3 laminated framed schematic in the substation.	
<u>Item</u>	<u>Unit</u>
(h) Repair roof leaks in transformer room.	Item
Report to site engineer for further action by others.	
<u>Item</u>	<u>Unit</u>
(i) Re-label panels	No.
The unit of measure shall be the number of panels re-labeled.	
The tendered rate shall include full compensation for the re-labeling of panels with engraved labels as specified in the bill of quantities.	
<u>Item</u>	<u>Unit</u>
0) Supply MV operating handles.	No.
The unit of measure shall be the number of operating handles supplied.	
The tendered rate shall include full compensation for the supply of operating handles if and when instructed by the engineer.	
<u>Item</u>	<u>Unit</u>
(k) Supply and install tool holder.	No.
The unit of measure shall be the number of tool holder installed.	
The tendered rate shall include full compensation for the supply and installation of suitable tool holders that can accommodate all operating handles for the switchgear in the MV room of the substation. Tool holders must be installed inside the MV room of the substation.	
<u>Item</u>	<u>Unit</u>
(l) Re-placement of 75W Rapid start fluorescent lights.	No.
The unit of measure shall be the number of light fittings re-placed.	
The tendered rate shall include full compensation for removal of the existing 2 x 75W commercial type fluorescent light and supply and installation of a new 2 x 58W switch start commercial fluorescent light fitting.	

	<u>Item</u>	<u>Unit</u>
(m)	Re-paint substation louvers and doors.	No

The unit of measure shall be the number of louvers or doors re-painted.

The tendered rate shall include full compensation for cleaning, de-rusting with a de-rusting agent, removal of loose paint, sand paper of surfaces, apply primer before two coats of enamel paint to the doors or louvers.

	<u>Item</u>	<u>Unit</u>
(n)	Re-paint substation rooms.	No

The unit of measure shall be the number of rooms re-painted.

The tendered rate shall include full compensation for cleaning of walls and ceilings and applying one coat primer and two coats of paint to match the existing colour of the walls.

**HA 12.04                      Scope of Maintenance Work**

**HA 12.04.01                Monthly**

Clean substation yard and buildings.

**HA 12.04.02                Annual**

Service substation building.

**HA 12.05                      Maintenance Work : Measurement and Payment**

Refer to clause SA 06 of the Additional Specification - SA General Maintenance.

Remuneration for the Maintenance work shall form of the overall Medium and Low Voltage Installation (Installation B3).

## TECHNICAL SPECIFICATION

### **HB           STANDBY POWER SYSTEMS**

#### CQNTENTS

HB 01	SCOPE
HB02	STANDARD SPECIFICATIONS, REGULATIONS, CODES AND ADDITIONAL SPECIFICATIONS
HB 03	OPERATING AND MAINTENANCE MANUALS
HB04	TEST AND INSPECTION FOLLOWING COMPLETION OF REPAIR WORK
HB 05	LOGGING AND RECORDING PROCEDURES
HB06	MAINTENANCE TOOLS AND SPARES
HBO?	QUALITY ASSURANCE SYSTEM
HB 08	RE-COMMISSIONING OF INSTALLATION
HB09	REPAIR WORK TO INSTALLATIONS
HB10	DIESEL GENERATORS: TECHNICAL DETAILS
HB 11	UPS UNITS: TECHNICAL DETAILS
HB12	MAINTENANCE OF STANDBY POWER INSTALLATIONS

#### **HB01           SCOPE**

**HB 01.01**       This specification comprises all aspects regarding the maintenance and servicing of standby power systems. The standby power sources consist of:

- i)       One 150 kVA diesel generator at Mahamba
- ii)      One 60 kVA diesel generator at Bothashoop
- iii)     One 60 kVA diesel generator at Emahlathini
- iv)      One 10kVA UPS unit at Mahamba Port of Entry
- v)       One 15kVA UPS unit at Bothashoop Port of Entry
- vi)      One 15kVA UPS unit at Emahlathini Port of Entry

**HB 01.02**       This specification shall form an integral part of the maintenance and servicing contract document and shall be read in conjunction with Portion 3, the Additional Specifications included with this document.

#### **HB02           STANDARD SPECIFICATIONS, REGULATIONS AND CODES**

**HB 02.01**       The latest edition, including all amendments up to date of tender of the following specifications, publication and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof.

#### **HB 02.02       SANS Specifications**

- 02.02.01       SANS 10400: NATIONAL BUILDING REGULATIONS
- 02.02.02       SANS 10142 : WIRING CODE

#### **HB 02.03       Department of Public Works Specification PW 774**

#### **HB 02.04       Occupational Health and Safety Act of 1993**

All regulations and statutory requirements as laid down in the latest edition of the Occupational Health and Safety Act of 1993: Construction Regulations, 2003 as promulgated in Government Gazette No 25207 and Regulation Gazette No 7721 of 18 July 2003 shall be adhered to.

**HB 02.05**      **Manufacturer's specifications and maintenance instructions**

**HB 02.06**      **Additional requirements**

Equipment and material supplied and installed shall be new and unused.  
The Contractor shall ensure that all safety regulations and measures are applied and enforced during repair and maintenance work on cabling, wiring, fuel tanks, batteries and diesel engines.

**HB03**      **OPERATING AND MAINTENANCE MANUALS**

**HB 03.01**      The Contractor shall be responsible for the compilation of a complete set of Operating-and-Maintenance manuals.

This shall be done in accordance with the Additional Specification SB - Operating and Maintenance manuals.

All information shall be recorded and reproduced in electronic format as well as supplying the Engineer with seven sets of hard copies.

**HB 03.02**      Over and above what is specified in the Additional Specification - SB Operating and Maintenance manuals, the Operating and Maintenance Manual to be compiled shall be structured and shall at least include the following:

**03.02.01**      Description of installation

- a) Complete system description of each standby power source. This shall be done for each installation individually. The system description shall contain detailed information regarding the supply configuration (cabling, distribution boards), the switching arrangement (change-over and override facilities) and the refuelling procedure as well as the earthing, fire and lightning protection arrangement.
- b) Service records

**03.02.02**      Commissioning Data

- a) Complete commissioning, test and inspection data of standby power system.

This shall be done for each installation individually. The commissioning data will comprise voltage and output current measurements, running hour meter readings, battery voltage during starting and engine compression tests.

**03.02.03**      Operating Data

- a) Safety precautions to be implemented.
- b) Operation of systems; automatic, manual and bypass switching.
- c) Emergency starting and forced change-over procedure.

**03.02.04**      Maintenance Documentation

- a) Recommended service intervals with service descriptions.
- b) Projected service life of:
  - diesel engine to next overhaul
  - diesel engine starter batteries
  - electronics on UPS units
  - battery pack
- c) Trouble shooting diagrams.
- d) Schedule of consumable spares.
- e) Schedule of batteries comprising the battery bank.

**HB 04 TEST AND INSPECTIONS PRIOR TO PRACTICAL COMPLETION OF REPAIR WORK**

**HB 04.01** It is the responsibility of the Contractor to provide all labour, accessories and properly calibrated and certified measuring instruments necessary to record the following parameters:

- 04.01.01 output phase voltages
- 04.01.02 output current per phase
- 04.01.03 insulation testing at 500V
- 04.01.04 system earthing resistance testing by means of wheatstone bridge instrument
- 04.01.05 load testing, utilising dummy loads

The Contractor is responsible for the arrangement of such tests. He shall give at least 72 hours notice to the Engineer prior to the test date.

**HB05 LOGGING AND RECORDING PROCEDURES**

**HB 05.01** The Contractor shall as part of this Contract institute a Recording system as part of his Maintenance Control Plan as defined in the Additional Specification SA - General Maintenance. This shall consist of a Record book which shall be utilised to log and record all faults, system checks, services, overhauls, breakdowns, maintenance visits, inspections, etc.

**HB 05.02** The logbook shall be stored in a safe place inside each generator room and shall only be utilised by the Contractor and Engineer. A copy of the monthly entries and recordings into this logbook shall be submitted by the Contractor together with his monthly report to the Engineer.

This logbook shall be structured to at least include the following:

- 05.02.01 Monthly inspection and maintenance actions.
- 05.02.02 Scheduled services.
- 05.02.03 Breakdown / call out reports.
- 05.02.04 Major overhaul or battery replacements.

**HB06 MAINTENANCE TOOLS AND SPARES**

**HB 06.01** On commencement of the Repair and Maintenance Contract, the Contractor shall supply and deliver certain tools and spares to the user client. These tools and spares will be the property of the Department of Public Works. Any deficiencies or short fall or damaged Tools and Spares during the contract shall be replaced with new equipment/ material.

**HB 06.02** The Tools and Spares shall be kept safe in a lockable store room on site. The Contractor shall provide his own lock for the designated store room. The inventory of the Tools and Spares shall be verified on a monthly basis. Any short fall shall be replaced by the Contractor as part of his responsibility under this contract.

**HB 06.03** The Tools and Spares shall at least include the following:  
 Distribution Board key (3 off)  
 Distribution Board face plate square key (3 off)  
 20L HD diesel oil as per engine manufacturer's specification  
 Oil funnel  
 25L distilled water  
 Battery hydrometer  
 12V diesel jockey pump



5m 20mm<sup>0</sup> diesel hose  
 10mm<sup>2</sup> battery jumper cables : 1 pair  
 First Aid Kit  
 Industrial type wall mounted (aluminium) paper towel dispenser with paper cartridge  
 per generator room similar or equal to "Kimberley Clark MP Wall Stand"

#### **HB07 QUALITY ASSURANCE SYSTEM**

- HB 07.01** Following formal approval of his Quality Assurance system by the Engineer to the Contractor shall implement the approved Quality Assurance system.
- HB 07.02** Records of this Quality Assurance system shall be kept throughout the duration of the contract and shall be submitted to the Engineer as required by the Department.

#### **HB08 RE-COMMISSIONING OF INSTALLATION**

On practical completion of the repair work, battery replacement and services, the installations shall be put into operation.

#### **HB09 REPAIR WORK TO STANDBY POWER INSTALLATIONS**

- HB 09.01** The scope of the maintenance work shall include, but shall not be limited to the activities listed below.
- HB 09.02** The Contractor shall record the repair actions in tabular format before the Contractor's responsibility for maintenance commences.
- HB 09.03** New equipment and material (eg. batteries, fuel pumps, starter motor, etc shall be supplied with a written guarantee confirming a defects liability period of 12 months from date of practical completion. These guarantees shall be furnished in favour of the Department of Public Works.

#### **HB 10 STANDBY GENERATORS: TECHNICAL DETAILS**

- HB 10.01** Installation description  
 Refer to the enclosed schedule:

ITEM No.	Locality	Engine Description	Alternator Description	Output kVA	Auto/ Manual/ Switching	Operational Yes/No	Approx year of installation	Critical load	Last service
	Mahamaba Port of Entry	John Deere	Marathon	150	Auto	Yes	2010	Offices & Security lights	2011
2	Bothashoop Port of Entry	John Deere	Leroy Somer	60	Auto	Yes	2007	Offices and Security lights	2011
3	Emahlathini Port of Entry	John Deere	Marelli Motori	60	Auto	Yes	2007	Offices and Security lights	2011

**HB 10.02      Scope of repair work : Generators**

**HB 10.02.01**      Clean plant room, clean and re-lamp luminaires. Seal all sleeves with chicken wire and builders foam. Put rodent poison inside cable trenches (2 x 500g). Paint floor with epoxy paint.

Service diesel engine and steam clean engine, alternator as well as day tank.

Inspect all rubber hoses and wiring; replace if required.

Service existing battery.

Do cold starting volt drop test on prime mover starter battery; replace starter battery if required.

Clean sliprings and inspect brushgear. Open alternator terminal box, clean and tighten terminations. Check and record earthing value as measured with resistance measuring instrument.

Service alarm and control panel and clean internally and externally. Simulate and verify all alarm and shut down conditions. Replace all inoperative lamps, sirens and meters. Check and complete all labelling and notices.

Repair lagging on exhaust system and reseal room exit port.

Reinstate fuel shut off system with fusible link.

Fit new padlocks on plant room.

Supply and install a fuel/water separator with automatic water dump feature in the fuel line from the tank to the generator. The separator shall be manufactured from robust corrosion resistant material and shall be similar or equal to Duvalco MK3 series.

Supply and install a fuel modular filtration with automatic water dump feature at the bulk fuel tank. The fuel modular filtration shall be manufactured from robust corrosion resistant material and shall be similar or equal to Duvalco FMS series.

A drip tray approximately 100mm deep shall be mounted below the fuel tank and must be large enough to collect any fuel that drips from the tank. The drip tray shall be manufactured from black mild steel. The thickness of the drip tray sheet steel shall not be less than 2mm.

**HB 10.02.02**      Do witnessed dummy load test.

**HB 10.02.03**      Service change-over switchgear. Disassemble contactors and clean. Test operation following service.

**HB 10.02.04**      Add an 12/24 V DC fluorescent emergency light, with switch above the control panel door of each generator installation.  
The light shall be energised via a push button switch with adjustable run down timer (0- 120 minutes)

**HB 10.03      Generator repair work : measurement and payment****HB 10.03.01      Re lant room**

The unit of measurement shall be the number of plant room cleaned and painted.

The tendered rate shall include full compensation for the repair and upgrade of the plant room. Walls and ceilings shall be washed with sugar soap. Floors shall be washed (Steam cleaned) and painted with grey 2-part industrial self levelling epoxy paint.

Cable trenches shall be cleaned and finally vacuumed. All cable sleeves shall be sealed with builders foam and chicken wire.

**HB 10.03.02 Service genset**

The unit of measurement shall be the number of services performed on alternators in the 20kW to 150kW range

The tendered rate shall include full compensation for the complete mechanical/electrical service of the generator installation according to the manufacturer's instructions, replacement of wiring, opening and cleaning of alternator and alarm panel as well as the steam cleaning of the assembly as described in Clause HB 10.02.

**HB 10.03.03 Diesel engine service**

The unit of measurement shall be the number of mechanical services performed on diesel engines in the 20kW to 150kW range.

The tendered rate shall include full compensation for the execution of a full engine service as per the manufacturer's recommendations including air, fuel and oil filters, oil, replacement of wiring, V-belts and hoses as needed and other consumable items as described in Clause HB 10.02 and the steam cleaning of the assembly.

The tendered rate shall further include for the supply and installation of a fuel shut off system with fusible link including all consumables such as pipes, cables, fittings and taps.

**HB 10.03.04 Replace starter battery**

The unit of measurement shall be the number of diesel starter batteries replaced.

The tendered rate shall include full compensation for the removal of the existing battery, the installation and reconnection of a new "Deltec Heavy-Duty Freedom"-type battery and final test of start up volt drop.

**HB 10.03.05 Dummi load test**

The unit of measurement shall be the number of on-site dummy load tests performed.

The tendered rate shall include full compensation for the opening of the alternator terminal box, connection of dummy load, 30 minute full load test, recording of test results and disconnection of load and reconnection of site load.

**HB 10.03.06 Change-over switchgear service**

The unit of measurement shall be the number of assemblies serviced.

The tendered rate shall include full compensation for the disassembly of the change-over contractor pair, cleaning and reinstallation as well as the testing following completion of the test.

Service alarm and control panel and clean internally and externally. Simulate and verify all alarm and shut down conditions. Replace all inoperative lamps, sirens and meters. Check and complete all labelling and notices.

**HB 10.03.07    Supply and install padlocks**

The unit of measurement shall be the number of 75mm padlocks installed.

The tendered rate shall include full compensation for the ordering, supply, engraving and installation of the plant room padlocks.

**HB 10.03.08    Su2Pb! of diesel fuel**

The unit of measurement shall be the quantity of diesel fuel supplied and transferred into day tanks upon instruction from the Engineer.

The tendered rate shall include full compensation for the supply, transport and transfer of diesel fuel.

**HB 10.03.09    Supply of Tools and Spares**

The unit of measurement shall be a lump sum. The tendered rate shall include full compensation for the supply and delivery of the Tools and Spares specified.

**HB 10.03.10    Reaair alarm sounder**

The unit of measurement shall be the number of alarm / flasher units installed. The tender rate shall include full compensation for the repair of the panel mounted alarm and circuit and the supply and installation of the specified external alarm/flasher unit, in full working order including all cabling to and from the Control panel.

**HB 10.03.11    Add 12/24V DC emergency light.**

The unit of measurement shall be the number of lights installed. The tender rate shall include full compensation for the supply and installation of all materials, brackets and fixings for the specified emergency light in full working order above the Control panel.

**HB 10.03.12    Supply and install fuel water separator**

The unit of measurement shall be the number of fuel/water separator units with automatic water dump installed.

The tendered rate shall include full compensation for the ordering, supply, installation and commissioning of the fuel/water separator unit similar or equal to Duvalco MK 3 series and Duvalco Modular Filtration System.

**HB 10.03.13    Supply and install a fuel drip tray**

The unit of measurement shall be the number of fuel drip trays supplied and installed.

The tendered rate shall include full compensation for the manufacturing, supply and installation of a fuel drip tray as described in Clause HB 10.03

**HB 10.03.14    Supply and Install water jacket heater**

The unit of measurement shall be the number of water jacket heaters supplied and installed.

The tendered rate shall include full compensation for the installation of a water heater complete with a thermostat, element connection of all water hoses including all couplings and taps, cabling to and from the control panel and testing and commissioning of the unit

## HB 10.03.15 Re air Exhaust

The unit of measurement shall be a sum for the removal of the existing exhaust and the supply and installation of the new exhaust similar to the existing.

The tendered rate shall include full compensation for the supply and installation of the new exhaust including, lagging, flexible connections and sealing of the room exit port.

## HB 10.03.16 8e-c\_ondition Diesel Engine

The unit of measurement shall be the number of diesel engines re-conditioned according to the manufacturer's specifications.

The tendered rate shall include full compensation for the disconnection, removal and complete overhaul of the diesel engine at an approved mechanical engineering works.

The tender rate shall further include for the replacement of all the internal components, seals, pipes, fittings etc of the diesel engine.

HB 10.03.17 **Supply and install day fuel tank**

The unit of measurement shall be a lump sum for the supply and installation of a day fuel tank as specified below.

The tendered rate shall include full compensation for the installation of the new day fuel tank including, connection, piping, jockey pump, fusible link and all consumables as specified below.

A fuel tank shall be installed in the plant room. The tank shall have sufficient capacity for standby sets to run the engine on full load for a period of 12 hours (+/- 400L). The fuel tank shall be a free standing type. The fuel tank shall be positioned such that free access to the tank may be afforded.

A water trap be fitted in the fuel pipeline from the tank to the engine.

The tank shall be fitted with a suitable filter, a full height gauge glass, "low fuel level" alarm, giving an audible and visible signal on the switchboard as well as a low-low fuel level cut-out.

An electrically operated pump with sufficient length of oil resistant hose to reach 2m beyond the door, shall be supplied, for each set for filling the fuel tank/s from 200 litre drums.

The interconnection fuel piping shall consist of copper tubes and the connection to vibrating components shall be in flexible tubing with armoured covering.

- The fuel tank shall be fitted with an alarm to provide an audible alarm on the generator control panel when the fuel level in the tank drops below 75 litres.
- A fuel level indicator shall be mounted on the tank in a position which is visible when operating the fuel pump. The indicator shall be a full height transparent gauge tube. The tube shall not be manufactured from glass or plastic. The lower gauge tube connection shall be fitted with a shut-off valve.
- A stopcock shall be fitted on the lowest point of the day tank to withdraw fuel samples.
- A mechanical fusible link across the diesel engine will provide fuel shut-off in case of fire. The daytank outlet shall be fitted with a 16 mm brass ball valve and 8 kg gravity dead-weight to facilitate the shut-off.

- A drip tray approximately 100mm deep shall be mounted below the fuel tank and must be large enough to collect any fuel that drips from the tank accessories. The drip tray shall be manufactured from black mild steel. The thickness of the drip tray sheet steel shall not be less than 2mm.
- Gravity feed lines shall be 22 mm Ø copper tubing with galvanised support brackets and galvanised protective unistrut sections between the bulk and day tanks. Underground piping shall be steel to SANS 62 with allowance for expansion, wrapped with Denso tape, overlapping 15 mm.
- The day tank level switch shall switch the 24 VDC solenoid valve at the day tank inlet to initiate gravity feed.
- Level switches shall be REMEX or approved equivalent.
- Note that a total of three level switches are required:
  - o empty tank engine cut-out signal.
  - o low fuel alarm
  - o switching the inlet solenoid valve
- The day tank will be fitted with a 32 mm overflow outlet piped to the bulk tank with similar size return line.
- An insulated 16 mm<sup>2</sup> earth wire shall be provided to bond the bulk tank to the generator day tank.
- The fuel line will be provided with a high capacity water separator and 5 micron fuel filter with replaceable filter cartridges.
- The bulk fuel tank shall be fitted with a 25 mm hose with a manual operated pump.

## **HB 11                      UPS UNITS: TECHNICAL DETAILS**

### **HB 11.01              Installation des rietion**

Refer to the enclosed schedule:

Item No	Locality	Manufacturer	Model	Output		Operational Yes/No	Approx year of installation	Critical load supplied	Last service
				Single phase	kVA				
1	Mahamba ICTRoom	Tower	Tower 1100	220	10 kVA	Yes	Unknown	Computers	2010
2	Bothashoop ICT Room	Tower	Tower 1100	220	15kVA	Yes	Unknown	Computers	2010
3	Emahlathini ICTRoom	Tower	Tower 1100	220	15kVA	Yes	Unknown	Computers	2010

**HB 11.02      Scope of repair work : UPS unit**

**HB 11.02.1** Remove cabinet cover / doors. Clean unit internally and externally. Check operation of ventilating fan and replace air intake filter, if fitted. Check and record earthing value with prescribed resistance measuring instrument.

**HB 11.02.02** Record output voltage, frequency and current in Record book. Record battery voltage.

**HB 11.02.03** Clean battery cabinet and tighten terminals. Do witnessed dummy load test and submit report on condition of batteries.

**HB 11.02.04** Replace UPS batteries upon instruction from Engineer.

**HB 11.03      UPS repair work : measurement and payment****HB 11.03.01      Service UPS electronic and battery cabinet**

The unit of measurement shall be the number of UPS systems opened and serviced in accordance with manufacturer's instructions and as set out in Clause HB 11.02.

The tendered rate shall include full compensation for the opening, cleaning , visual inspection of cable terminations, ventilating fans, battery links and the recording of earthing resistance.

The tendered rate shall further include full compensation for the testing of all control cards and replacement of any defective control cards.

**HB 11.03.02      Dummy load test**

The unit of measurement shall be the number of on-site UPS dummy load tests performed.

The tendered rate shall include full compensation for the connection of a UPS dummy load, 30 minute full load test recording of test results, including battery voltage and reconnection of site cabling as well as a written report on battery condition.

**HB 11.03.03      Re\_place UPS batteries**

The unit of measurement shall be the number of batteries replaced.

The tendered rate shall include full compensation for the disconnection and safe disposal of old batteries and supply, installation and connection of new sealed "Willard Vantage" UPS batteries.

**HB 11.03.04      Re\_place UPS Unit**

The unit of measurement shall be the number of UPS Units supplied and installed.

The tender rate shall include full compensation for the delivery, installation including all cabling and commissioning of the UPS unit.

**HB 11.03.05      Re\_place UPS Inverter**

The unit of measurement shall be the number of defective UPS inverters diagnosed and replaced.

The tender rate shall include full compensation for the removal of the defective boards as well as the supply, installation and testing of the new inverter board.

**HB 11.03.06    Replace UPS Battery Charger Card**

The unit of measurement shall be the number of defective UPS battery charger cards diagnosed and replaced.

The tender rate shall include full compensation for the removal of the defective boards as well as the supply, installation and testing of the new battery charger card.

**HB 11.03.07    Relllace UPS Fuses**

The unit of measurement shall be the number of defective fuses replaced.

The tender rate shall include full compensation for the removal of the defective fuses as well as the supply, installation and testing of the new fuse.

**HB12                    MAINTENANCE OF THE INSTALLATION**

**HB 12.01**            Monthly maintenance responsibilities for each installation including all units and components as specified, shall commence with access to the site. A difference shall be made in payment for the maintenance prior to and after practical completion of repair work.

Maintenance responsibilities of the completed installation shall commence upon the issue of a certificate of practical completion for repair work, and shall continue for the remainder of the 36-month contract period.

**HB 12.02**            The following maintenance actions will be required under the contract:

12.02.01            routine preventative maintenance

12.02.02            corrective maintenance

12.02.03            breakdown maintenance

These actions are defined in the Additional Specification SA - General Maintenance.

**HB 12.03**            The maintenance schedules and frequency of services and maintenance activities hall be developed under the maintenance control plan which will be instituted by the Contractor. The Contractor's responsibility in this regard is specified in the Additional Specification SA - General Maintenance.

**HB 12.04            Generator main nance : scope of work.**

**HB 12.04.01    Monthl    ection**

(a)            The following activities shall be executed during the monthly generator inspections:

check oil level and top up as required.

check oil viscosity for dilution by water or fuel.

check starter battery terminals and apply contact grease.

check battery cables for damage and secure terminations.

check battery electrolyte.

check battery voltage and record.

check battery voltage drop during engine cranking and record.

check battery charger operation after cranking test.

check starter motor for abnormal noise.

check diesel engine while running for noise, vibration or loose components.

check all flexible hoses for leaks, corrosion and ageing.

check all engine V-belts.

monitor engine/ alternator coupling for noise.



- (b) Verify that alarm functions are operational by simulation:

low oil pressure.  
 high engine temperature.  
 low engine coolant level.  
 abnormal speed.  
 synchronising failure (if applicable)  
 cooling water pump failure.  
 cooling tower fan failure (if applicable).  
 low battery voltage.  
 low fuel day tank.  
 fuel pump failure.  
 low fuel bulk tank (if applicable).

- (c) Test that following alarms trigger correctly by creating the alarm condition:

Unit not in auto	turn selector switch to manual or test
Battery charger failure	switch off AC supply to battery charger
Auxiliary supply failure	switch off auxiliary power supply

- (d) Alternator shall be checked for accumulation of dust on the regulator and for any loose components.
- (e) Test run shall be undertaken, if possible on load, and volt, ampere and frequency readings recorded.
- (f) Alternator shall be cleaned and switched back into 'auto' mode.
- (g) Complete Standby Generator monthly log sheets
- (h) Record running hours, diesel consumption etc.

#### **HB 12.04.02 Annual insaection**

The following activities shall be executed in addition to the monthly maintenance work after every twelve months.

- (a) Drain an oil sample and submit for analysis to establish need for an oil change. Fix test report in Record book.
- (b) Record output parameters while on load.
- (c) Record running hours.
- (d) Replace oil and fuel filters every 150 hours
- (e) Flush engine and replace coolant

#### **HB 12.04.03 Every two years : inspecti n and service**

In addition to the annual service, the cooling system shall be drained, flushed and refilled with water and prescribed water conditioner.

HB 12.05 Generator maintenance : measurement and Removal

Refer to Clause SA 06 of the ADDITIONAL SPECIFICATION  
MAINTENANCE.

SA GENERAL

HB 12.06 UPS maintenance : scope of work

HB 12.06.01 Monthly inspection

(a) The following activities shall be executed during a monthly inspection:

- record mains input voltage.
- record unregulated DC voltage.
- record battery charger voltage.
- visually check appearance of DC capacitors.
- visually inspect soft-start relays and resistors.
- record power supply output voltage on 5V and on 12V tops.
- measure "free running" frequency.
- check phase-lock loop.
- measure inverter output voltage and verify wave shape.
- check fan operation.
- check and record phase error voltage.
- Mains failure test

(b) The following must be measured and recorded:

- output voltage.
- load current.
- verify correct fuse ratings.

(c) Clean cabinets externally and internally.

HB 12.07 UPS maintenance : measurement and payment

Refer to Clause SA 06 of the ADDITIONAL SPECIFICATION  
MAINTENANCE.

SA GENERAL

## TECHNICAL SPECIFICATION

### HD SUB STATION TRANSFORMERS

#### CONTENTS

HD 01	SCOPE
HD02	STANDARD SPECIFICATIONS, REGULATIONS, CODES AND ADDITIONAL SPECIFICATIONS
HD03	AS-BUILT INFORMATION AND OPERATING AND MAINTENANCE MANUALS
HD04	TEST AND INSPECTION FOLLOWING COMPLETION OF REPAIR WORK
HD05	LOGGING AND RECORDING PROCEDURES
HD06	MAINTENANCE TOOLS AND SPARES
HD07	QUALITY ASSURANCE SYSTEM
HOOS	RE-COMMISSIONING OF INSTALLATION
HD09	REPAIR WORK TO INSTALLATIONS
HD 10	INSTALLATION MAINTENANCE
HD 11	SUBSTATION TRANSFORMERS: TECHNICAL DETAILS

#### HD 01 SCOPE

HD 01.01	This specification comprises all aspects regarding the repair and maintenance of transformer systems. Transformers comprise: <ul style="list-style-type: none"> <li>♦ substation transformers</li> <li>♦ pole mounted transformers.</li> </ul>
HD 01.02	This specification shall form an integral part of the repair and maintenance contract document and shall be read in conjunction with Part C, the Additional Specification included with this document.

#### HD02 "STANDARD SPECIFICATIONS" REGULATIONS AND CODES

HD 02.01	The latest edition, including all amendments up to date of tender of the following specifications, publication and codes of practice shall be read in conjunction with the specification and shall deemed to form part thereof.
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#### **HD 02.02 SANS Specifications**

- ♦ SANS 0780
- ♦ SANS 10400
- ♦ SANS 10142
- ♦ SANS 10225
- ♦ SANS 01277
- ♦ SANS 1088
- ♦ SANS 1749
- ♦ SANS 1250
- ♦ SANS 1279
- ♦ SANS 1777
- ♦ SANS 1763
- ♦ SANS 1266
- ♦ ARP 035

#### HD 02.03 Department of Public Works Specifications

- ♦ PW 774

**HD08 RE-COMMISSIONING OF INSTALLATION**

**HD 08.01** On completion of the repair work the transformer installations shall be put into operation.

**HD09 REPAIR WORK TO TRANSFORMER INSTALLATIONS**

**HD 09.01** The various transformer systems shall be repaired as measured in the bills of quantities, Installation A3, during the first period of the repair and maintenance contract.

**HD 09.02** The scope of the repair work shall include, but shall not be limited to the activities listed below.

**HD 09.03** The Contractor shall record the repair actions in tabular format before the maintenance phase commences.

**HD 09.04** Repair work shall be executed within the approved period for repairs. This period shall be agreed at the start of the contract period.

**HD 09.05** New equipment and material (e.g. air driers etc.) shall be supplied with a written guarantee confirming a defects liability period of 12 months from date of hand-over. These guarantees shall be furnished in favour of the User Client.

**HD 09.06** The maintenance phase of this contract shall commence once the repair work on the installation have been commissioned and handed over to the satisfaction of the Engineer.

**HD 10 INSTALLATION MAINTENANCE**

**HD 10.01** The various transformer systems shall be maintained following the initial repair work. The maintenance contract shall run for the balance of the 36 month contract period.

**HD 10.02** The following maintenance actions will be required under this period of the contract:

- ♦ routine preventative maintenance
- ♦ corrective maintenance
- ♦ breakdown maintenance

These actions are defined in the Additional Specification SA - General Maintenance.

**HD 10.03** The maintenance schedules and frequency of services and maintenance activities shall be developed under the maintenance control plan which will be instituted by the Contractor. The Contractor's responsibility in this regard is specified in the Additional Specification SA - General Maintenance.

**HD 11 TRANSFORMERS: TECI:LNJCA L DETAILS**

**HD 11.01** Installation description

This section describes the transformers that will be repaired and maintained in terms of this contract.

The transformer in the transformer room of the substation is rated at 315kVA and is of the dehydrating type.

HD 11.02

**Scope of repair work**

Oil test: Specific tests to be carried out includes di-electric test, moisture content test, acidity test and gas analysis, per random sample.

Purification of transformer oil: oil to be drained purified and replaced.

Service transformer: Power wash at high pressure and high temperature. Check working of oil level gauge.

Clean and re-torque transformer bushings. Re-torque all loose bolts with impact wrench. Measure earth resistance.

Insulation resistance test: Perform at windings MV to LV, MV to earth and LV to earth.

Fit drier: Fit silica gel air drier.

Check drier: Check condition of drying agent and replace, if necessary.

HD 11.03

**Reeairwork**

<u>Item</u>	<u>Unit</u>
(a) Service transformer	No

The unit of measure shall be the number of transformers serviced.

The tendered rate shall include full compensation for cleaning of the transformer, re-torque of bushings and bolts, check oil level gauge, tightening of terminations, replace gaskets, seals, record tap changer settings, etc.

<u>Item</u>	<u>Unit</u>
(b) Oil test	No

The unit of measure shall be the number of transformers that is tested.

The tenderer shall include full compensation for the complete test to be performed, which include the following tests:

- ▶ di-electric tests
- ▶ moisture content tests
- ▶ accidity tests and
- ▶ gas analysis tests.

<u>Item</u>	<u>Unit</u>
(c) Oil purification	Item

The unit of measure shall be number of transformers which oil has been purified.

The tendered rate shall include full compensation for all labour, transport, draining, on site purification of transformer oil as per the oil test results or replacement of oil.

The tendered rate shall further include full compensation for the testing of the oil as per clause HD10.03 (b) and submitting the test results to the Representative.

<u>Item</u>	<u>Unit</u>
(d) Fit silica gel air drier	No

The unit of measure shall be the number of air driers installed.

The tendered rate shall include full compensation for the ordering, supply and installation of complete air driers to the supplier's specifications.

<u>Item</u>	<u>Unit</u>
(e) Replace drier gel	No
The unit of measure shall be the number of driers where the drying agent is replaced.	

The tendered rate shall include full compensation for the ordering, supply and installation of drier gel.

<u>Item</u>	<u>Unit</u>
(f) Add additional transformer oil	litres

The unit of measure shall be the number of litres of oil added to the transformer.

The tendered rate shall include full compensation for ordering, supply and adding additional oil (oil to SANS 0555 specification) to be supplied in 25 litre containers.

<u>Item</u>	<u>Unit</u>
(g) Repair oil leak	No.

The tendered rate shall include full compensation for the replacement of the transformer gasket if and when instructed by the engineer.

<u>Item</u>	<u>Unit</u>
(h) Re-tape LV and MV bushings and MV busbars.	item.

The unit of measure shall be a lump sum.

The tendered rate shall include full compensation to re-tape the LV and MV bushing and MV busbars to the bushings of the MV panel using PVC insulation tape.

HD 11.04	Schedule of maintenance work
HD 11.04.01	General
	Refer to HD 10
HD 11.04.02	<b>Monthly</b>
	Check oil levels Check silica gel Check for oil leaks Visually inspect transformers and terminations.
HD 11.04.03	<b>Annual</b>
	Service transformers Record values in logbook Test Oil Purification if required
HD 11.05	<b>Maintenance work: measurement and maintenance</b>
	Refer to clause SA 06 of the Additional specification - SA General Maintenance.
	Remuneration for the maintenance work shall form part of the overall Medium and Low Voltage Installation (Installation 83).

## TECHNICAL SPECIFICATION

### HE EXTERIOR LIGHTING SYSTEMS

#### CONTENTS

HE 01	SCOPE
HE02	STANDARD SPECIFICATIONS, REGULATIONS, CODES AND ADDITIONAL SPECIFICATIONS
HE03	OPERATING AND MAINTENANCE MANUALS
HE04	TEST AND INSPECTION
HE 05	LOGGING AND RECORDING PROCEDURES
HE06	QUALITY ASSURANCE SYSTEM
HE07	RE-COMMISSIONING OF INSTALLATION
HE08	EXTERIOR LIGHTING INSTALLATIONS AND KIOSKS
HE09	AREA LIGHTING: TECHNICAL DETAILS
HE10	SECURITY FENCE LIGHTING: TECHNICAL DETAILS
HE 11	STREET LIGHTING: TECHNICAL DETAILS
HE12	MAINTENANCE OF EXTERIOR LIGHTING SYSTEMS AND DISTRIBUTION KIOSKS

#### **HE01 SCOPE**

**HE 01.01** This specification comprises all aspects regarding the maintenance and servicing of external lighting systems. External lighting comprises:

- i) Area lighting
- ii) Security lighting along perimeter fences
- iii) Street lighting

**HE 01.02** This specification shall form an integral part of the maintenance and servicing contract document and shall be read in conjunction with Part C, the Additional Specifications included with this document.

#### **HE02 STANDARD SPECIFICATIONS, REGULATIONS AND CODES**

**HE 02.01** The latest edition, including all amendments up to date of tender of the following specifications, publication and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof.

#### **HE 02.02 SANS Specifications**

02.02.01	<b>SANS 10400</b>	National Building Regulation
02.02.02	<b>SANS 10142</b>	Wiring code
02.02.03	<b>SANS 10225</b>	Lighting masts
02.02.04	<b>SANS 1277</b>	Road lighting luminaires
02.02.05	<b>SANS 1088</b>	Spigot entries
02.02.06	<b>SANS 1749</b>	Glass polyester poles
02.02.07	<b>SANS 1250</b>	Capacitors, ballasts & lamps
02.02.08	<b>SANS 1279</b>	Floodlight luminaires
02.02.09	<b>SANS 1777</b>	Daylight switches
02.02.10	<b>SANS 763</b>	Galvanised coatings
02.02.11	<b>SANS 1266</b>	Discharge lamps
02.02.12	<b>ARP 035</b>	Streetlighting maintenance



- HE 02.03      Department of Public Works Specification PW 774
- HE 02.04      Occupational Health and Safety Act of 1993: Construction Regulations, 2003 as promulgated in Government Gazette No 25207 and Regulation Gazette No 7721 of 18 Jul\_y\_ 2003.
- HE 02.05      Manufacturer's specifications and installation instructions
- HE 02.06      Additional requirements
- Equipment and material supplied and installed shall be new and unused. Luminaires and control gear shall bear the SANS stamp. The Contractor shall ensure that all safety regulations and measures are applied and enforced during repair and maintenance work on cabling, wiring, luminaires, lighting poles and high masts.

### **HE03                      OPERATING AND MAINTENANCE MANUALS**

- HE 03.01**      The Contractor shall be responsible for the compilation of a complete set of Operating-and-Maintenance manuals.
- This shall be done in accordance with the Additional Specification SB - Operating and Maintenance manuals.
- All information shall be recorded and reproduced in electronic format as well as supplying the Engineer with seven sets of hard copies.
- HE 03.02**      Over and above what is specified in the Additional Specification - SB Operating and Maintenance manuals, the Operating and Maintenance Manual to be compiled shall be structured and shall at least include the following:
- 03.02.01      DescriQtion of Installation
- Complete system description of the lighting system. This shall be done for each lighting installation individually. The system description shall contain detailed information regarding the supply configuration (Distribution board, cabling, distribution kiosks, pole mounted distribution board), the switching arrangement (timers, photocells, override facilities) and the lighting (luminaire detail, lamp detail) as well as the earthing and lightning protection arrangement.
- 03.02.02      Commissioning Data
- Complete commissioning, test and inspection data of lighting system.
- This shall be done for each lighting installation individually. The commissioning data will comprise start-up and running current measurements at each termination point e.g. distribution board, kiosk and mast. Full data on lamps fitted with installation dates.
- 03.02.03      Operating data
- a)      Safety precautions to be implemented.
- b)      Operation of lighting systems; automatic, manual and bypass switching.
- 03.02.04      Maintenance instructions
- a)      Projected frequency of lamp replacement per lighting system.
- b)      Procedure to verify operation of photocell - controlled circuits.
- c)      Procedure to verify operation of timer- controlled circuits.
- d)      Trouble shooting diagram.

### HE.3

- e) Luminaire details, including manufacturers brochures / pamphlets, order number, list of components and lamp specification.
- f) Schedule of serviceable components per lighting system. These schedules shall include lamps, starters, ignitors, ballasts, lenses, etc.

#### **HE04 TESTS AND INSPECTIONS**

**HE 04.01** It is the responsibility of the Contractor to provide all labour, accessories and properly calibrated and certified measuring instruments necessary to record the following parameters:

- 04.01.01** Phase voltages
- 04.01.02** Current per phase
- 04.01.03** Illumination levels in lux
- 04.01.04** Insulation testing at 500V
- 04.01.05** Earthing resistance testing by means of wheatstone bridge instrument

The Contractor is responsible for the arrangement of such tests. He shall give at least 72 hours notice to the Engineer prior to the test date.

#### **HE05 LOGGING AND RECORDING PROCEDURES**

**HE 05.01** The Contractor shall as part of this Contract institute a Recording system as part of his Maintenance Control Plan as defined in the Additional Specification SA - General Maintenance. This shall consist of a Record book which shall be utilised to log and record all faults, system checks, breakdowns, maintenance visits, inspections etc.

**HE 05.02** The logbook shall be stored in a safe place inside the prison maintenance supervisor's office and shall only be utilised by the Contractor and Engineer. A copy of the monthly entries and recordings into this logbook shall be submitted by the Contractor together with his monthly report to the Engineer.

This logbook shall be structured to at least include the following:

- 05.02.01** Monthly lamp inspection and maintenance actions.
- 05.02.02** Bi-annual inspection and testing of lighting systems.
- 05.02.03** Annual earthing test report.
- 05.02.04** Breakdown / call out reports.

#### **HE06 QUALITY ASSURANCE SYSTEM**

**HE 06.01** Following formal approval of his Quality Assurance system by the Engineer, the Contractor shall implement the approved QA system.

**HE 06.02** Records of this QA system shall be kept throughout the duration of the contract and shall be submitted to the Engineer as required by the Department.

#### **HE07 RE-COMMISSIONING OF INSTALLATION**

**HE 07.01** On completion of the servicing work and lamp replacement, the lighting installations shall be put into operation.

**HE 07.02** Lighting installations shall be energised for a minimum continuous period of 96 hours immediately prior to the Engineer's inspection to verify lamp stability and reliability of power reticulation

**HE08 EXTERIOR LIGHTING INSTALLATIONS**

- HE 08.01 The various lighting systems shall be serviced as part of installation H during the first phase of the maintenance contract
- HE 08.02 The scope of the work shall include, but shall not be limited to the activities listed below.
- HE 08.03 The Contractor shall record the repair actions in tabular format before the Contractor's responsibility for maintenance commences.
- HE 08.04** Repair work shall be executed within the approved period for repairs.
- HE 08.05** New equipment and material shall be supplied with a written guarantee confirming a defects liability period of 12 months from date of practical completion. These guarantees shall be furnished in favour of the Department of Public Works.
- HE 08.06** The following measurement and payment items shall apply for repair work

	<u>Item</u>	<u>Unit</u>
1) <b>HE 08.06(a)</b>	<b><u>Excavate in all materials for trenches, backfill, compact and dispose of surplus material</u></b>	m <sup>3</sup>

This rate shall apply to all the excavations.

The unit of measurement shall be the cubic metre of material excavated in trenches, classified according to the depth and width specified listed. The width classification shall be in accordance with the authorised dimensions and the depth classification in accordance with the total depth of the trench and not with the depth range in which the material is situated before excavation. The depth of excavation shall be measured to the underside of the bedding.

The tendered rate shall include full compensation for clearing and grubbing the trench areas and the temporary removal of improvements from the line of the trench, for excavating the trench, preparing the bottom of the trench, separating material unsuitable for backfill, keeping the excavations safe, dealing with any surface or subsurface water, measuring, classification and keeping of all records and for separating topsoil and selected backfill material where necessary.

The rate shall furthermore cover the costs of installing the sand bed and sand cover, backfilling, compacting and disposing of the surplus material.

	<u>Item</u>	<u>Unit</u>
<b>HE 08.06(b)</b>	<b><u>Extra over item HE 09.06(a) for excavating in hard material</u></b>	m <sup>3</sup>

The unit of measurement shall be the cubic metre of material excavated and classified as hard, in accordance with the classification set out hereunder.

The tendered rate shall be paid over and above the rate tendered for excavation in respect of items HD 09.06(a) in full compensation for the additional cost of excavating in hard material instead of soft.

The tendered rate shall include full compensation for any overbreak as well as the additional backfilling required, reinstating the trench bottom, and for any other incidentals resulting from overbreak.

The materials excavated shall be classified as follows for payment purposes:  
Hard material:

## HE.5

Material which cannot be excavated efficiently except with the use of pneumatic tools, blasting or wedging and splitting, and shall include boulders exceeding 0,15 m<sup>3</sup> in volume.

Soft material:

All material not classified as hard material.

Notwithstanding the above classification, all material excavated from previously constructed fills, embankments, pavement layers and from above existing services shall be classified as soft material.

The decision of the Engineer as to the classification of the material shall be final and binding and any objection as to the classification shall be made before the excavation has been backfilled.

	<u>Item</u>	<u>Unit</u>
HE 08.0S(c)	<b><u>Extra over item 3.10.1.1 for excavating by hand in all materials</u></b>	m <sup>3</sup>
	<p>The unit of measurement shall be the cubic metre of trench material excavated by means of hand tools as instructed or authorised in writing by the Engineer where the use of conventional excavating equipment is either impractical or likely to cause damage to services, trees or property or where the electrical Contractor has to excavate by hand where he cannot excavate by machine.</p> <p>The volumes of the trench excavation will be computed from the length and the depth to the bottom of the specified bedding layer and the minimum base widths specified in the drawings. The rate shall cover the cost of complying with the safety and protection requirements specified except where particular items are scheduled to cover particular costs for the excavation.</p> <p>The tendered rate shall be paid extra over the rates tendered for item HE09.06(a).1 in full compensation for the additional expense of excavating by means of hand labour instead of conventional trenching equipment.</p>	
HE 08.0S(d)	<b><u>Extra over item HD09.06(a) for using backfill material obtained from sources <u>provided by</u> the Contractor</u></b>	m <sup>3</sup>

The unit of measurement shall be the cubic metre of imported backfill material.

Item HD09.06(d) above will not be measured for payment unless importation has been ordered in writing. The volume will be computed from the trench width and the depth from ground level to the top of the sand bed cover as shown on the tender drawings. The rate for material from designated borrow pits shall cover the cost of excavation and selection of suitable material, the moving of the material to the backfilling site, and the disposal of the material that becomes surplus as a result of the importation, all within 0,5 km.

The tendered rate for item HE09.06(d) paid extra over item HE09.06(a) shall cover the cost of the acquisition of the material and of the disposal of the surplus material resulting from the importation together with all the costs of transporting the material to the site regardless of distance.

	<u>Item</u>	<u>Unit</u>
HE 08.06(e)	<b><u>Supply and Install Cable Sleeves</u></b>	m
	The unit of measurement shall be the linear length in meter of cable sleeves supplied and installed.	
	The tendered rate shall include full compensation for the supply, delivery, handling and installing the cable sleeves including all the required couplings, steel draw wires and plugs.	
	<u>Item</u>	<u>Unit</u>
HE 08.06(f)	<b><u>Supply and Install Plastic Warning Tape</u></b>	m
	The unit of measurement shall be the length in meter of plastic warning tape supplied and installed.	
	The tendered rate shall include full compensation for the supplying, handling and laying the plastic warning tape.	
	<u>Item</u>	<u>Unit</u>
HE 08.06(g)	<b><u>Supply and delivery of low-voltage cable</u></b>	m
	The unit of measurement shall be the length of low-voltage cable supplied.	
	The tendered rate shall include full compensation for the manufacture, supply and delivery of the specified cable to the site.	
	Separate items shall be scheduled under this payment item for each size and type of cable required.	
	<u>Item</u>	<u>Unit</u>
HE 08.06(h)	<b><u>Lay LV-cable</u></b>	m
	The unit of measurement shall be the linear length in meter of LV-cable installed.	
	The tendered rate shall include full compensation for the handling, inspecting, laying, cutting and testing the cable. Cables shall be measured linearly over all lengths laid. Separate items shall be scheduled for each size and each type of cable laid.	
	<u>Item</u>	<u>Unit</u>
HE 08.06 (i)	<b><u>Termination of LV-cables</u></b>	No
	The unit of measurement shall be the number of LV-cable terminations.	
	The tendered rate shall include full compensation for providing the cable glands, shrouds and lugs, the cost of handling, fitting and cutting the cable. Separate items shall be scheduled for each size and type of cable.	
	<u>Item</u>	<u>Unit</u>
HE 08.06(j)	<b><u>Supply bare copper earth conductor</u></b>	m
	The unit of measurement shall be the length in meter of bare copper earth conductor supplied.	
	The tendered rate shall include full compensation for procuring, furnishing and laying the specified earth continuity conductor.	

	<u>Item</u>	<u>Unit</u>
HE 08.06(k)	<u>Installation of bare copper</u> eaxth conductor	m
	<p>The unit of measurement shall be the length in meter of bare copper earth conductor installed.</p> <p>The tendered rate shall include full compensation for procuring, furnishing and laying the specified earth continuity conductor.</p>	
	<u>Item</u>	<u>Unit</u>
HE 08.06(1)	<b>Terminate and connect bare co.(!l;!ler earth conductor</b>	No
	<p>The unit of measurement shall be the number of bare copper earth conductors terminated and connected.</p> <p>The tendered rate shall include full compensation for supplying all the material required to terminate and connect the bare copper earth conductors and the connecting thereof to the earth bars.</p>	
	<u>Item</u>	<u>Unit</u>
HE 08.0S(m)	<u>Jointing of low-voltage cable</u>	No
	<p>The unit of measurement shall be the number of LV-cables joints.</p> <p>The tendered rate shall include full compensation for the cost of providing the kits, the cost of cutting the cable, handling and fitting the kits and the cost of testing the joints.</p>	
	<u>Item</u>	<u>Unit</u>
HE 08.06(n)	<u>Re-lamp</u> luminaire	No
	<p>The unit of measurement shall be the number of luminaire lamps replaced.</p> <p>The tendered rate shall include full compensation for the supply and installation of the lamp according to the manufacturer's instructions.</p> <p>Separate items shall be scheduled for each type of lamp.</p>	
	<u>Item</u>	<u>Unit</u>
HE 08.06(0)	<u>Supply and installation of internal luminaire components</u>	No
	<p>The unit of measurement shall be the number of internal luminaire components replaced.</p> <p>The tendered rate shall include full compensation for the supply and installation of the components according to the manufacturer's instructions.</p> <p>Separate items shall be scheduled for each component.</p>	
	<u>Item</u>	<u>Unit</u>
HE 08.0S(p)	<u>Internal wiring</u> of luminaire	No
	<p>The unit of measurement shall be the number of luminaires rewired with silicone insulated wiring.</p> <p>The tendered rate shall include full compensation for the supply and wiring of a luminaire with silicone insulated wiring where the wiring are specified seperately.</p>	

<u>Item</u>	<u>Unit</u>
HE 08.0S(q) <b><u>Supply</u></b> and install circuit breakers	No
The unit of measurement shall be the number of circuit breakers supplied and installed.	
The tendered rate shall include full compensation for the supply and installation of the circuit breakers where the circuit breakers are specified separately.	

<u>Item</u>	<u>Unit</u>
HE 08.06(r) <b><u>Supply</u></b> and install isolators	No
The unit of measurement shall be the number of isolators supplied and installed.	
The tendered rate shall include full compensation for the supply and installation of the isolators where the isolators are specified separately.	

<u>Item</u>	<u>Unit</u>
HE 08.0S(s) <b><u>Supply</u></b> and install contactors	No
The unit of measurement shall be the number of contactors supplied and installed.	
The tendered rate shall include full compensation for the supply and installation of the contactors where the contactors are specified separately.	

<u>Item</u>	<u>Unit</u>
HE 08.06(t) <b>Su</b> and install of low tension fuses	No
The unit of measurement shall be the number of fuses supplied and installed.	
The tendered rate shall include full compensation for the supply and installation of the fuses where the fuses are specified separately.	

<u>Item</u>	<u>Unit</u>
HE 08.06(u) <b><u>Supply and install National photocell (plug-in type)</u></b>	No
The unit of measurement shall be the number of photocells supplied and installed.	
The tendered rate shall include full compensation for the supply and installing of the photocells where the photocells are specified separately.	

<u>Item</u>	<u>Unit</u>
HE 08.06(v) <b><u>Supply and install Heinemann QAT-R-Clip in timer</u></b>	No
The unit of measurement shall be the number of timers supplied and installed.	
The tendered rate shall include full compensation for the supply and installing of the timers where the timers are specified separately.	

## HE.9

<u>Item</u>	<u>Unit</u>
HE 08.0S(w) <b><u>Supply</u></b> and install 0-30A HRC fuses	No

The unit of measurement shall be the number of fuses supplied and installed.

The tendered rate shall include full compensation for the supply and installing of the fuses where the circuit breakers are specified separately.

<u>Item</u>	<u>Unit</u>
HE 08.0S(x) <b><u>Supply and install end connectors and insulating</u></b> sleeves	No

The unit of measurement shall be the number of end connectors and insulating sleeves supplied and installed.

The tendered rate shall include full compensation for the supply and installation of the end connectors at the light pole or where cables forms a looping system.

The end connectors shall be similar or equal to Pratley No 2 end connectors and insulating sleeves.

<u>Item</u>	<u>Unit</u>
<b>HE 08.06 (y) <u>Replace pole</u></b>	

The unit of measure shall be the number of poles replaced.

The tendered rate shall include full compensation for the removal of all equipment from the existing pole, removal of the existing pole from site, ordering, supply and installation of the pole in the position specified.

The contractor shall install all existing equipment onto the new pole

<u>Item</u>	<u>Unit</u>
<b>HE 08.06 (z) <u>Replace Luminaire diffuser</u></b>	

The unit of measure shall be the number of luminaire diffusers replaced.

The tendered rate shall include full compensation for the removal of the diffuser from the existing luminaire, ordering, supply and installation of the new diffuser as specified according to manufactures instructions.

<u>Item</u>	<u>Unit</u>
<b>HE 08.06 (aa) <u>Replace pole</u> mounted brackets</b>	

The unit of measure shall be the number of pole brackets replaced.

The tendered rate shall include full compensation for the ordering, supply and installation of the pole bracket including all fixing accessories as specified according to manufactures instructions.

The tendered rate shall further include for the removal of all old equipment from the pole and the supply and installation of the new equipment onto the pole bracket including the connection of the equipment.



HE 10.02 Scope of repair work

Open each pole cover and inspect fuse or circuit breaker, tray and shield plate as well as earthing connection. Check and replace cover seal if required. Wash luminaire and lens, replace neoprene seal and re-lamp luminaires.

Replace luminaires: Remove existing damaged luminaires, supply and install similar and approved luminaires complete with lamps and control gear, if applicable. Check aiming angle and adjust if necessary.

Open upstream distribution board. Check and fasten cable terminations, fit labelling and blank face-plate covers. Check locking mechanism and fit padlock.

Open distribution kiosk. Clean inside and add termite and rodent poison. Fit circuit labelling. Check locking mechanism and fit padlock.

Open each distribution Kiosk, clean inside provide termite and rodent poison. Check earth bar and earth continuity. Check and fasten cable terminations, fit labelling and blank face-plate covers. Check locking mechanism and fit padlock. Check earth connection to electrode.

Service luminaires by washing with detergent and re-lamping where necessary. Clean lenses. Check condition of seals and glands and test for earth continuity

HE 10.03 Repair work: Measurement and payment

<u>Item</u>	<u>Unit</u>
(a) <b>Service <u>security light pole</u></b>	No
The unit of measurement shall be the number of security light poles opened and serviced.	
The tendered rate shall include full compensation for the opening of pole box, visual inspections, corrosion protection, straightening of poles if necessary, treating of wooden poles with cresote and securing circuit breakers and terminations.	
The contractor shall give a general report on the condition of the pole and equipment. The report should indicate if poles are rotten (wood poles), bent (steel poles), broken (wood, steel, concrete or fiberglass poles) or if the pole should be painted (steel). Strap all cable to pole.	

<u>Item</u>	<u>Unit</u>
(b) <b>Re-lam_p luminaire</b>	No

The unit of measurement shall be the number of security lamps replaced.

The tendered rate shall include full compensation for the supply and installation of the lamp according to the manufacturer's instructions.

<u>Item</u>	<u>Unit</u>
(c) <b>Service distribution kiosk</b>	No

The unit of measurement shall be the number of distribution kiosks or boards opened and serviced.

The tendered rate shall include full compensation for the opening of kiosk or distribution board, vermin protection, cleaning of circuit breakers, earth testing, secure circuit breakers and terminations and fitting of blank covers. The contractor is to submit a report on the general condition of the kiosk or distribution board (damaged, rust marks, etc.)

<u>Item</u>	<u>Unit</u>
(d) Re2lace luminaires	No

The unit of measurement shall be the number of security floodlight luminaires replaced.

The tendered rate shall include full compensation for the supply and installation of the luminaire complete with the lamp and control gear according to the manufacturer's instructions.

Similar or equal to Beka Flood 400W HPS Floodlight	
<u>Item</u>	<u>Unit</u>
(e) <b>Service luminaire</b>	No

The unit of measure shall be the number of luminaires serviced.

The tendered rate shall include full compensation for the service of the luminaire, including washing, corrosion protection, checking of seals and glands, cleaning of lenses, tightening of brackets bolts, checking of earthing continuity, checking of aiming angle and adjust if necessary

## **HE 11 STREETLIGHTING: TECHNICAL DETAILS**

### **HE 11.01 Installation description**

This section describes the electrical distribution network that will be repaired and maintained in terms of this contract.

Luminaires are suspended on steel, wood, concrete and fibreglass poles of various lengths. Street lights are controlled by means of photocells and manual on/off switches.

AREA/STREET	POLE/ MAST INFORMATION		LUMINAIRE INFORMATION		
	MOUNTING HEIGHT	DESCRIPTION / MATERIAL	DESCRIPTION	SWITCHING	NUMBER
Mahamba	3m	Fibreglass Pole	70W HPS Post top	Photocell	23
Mahamba	7m	Wooden pole	125W MV Streetlight	Auto	4
Emahlathini	7m	Wooden pole	125W MV Streetlight	Auto	9
Emahlathini	3m	Fibreglass Pole	125W MV Post top	Photocell	6
BothasHoop	7m	Wooden pole	125W MV Streetlight	Auto	14

- b) Annual
  - i) Service all luminaires
  - ii) Measure earth resistance of electrode
  - iii) Measure earth resistance of trench earth
  - v) Record values in record book

12.04.02 Scope of maintenance work on security lighting

- a) Monthly
  - i) Verify operation of switching element.
  - ii) Check lamps.
  - iii) Check that all pole covers are secure.
  - iv) Visually check distribution kiosk.
- b) Annual
 

Measure phase voltages and line currents in distribution kiosk or local distribution board. Record values in record book. Do vermin protection. Service all luminaires.

12.04.03 Scope of maintenance work on street lighting

- a) Monthly
  - i) Verify operation of switching element.
  - ii) Check lamps.
  - iii) Check that all pole covers are secure.
  - iv) Visually check distribution kiosk.
- b) Annual
 

Measure phase voltages and line currents in distribution kiosk. Record values in Record book. Do vermin protection. Service all luminaries and distribution kiosks.

**HE.12.05** Maintenance shall include all repairs, replacing of components or materials, routine setting or any other actions necessary to ensure a perfect functional condition.

**HE.12.06** Maintenance work measurement and payment.

Refer to clause SA06 of the ADDITIONAL SPECIFICATION : SA GENERAL MAINTENANCE

## **TECHNICAL SPECIFICATION**

### **FC            HOT-WATER GENERATING INSTALLATIONS**

#### **CONTENTS**

FC 01	SCOPE
FC 02	STANDARD SPECIFICATIONS
FC 03	VARIATIONS AND ADDITIONS TO STANDARD SPECIFICATIONS
FC 04	OPERATING AND MAINTENANCE MANUALS
FC 05	TRAINING OF OPERATORS FOR THE OPERATION OF THE INSTALLATION AND EQUIPMENT
FC 06	LOGGING AND RECORDING PROCEDURES
FC 07	TESTS AND INSPECTIONS ON COMPLETION OF REPAIR WORK
FC 08	QUALITY ASSURANCE SYSTEM
FC 09	COMMISSIONING AND RECOMMISSIONING OF PLANT AND INSTALLATION
FC 10	GUARANTEE OF INSTALLATION AND EQUIPMENT
FC 11	MAINTENANCE TOOLS AND SPARES
FC 12	REPAIR WORK TO INSTALLATIONS, SYSTEMS AND EQUIPMENT
FC 13	MAINTENANCE TO INSTALLATIONS AND EQUIPMENT

#### **FC 01            SCOPE**

This specification covers the general repair and maintenance of hot-water generating installations, which include the following:

- (a) Steam generated hot-water heating equipment
- (b) Electrical generated hot-water heating equipment
- (c) Primary and secondary pumps
- (d) Hot-water storage vessels
- (e) Lagging and cladding of vessels and piping systems
- (f) Hot-water reheating vessels
- (g) Corrosion protection linings to storage vessels and re-heaters
- (h) Hot, cold and drainage pipework to the plant room installation
- (i) Electrical control systems, wiring and control panels
- (j) Thermostats and safety equipment.

This specification also addresses the training of

- User Client and associates, and
- maintenance staff.

This specification shall form an integral part of the repair and maintenance contract document, and shall be read in conjunction with the additional and particular specifications compiled as part of this document.

This specification shall act as a guideline to the particular specification and, in the event of any discrepancies between the Technical Specification and the Particular Specification, the latter shall take precedence.

The latest edition, including all amendments up to date of tender of the following specifications, publications and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof:

SABS 0400 - The applications of the building regulations SABS  
0142 - Code of practice for the wiring of premises SABS 0140  
- Identification colour marking  
SABS 044 - Parts I to IV: Welding  
SABS 460 - Copper tubes for domestic plumbing  
SABS 0252 - Parts I and II  
SABS 0103 - The measurement and rating of environmental noise with  
respect to annoyance and speech communications  
SABS Specifications listed on page 3 of the DPW specification OW 371  
Atmospheric Pollution Prevention Act, No 45 of 1965  
BS 2790  
BS 1740  
BS 21  
BS 1640  
BS 5500

OW 371 - Specification of materials and methods to be used  
(Fourth revision, October 1993)

STD.PWD.VII - Standard Specification for steam boiler installations

Standard Specification for electrical installations and equipment pertaining to  
mechanical installations

All regulations and statutory requirements as laid down in the latest edition of the Occupational Health and Safety Act, 1993 (Act No 85 of 1993) shall be adhered to.

All equipment and materials shall be installed, serviced and repaired strictly in accordance with the manufacturers' specifications, instructions and codes of practice.

All municipal regulations, laws, by-laws and special requirements of the Local Authority shall be adhered to unless otherwise specified.

The following additional general specifications and requirements shall be read in conjunction with this specification and shall be adhered to unless otherwise specified in the Particular Specification.

**FC 03.01****GENERAL REPAIR AND INSTALLATIONS REQUIREMENTS**

- (a) All materials and equipment supplied and installed shall be new and of high quality and manufactured to the relevant specifications, suitable for providing efficient, reliable and trouble-free service.
- (b) All work shall be executed in a first-class workman-like manner by qualified tradesmen.
- (c) All equipment, component parts, fittings and materials supplied and/or installed, shall conform in respect of quality, manufacture, test and performance to the requirements of the applicable current SABS specifications and codes, except where otherwise specified or approved by the Engineer in writing.
- (d) All materials and workmanship which, in the opinion of the Engineer, is inferior to that specified for the work, will be condemned. All condemned material and workmanship shall be replaced or rectified as directed and approved by the Engineer.
- (e) The Contractor shall submit a detailed list of the equipment and material to be used to the Engineer for approval before placing orders or commencing installation.
- (f) All new equipment, materials and systems shall be installed and positioned such as to not impede on access routes, entrances and other services. The Contractor shall coordinate these items taking other services and equipment into account.
- (g) All control equipment and serviceable items shall be installed and positioned such that they will be accessible and maintainable.
- (h) The Contractor shall make sure that all safety regulations and measures are applied and enforced during the repair and construction periods to ensure the safety of the public and User Client.
- (i) Repair work shall be programmed in accordance with Additional Specification SC: General Decommissioning, Testing and Commissioning Procedures, to ensure the shortest possible down-time of any service and the least inconvenience to the User Client and public. The Contractor shall make sure that the necessary notifications and notices are timeously put into place for these activities.

**FC 04****OPERATING AND MAINTENANCE MANUALS**

The Contractor shall be responsible for the compilation of an inventory list and operating and maintenance manuals.

This shall be done in accordance with Additional Specification SB: Operating and Maintenance Manuals.

All information shall be recorded and reproduced in electronic format, as well as three sets of hard copies to be supplied to the Department.

Over and above what is specified in Additional Specification SB: Operating and Maintenance Manuals, the operating and maintenance manual to be compiled shall be structured to include at least the following:

(a) System description

Complete system description and the working of the plant.

(b) Commissioning data

Complete commissioning, test and inspection data of systems and equipment.

(c) Operating data

- (i) Systems and equipment running check list and frequency of servicing required;
- (ii) Safety precautions to be implemented;
- (iii) Operator's duties (logging requirements);
- (iv) Lubricating oils and service instructions.

(d) Mechanical equipment

- (i) Description of all major items with the make, model number, names, addresses and telephone numbers of the suppliers, manufacturers or their agents;
- (ii) Design capacities of all equipment, including selection parameters, selection curves, capacity tables, etc;
- (iii) Manufacturer's brochures and pamphlets;
- (iv) Schedule of spares with part numbers recommended to be held as stock;
- (v) Vessels pressure test and certification certificates.

(e) Maintenance instructions

- (i) Schedule of maintenance particulars, frequency of services and replacements;
- (ii) Trouble-shooting guide;
- (iii) Part number of all replacement items and spares;
- (iv) Capacity curves of all pumps;
- (v) Serial numbers of all items of equipment.

(f) Electrical equipment

- (i) Schedule of equipment, indicating manufacturer, type, model number, capacity and addresses and telephone numbers of suppliers;
- (ii) Maintenance instructions;
- (iii) Manufacturer's brochures and pamphlets;
- (iv) Complete as-built circuit diagrams and diagrammatic representation of interconnections of all electrical equipment.

(g) Instrumentation and control

- (i) Description of each control system;
- (ii) Schedule of control equipment, indicating manufacturer, type, model number, capacity and addresses and telephone numbers of suppliers;
- (iii) Maintenance instructions;
- (iv) Manufacturer's brochures and pamphlets.

- (h) Drawings
  - (i) Paper prints of all as-built mechanical and electrical drawings;
  - (ii) Wiring diagrams framed behind glass shall be mounted adjacent to each relevant control panel.

#### **FC 05            TRAINING OF OPERATORS FOR THE OPERATION OF THE INSTALLATION AND EQUIPMENT**

In addition to the requirements of Additional Specification SD: General Training, the Contractor shall allow and provide for additional training of the User Client's representative(s) as specified and set out in this specification. The objective of this training will be to ensure that the following be achieved:

- (a) The identification of pending faults and repairs at an early stage;
- (b) Reducing the maintenance cost of the equipment to an acceptable level, and maintaining the cost at this level;
- (c) Preventing malicious operation of the systems and equipment.

The training course for the User Client's representative(s) shall include at least the following:

- (a) Equipment and component recognition.
- (b) How to operate the equipment including the following:
  - (i) Starting the equipment;
  - (ii) Manual and automatic controlling;
  - (iii) Shut-down and isolating of equipment and systems;
  - (iv) Cleaning of equipment.
- (c) Emergency procedures to be followed in the case of breakages, system faults, steam cuts, etc.
- (d) Safety precautions to be followed and implemented.
- (e) The identification, reporting and recording of faults and operation of equipment.
- (f) The logging of equipment operation, readings and settings.

#### **FC 06            LOGGING AND RECORDING PROCEDURES**

The Contractor shall under this repair and maintenance contract institute a logging and recording system as part of his maintenance control plan as defined in Additional specification SA: General and Maintenance. This shall consist of a log and record book, which shall be utilised to log and record all operations, faults, system checks, breakdowns, maintenance visits, inspections, etc.

The logbook shall be kept in a safe place as agreed with the User Client and the Engineer and shall only be utilised by the maintenance personnel, the Contractor and the Engineer. Copies of the monthly entries and recordings into the logbook shall be submitted by the Contractor together with his monthly report to the Engineer.



The logbook shall be structured to include at least the following:

- (a) Weekly inspection and maintenance actions;
- (b) Monthly inspection and maintenance actions;
- (c) Four-monthly inspection and maintenance actions;
- (d) Annual inspection and maintenance actions;
- (e) Breakdown reports;
- (f) Daily system and equipment operating conditions, observations, recordings and measurements;
- (g) Inspection and test comments and reports.

The Contractor shall also institute an attendance register, which shall be kept in a safe place as agreed with the User Client and the Engineer. This register shall be completed by all persons visiting the installation, including:

- (a) Maintenance personnel
- (b) Contractor
- (c) Inspectors
- (d) User client personnel
- (e) Engineer.

The register shall state the date, time-in, time-out, name, company and reason for visit.

A copy of the register shall be submitted by the Contractor together with his monthly report.

## **FC 07 TESTS AND INSPECTIONS ON COMPLETION OF REPAIR WORK**

Except where otherwise provided in the Contract, the Contractor shall provide all labour, materials, power, fuel, accessories and properly calibrated and certified instruments necessary for carrying out such tests. The Contractor shall make arrangements for such tests and he shall give at least 72 hours written notice to the Engineer before commencing the test.

In the event of the plant or installation not passing the test, the Employer shall be at liberty to deduct from the Contract amount all reasonable expenses incurred by the Employer or the Engineer attending the repeated test.

Whenever any installation or equipment is operated for testing or adjusting as provided for above, the Contractor shall operate the entire system for as long a period as may be required to prove satisfactory performance at all times in the occupied space served by that system for up to twenty-four hours a day continuously until the system is handed over.

The Contractor shall provide all labour and supervision required for such operation and the Department may assign operating personnel as observers, but such observation time shall not be counted as instruction time.

After completing the installation or system, all equipment shall be tested, adjusted and readjusted until it operates to the satisfaction and approval of the Engineer.

The Contractor shall submit certificates of tests carried out to prove the efficiency of all equipment, as well as certificates to be obtained from all relevant authorities and statutory bodies, etc.

**FC 08      QUALITY ASSURANCE SYSTEM**

The Contractor shall institute an approved quality assurance (QA) system that shall be submitted to the Engineer for approval. The records of this QA system shall be kept throughout the duration of the Contract and submitted to the Engineer at regular intervals as required.

**FC 09      COMMISSIONING AND RECOMMISSIONING OF PLANT AND INSTALLATION****FC 09.01      GENERAL**

On completion of the repair work and/or the installation of new systems the plant and equipment shall be put into operation after all tests and adjustments have been carried out to the satisfaction of the Engineer. Where new plant is installed the Contractor shall run and operate the system for a period of time as specified by the Engineer and train the staff of the User Client to operate and maintain the system.

Logging of the operation of the installations shall commence immediately upon start-up.

The Contractor shall submit a full commissioning report.

**FC 09.02      RECOMMISSIONING OF HOT-WATER GENERATING INSTALLATION AND ANCILLARY EQUIPMENT**

On completion of any repairs the Contractor shall re-commission the systems, installation and/or equipment influenced by such repairs.

This operation shall be done strictly in accordance with the manufacturer's specification and relevant standards, norms and specifications from the applicable body, authority and/or department. The operation shall include but not be limited to the following:

- (a) All required pre-commissioning mechanical checks
  - (i) Check all steam, water and drain connections (when applicable).
  - (ii) Check all moving parts.
  - (iii) Check seals, gaskets and joints.
  - (iv) Reinstall all plugs and covers and check that they are properly secured.
  - (v) Check and record that all lubrication to equipment and components has been done in accordance with manufacturer's specification.
  - (vi) Check and ensure that all valves and safety valves are correctly installed and in the correct operating position. Safety valves are to be set in accordance with the required blow-off pressure for the installation.
  - (vii) Check and ensure that all control equipment such as pressure-reducing valves, heat control equipment, etc, are set and adjusted to the correct controlling value in accordance with the system parameters and manufacturer's specification.

- (viii) All steam and condensate pre-commissioning checks shall be done in accordance with Technical Specification FB (where applicable).
  - (ix) Check and confirm that all required tests and inspections to storage vessels, primary heater vessels and re-heater vessels have been done and that all required certificates are in place.
  - (x) Check and ensure that the domestic hot-water and cold-water piping system is operational and that no leaks are present.
  - (xi) Check, test and inspect the correct installation and operation of all primary and secondary pumping systems (where applicable).
  - (xii) Check that all the required pressure testing to the repaired installations and/or new equipment has been done, witnessed and recorded in accordance with the relevant specifications.
  - (xiii) Check, test and inspect all bracketing and supports for the relevant installations and equipment to ensure that they are properly secured and installed in accordance with the manufacturer's specifications and installation specification.
  - (xiv) Check, inspect and ensure that all lagging and cladding to the vessels and piping installation are installed and repaired in accordance with the applicable specifications from the relevant controlling authority.
  - (xv) Check, inspect and ensure that no leaks to equipment, systems and installations occur.
- (b) All required pre-commissioning electrical checks
- (i) Check all wiring connections for tightness and repair any hot connections.
  - (ii) Check that all electrical equipment has been properly reconnected in accordance with the manufacturer's specification.
  - (iii) Perform and record all required electrical insulation tests on equipment.
  - (iv) Check and test all controls without livening up electrical equipment.
  - (v) Check all motor-driven equipment for correct rotational directions.
  - (vi) Check and test the operation of all indication and warning lights.
  - (vii) Check, set, record and readjust all equipment control and set points in accordance with manufacturer's specifications.
  - (viii) Run all motor-driven equipment for a period to ensure free movement and correct operation.

(c) Commissioning of equipment

On completion of the pre-commissioning checks the Contractor shall proceed with the commissioning of the equipment. This shall be done strictly in accordance with the manufacturer's specification and system parameters and shall include but not be limited to the following:

- (i) During the commissioning process all safety and warning system checks are to be performed on the thermostatic control system where applicable.
- (ii) During load conditions the equipment shall be readjusted and finally switched to automatic operation on completion of all automatic control functions for correct operation where applicable.
- (iii) Check that steam pressure valves are readjusted where necessary to the correct set point under load conditions where applicable.  
This shall be done in accordance with Technical Specification  
FB: Steam Generating Installations.
- (iv) Check the operation of all steam trap arrangements where applicable.  
This shall be done in accordance with Technical Specification  
FB: Steam Generating Installations.
- (v) Check that water pressure-reducing valves are adjusted and set to the correct operating value for the specific system.
- (vi) Check the correct operation of all systems. Readjust primary and secondary pumping control equipment where applicable.
- (vii) Test and check for any leaks to the system, equipment and installation.
- (viii) Check for any unnecessary strain to system, equipment and installation due to expansion and contraction.
- (ix) Check the correct functioning of all heating temperature control equipment to ensure the correct switching levels and that all safeties are operational.
- (x) Record temperatures and flow conditions.

The Contractor shall visit, inspect, test and readjust the systems, equipment and installation during the week following the recommissioning to ensure the correct functioning of the equipment and its associated components.

## **FC 10      GUARANTEE OF INSTALLATION AND EQUIPMENT**

The Contractor shall provide guarantees obtained from the manufacturer(s) and/or supplier(s) to the effect that each piece of new equipment, supplied and installed under the repair contract, complies with the required performance and will function as part of the complete system.

All new equipment, including, the complete new installations and the systems as a whole shall be guaranteed for a period of 12 (twelve) months commencing upon the day of issue of a certificate of completion for the repair work of the installation.

**FC 11      MAINTENANCE TOOLS AND SPARES**

Each installation shall be equipped with the necessary maintenance tools and spares required by the specific type of equipment and installation for the daily operation and maintenance of the system. At the start of the repair and maintenance contract the Contractor shall in the presence of the User Client make an inventory of the existing tools and spares, and any shortfall or damaged tools and spares shall be replaced with new. All replacement tools and spares shall be as specified by the equipment manufacturers. These tools and spares shall be kept in a lockable room or cabinet of which the maintenance supervisor and the Contractor shall carry keys. The Contractor shall on a monthly basis take stock of these items in the presence of the User Client's maintenance supervisor and record and report to the Engineer. Any shortfall shall be replaced by the Contractor as part of his responsibility under this Contract.

The tools and spares to be carried shall include but not be limited to at least the following:

**(a)    Tools**

- (i) Grease and oil lubrication equipment;
- (ii) Equipment operating keys and tools.

**(b)    Spares**

- (i) Spare sight glasses for sight glass indicators, seals and gaskets (where applicable);
- (ii) Spare seats, gaskets and gland packings for valves, etc;
- (iii) Spare steam traps, at least one of each type present on the installation (where applicable);
- (iv) Spare pressure gauges, at least one of each range and type;
- (v) Spare electrical elements (where applicable);
- (vi) Spare thermostats, at least one of each type present on the installation (where applicable);
- (vii) Spare pilot lights, contactors, circuit brackets, relays, thermal overloads, etc, for electrical control panels;
- (viii) Spare temperature gauges, at least one of each range and type.

**FC 12      REPAIR WORK TO INSTALLATIONS, SYSTEMS AND EQUIPMENT****FC 12.01      GENERAL**

During the repair and maintenance contract all the systems, installations and equipment shall be repaired as specified in the Particular Specification. This repair work shall include but not be limited to the specified Particular Specification details.

All repair work shall be executed using approved materials and equipment suitable to the systems and/or installations they serve. The said repair work shall be executed in accordance with the relevant codes of practice, standards, regulations, municipal laws and by-laws, manufacturer's specifications and codes of practice and all additional and particular specifications included in this document.

The repair work items are listed in the Particular Specification and Schedule of Quantities with all relevant details, such as capacity, size, manufacturer, model number, etc.

All repair work shall be executed within the specified durations listed in the Appendix to Tender. All new equipment, materials and systems shall be furnished with a written guarantee of a defects liability period of 12 months commencing on the date of issue of a certificate for completion of the repair work. These guarantees shall be furnished in favour of the Department of Public Works.

Repair work items for the steam generating installations shall be categorised under the following headings:

- (a) General requirements for hot-water generating installations
- (b) Steam and condensate pipework (where applicable)  
Refer to Technical Specification FB: Steam Distribution Installations.
- (c) Hot-water storage vessels
  - (i) Existing hot-water storage vessels
  - (ii) Electrically driven storage vessels, new hot-water storage vessels
  - (iii) Heating services for hot-water storage vessels.
- (d) Lagging and cladding of vessels and piping
  - (i) Vessel lagging and cladding
  - (ii) Hot-water and hot-water return pipe lagging and cladding
- (e) Pressure testing
- (f) Corrosion protection linings
- (g) Sterilisation of installation
- (h) Heating control equipment
  - (i) Steam heating equipment
  - (ii) Electrical heating equipment
- (i) Instruments and controls
  - (i) Type of instrumentation and controls
  - (ii) Instrumentation and controls, installation requests
- (j) Primary and secondary pumping installations
  - (i) Primary pumping equipment
  - (ii) Secondary pumping equipment
- (k) Domestic hot-water and cold-water pipe installations
  - (i) Strainers
  - (ii) Valves
  - (iii) Air vents
  - (iv) Thermostatic water flow control valve
  - (v) Expansion equipment
  - (vi) Flow meters
  - (vii) Check valves
  - (viii) Vacuum breakers
  - (ix) Expansion release valve
  - (x) Safety valves

- (xi) Pressure gauges
- (l) Electrical installations
  - (i) Electrical control panels
  - (ii) Wiring and cabling.

Any repair work, which may be required on the systems, equipment and installation, shall be executed using approved materials, equipment, methods and tooling suitable for the specific application. The said repair work shall be executed in accordance with the relevant codes of practice, standards, regulations, statutory regulations, manufacturer's specifications and codes of practice and as specified in all additional and particular specifications included in this document.

At the start of the repair and maintenance contract, the repair work specified in the Particular Specification shall be done in accordance with the items listed. Any repair work during the maintenance period shall also adhere to this specification.

## **FC 12.02      GENERAL REQUIREMENTS FOR HOT-WATER GENERATING INSTALLATIONS**

All repair work and new installation of hot-water generating installations shall adhere to the standard specifications of the Department of Public Works and all relevant specifications, norms, standards and regulations applicable to this type of installation, including the following general requirements:

- (a) The hot-water generating installation shall be repaired, installed and maintained as a complete functional unit, with all the responsibilities, functions and operating parameters taken into account to ensure the continuous supply of hot water to the consumer points.
- (b) The hot-water generating installation shall be capable of providing ample supply of hot water to the consumer points by means of ensuring the correct sizing of the hot-water storage and production.

## **FC 12.03      STEAM AND CONDENSATE PIPEWORK**

All steam and condensate installations shall be done in accordance with Technical Specification FB: Steam Distribution Installations.

## **FC 12.04      HOT-WATER STORAGE VESSELS**

### **FC 12.04.01      Existing hot-water storage vessels**

At the start of the maintenance and repair contract the Contractor shall inspect, repair, service, clean out and test all hot-water storage vessels.

The inspection shall include the following:

- (a) Isolate drain, open manholes and clean out hot-water vessels.
- (b) Inspect vessel welds.
- (c) Inspect internal corrosion lining and check for any pit holes and damages to the vessel material and connections.
- (d) Inspect lagging and cladding.

- (e) Inspect condition of all elements, steam heating coils, controls, safety valves, etc.

During this inspection the Contractor shall notify the Engineer in advance to allow the Engineer to witness the Contractor's findings. The Contractor shall submit a written report on the findings.

All manhole and pipe gaskets shall be replaced.

No repair work shall be proceeded with prior to approval from the Engineer.

Should any welding repair work be required it shall be performed by a coded welder in accordance with acceptable practices, codes and norms.

Should the corrosion lining be damaged or corroded, thus necessitating the relining of the vessel, this shall be done with an approved lining suitable for the water quality and operating temperature under which this system is functioning.

For further details on repair to resisting linings and installation of new linings refer to FC12.06.

All safety valves shall be serviced, overhauled and readjusted to the correct safety pressure blow-off part.

All lagging and cladding shall be inspected, repaired and where necessary replaced.

On completion of all repair and service work the Contractor shall reinstate all equipment, fill the hot-water vessel with water and pressure test it to 1,5 times the permissible operating pressure or allowable test pressure.

On passing of the pressure test the Contractor shall re-commission the hot-water vessels and put it back on line.

#### **FC 12.04.02    New hot-water storage vessels**

Where new hot-water storage vessels are to be installed it shall be done in accordance with the following specification and on approval of the necessary workshop drawings to be provided by the Contractor.

The storage vessels shall be of the vertical cylindrical type with dished ends on both sides, and shall be manufactured to BS 5500 Category II in mild steel for a working pressure as indicated for the three systems. A pressure test certificate for each vessel shall be supplied by the manufacturer.

The vessel shall be equipped with at least the following :

- (a) Properly sized flanged manhole for easy access
- (b) Flanged inlets and outlets to SABS 1123 Table 10
- (c) Sparge pipe on the cold-water inlet
- (d) Correctly sized thermometer
- (e) Correctly sized temperature and pressure relief valve
- (f) Air release valve
- (g) Correctly sized pressure gauge
- (h) BSP threaded sockets for thermostats
- (i) 40 mm diameter BSP threaded socket at the lowest point of the storage tank for draining purposes
- (j) 50 mm diameter boss element segments for auxiliary elements.

An expansion relief valve shall be installed on the inlet to the storage vessels for thermal expansion.



Where pipe connections to the storage vessel are done with dissimilar materials (such as copper), isolating flanges shall be used (dielectric coupling).

Before ordering and manufacturing of storage vessels a workshop drawing shall be submitted to the Engineer for approval.

The Contractor shall satisfy himself that access and plantroom sizes are to the dimensions on the drawings and that the equipment will fit into the space allowed.

#### **FC 12.04.03     Heating sources for hot-water storage vessels**

##### **(a)     Electrical elements**

Where electrical immersion elements are used to heat the water inside the hot-water storage vessel, these elements shall be replaced at the start of the repair and maintenance contract.

All the thermostat controls and safety cut outs shall be cleared, inspected, tested, adjusted to the set point and where necessary replaced.

##### **(b)     Steam heating**

Where steam heat exchangers are used to heat the water inside the storage vessel, these coils shall be removed together with the steam chest and associated equipment. The coils shall be descaled, cleaned, inspected and tested.

Where necessary the heat exchanger and/or coils shall be replaced.

#### **FC 12.05     LAGGING AND CLADDING**

All lagging and cladding to hot-water vessels, primary heaters, secondary heaters and hot and circulation water piping shall be inspected for defects, damages and shortages at the start of the repair and maintenance contract. The Contractor shall report his findings to the Engineer in writing.

All repairs to be done shall match the existing installation and the Contractor shall ensure that no sharp edges from the metal cladding pose a danger to anybody.

The following specification shall be adhered to:

##### **(a)     Vessel lagging and cladding**

The storage vessels shall be insulated with a 80 mm thick layer of mineral glass wool with a density of 88 kg/m<sup>3</sup> and finally covered with 0,6 mm thick galvanized sheet metal. The sheet-metal work has to be done by a specialist. (All edges are to be rolled and no sharp edges will be allowed.)

##### **(b)     Hot-water and return water pipe lagging and cladding**

All hot water and hot-water return pipes shall be insulated with preformed fibreglass sections covered with galvanized sheet-metal muffs in a water tight manner. Sheet-metal muffs shall be installed with the joints overlapping at least 50 mm and the longitudinal overlap pointing downwards to prevent ingress of water. The sheet-metal muff shall be strapped with 10 mm galvanized straps by means of a strapping tool with a

minimum of 2 straps/section. All pipe bends, T-pieces, etc, shall be insulated with 25 mm diameter fibreglass rope covered with a 12 mm thick layer of self-setting fibre cement. A reinforcing gauze shall be wrapped over the fibre cement while wet and then painted with mastic paint when dry.

Table FC 12.05/1 below provides a guideline for the preformed fibreglass section thickness to be used.

The fibreglass sections shall have a density of at least 88 kg/m<sup>3</sup>.

TABLE FC 12.05/1: FIBREGLASS SECTION THICKNESS

PIPE SIZE (STEEL)	PIPE SIZE (COPPER)	THERMAFLEX THICKNESS
100 mm dia	108 mm dia	50 mm
80 mm dia	76 mm dia	40 mm
65 mm dia	67 mm dia	40 mm
50 mm dia	54 mm dia	25 mm
40 mm dia	42 mm dia	25 mm
32 mm dia	35 mm dia	25 mm
25 mm dia	28 mm dia	20 mm
20 mm dia	22 mm dia	20 mm
15 mm dia	15 mm dia	15 mm

## FC 12.06

### **PRESSURE TESTING**

The Contractor shall at the completion of the repair contract arrange for a complete pressure test to be executed on the hot-water generating installation. This shall be done in collaboration with the User Client and Engineer to ensure the minimum down-time of the installation, as well as to establish a suitable period for this pressure test. All leaks shall be repaired and the system shall be tested at the cost of the Contractor. This test shall be witnessed by the Engineer.

The tests shall be performed on all hot-water storage vessels, primary heating vessels, secondary heater vessels and domestic water pipe systems.

All safety and expansion release valves shall be removed and plugged, and on completion these shall be reinstalled.

The systems shall be filled with water after all branches have been plugged, sealed or closed.

The systems shall be hydraulically pressure tested by means of a suitable manually operated or mechanically driven pressure pump.

A pressure of at least 1,5 times the working pressure of the class rating of pipes or fittings shall be applied for a period of time specified in the specifications or as recommended by the manufacturers. (Refer to SABS 1200 for minimum and maximum test pressures.)

Tests should not be performed against closed valves.

Leakage which occurs shall be measured, calculated and checked against the allowable losses, as specified in SABS 1200.

If the completed sections comply with all specifications and pass the tests and inspection, it can be approved and the Contractor may be instructed to re-commission the plant.

#### **FC 12.07      CORROSION PROTECTION LININGS**

All vessel corrosion protection linings shall be inspected and repaired and/or replaced where necessary.

Repairs shall only be done to linings where the supplier and installer of these linings approve of such repairs. These repairs shall then be done strictly in accordance with the manufacturer's specification and shall be certified by an approved inspection authority.

Where new linings are to be installed, the required preparation work including sand blasting and removal of old lining shall be done in accordance with the recommendation of the supplier of the new lining.

Where new linings are to be introduced they shall be similar or equal to the following:

- (a) Internally coated with a durable, high operating temperature glass flake lining with DTF of one millimetre, similar or equal to a Polygrass VE lining as supplied by Corrocoate, suitable for an operating temperature of 95 °C at the indicated working pressures.

The applications of these linings shall be witnessed and certified as being to the manufacturer's application standards by an approved inspection authority.

- (b) Externally the vessels shall be coated with two coats of red oxide paint.

#### **FC 12.08      STERILISATION OF WATER SIDE OF INSTALLATION**

The Contractor shall at the completion of the repair contract sterilise the complete water side of the hot-water system including vessels and pipes.

This shall be done as described in the following guidelines.

- (a) The complete system shall be filled with potable water chlorinated to a concentration of 15 mg of chlorine per litre of water which shall remain in contact with the inner surface of the pipeline for a period of not less than 24 hours. The pipeline shall be filled for sterilising in such a manner that no chlorine shock is created or air is trapped in the pipeline.
- (b) The Contractor shall submit full details of the proposed method for sterilising the pipeline to the Engineer for approval at least 14 days before commencing sterilising.
- (c) The cost of water for filling the pipeline for sterilising shall be borne by the Contractor.

- (d) The Contractor shall provide all materials, tools, equipment and labour necessary to sterilise the pipeline. After sterilising the pipeline the Contractor shall, at no extra cost, empty the pipeline and dispose of the water in a manner approved by the Engineer.
- (e) The Contractor may use the following products as a source of chlorine:
  - (i) Chloride of lime to SABS 295 yielding 33 % free chlorine by mass;
  - (ii) Calcium hypochlorite to SABS 295 yielding 70 % free chlorine by mass;
  - (iii) Chlorine gas applied by chlorinator.
- (f) After sterilisation, an approved water quality test to a minimum number of 10 % of the total water points, randomly selected, evenly spread and marked on drawings, shall be carried out. This test shall include a full bacteriological test as per SABS 241 and the results shall be submitted to the Engineer for inclusion in the Contract documents. Each abortive test shall be for the Contractor's cost.

When tested the water shall comply with the limits given in column 2 or 3, as relevant, of table FC 12.08/1.

TABLE FC 12.08/1: BACTERIOLOGICAL REQUIREMENTS

1 PROPERTY	2 RECOMMENDED MAXIMUM LIMIT	3 MAXIMUM ALLOWABLE LIMIT
Total coliform bacteria count per 100 millilitre	Nil*	5
Faecal coliform bacteria count per 100 millilitre	Nil	Nil
Standard plate count per millilitre	100	Not specified

Note:

\* If any coliform bacteria are found in a sample, take a second sample immediately after the tests on the first sample have been completed; this sample shall be free from coliform bacteria.

Not more than 5 % of the total number of water samples (from any one reticulation system) tested per year may contain coliform bacteria.

## **FC 12.09      HEATING CONTROL EQUIPMENT**

The Contractor shall at the start of the repair and maintenance contract inspect, test, repair, readjust, and if necessary replace heating controls for the hot-water system.

This shall include the following:

- (a) Check for correct switching and/or control temperature operating points.
- (b) Check, test and ensure that the safety cut-out mechanisms are in place and switch and/or control at the correct level.
- (c) Ensure that equipment has been installed in accordance with the manufacturer's specification.
- (d) Ensure that all pockets are descaled and free of any defects.

The following control equipment shall be serviced, repaired and where required replaced if damaged beyond repair.

#### **FC 12.09.01     Steam heating control equipment**

Where immersed type thermostatic steam control valves are utilised they shall be serviced and repaired as follows:

- (a) Dismantle and strip down thermostatic control valve including removal of pocket.
- (b) Descale and clean all equipment.
- (c) Replace element subassembly if necessary.
- (d) Replace cover joint, gland packing, heater joint, coupling joint and all gaskets where applicable.
- (e) Check valve seat and if necessary reseal.
- (f) Reassemble control valve and reinstall, test and adjust to correct level.

All other type of thermostatic heating control valves shall be serviced, repaired and overhauled in accordance with the manufacturer's specification.

#### **FC 12.09.02     Electrical heating control equipment**

All electrical thermostat control equipment shall be serviced and repaired in accordance with the manufacturer's specification.

This shall include the following:

- (a) Dismantle, clean and descale thermostat pockets.
- (b) Test switching actions for correct operation.
- (c) Test safety cut-out switching points for correct operation.

Replace thermostat if the switching does not take place in accordance with the manufacturer's specification.

#### **FC 12.10     PRIMARY AND SECONDARY PUMP INSTALLATIONS**

The Contractor shall at the start of the repair and maintenance contract inspect, test, service and if required replace primary and secondary circulating pumps.

The pumps are to be inspected, tested, serviced and repaired together with their associated equipment and pipework. All repair and service work shall be done strictly in accordance with the manufacturer's specification.

The repair work to the pumps and equipment shall include at least the following:

- (a) Inspect and test the pumps for correct operation.
- (b) Replace gland packings, seals and gaskets.

- (c) Inspect and test for any bearing noise and replace if necessary.
- (d) Clean out pump strainers, check non-return valves, valves, etc.
- (e) Test pump motor windings for balance phases, insulation test and check wiring.
- (f) Inspect pump mountings and repair if necessary.

Where in-line glandless canned pumps are used, these shall be inspected, tested, serviced where possible, impeller inspected and cleaned and if found beyond repair, replace with a suitable replacement in accordance with the operating parameters.

#### **FC 12.11      DOMESTIC HOT AND COLD WATER INSTALLATIONS**

The Contractor shall at the start of the repair and maintenance contract inspect, tests, service, repair and if required, replace damaged items on the complete hot and cold-water piping installation inside the hot-water generating plant rooms.

The repair work specification shall be read in conjunction with Technical Specification AA: Plumbing and Drainage Installations.

Repair work to the domestic hot and cold-water installation networks shall be as detailed in the Particular Specification and shall include, but not be limited to the following:

- (a) Replace damaged, broken, leaking and corroded above and underground pipework, fittings and equipment.
- (b) Repair, replace and service valves, including new gaskets, gland packings, seals, bolt and nuts, etc.
- (c) Test the proper closing of all valves and where valves do not close properly, the valves shall be refurbished, descaled and if necessary replaced.
- (d) Repair, clean and service all strainers including replacement of strainer elements where corroded and installation of new gaskets.
- (e) Repair, service, test and readjust pressure-reducing valves. Pressure gauges shall be recalibrated and checked. Up and downstream pressures are to be logged. Downstream pressure to be adjusted to an acceptable level taking the allowable working pressure of the system and its components into account.
- (f) Repair, service and check the proper functioning of all non-return valves.
- (g) Repair, service, readjust and calibrate all safety and expansion relief valves.
- (h) Repair, service and clean out all air release valves and vacuum breakers.
- (i) Do repair work to bracketing systems including fixing and repair of existing brackets and the introduction of additional brackets where required.

- (j) Hot-water pipe lagging and cladding shall be inspected, repaired, sealed and replaced where required.
- (k) Repair, service and log readings of watermeters including cleaning of integral strainers.
- (l) Water pipes are to be sampled for corrosion and scaling. The Engineer shall evaluate the actions to be carried out if the outcome of this sampling requires attention.
- (m) Water supply shall be sampled and chemically analysed for the suitability to the systems and materials it serves.
- (n) Pressure test and sterilise repaired new installation and equipment.
- (o) Reinstate and make good walls, tiling, floors, concrete, finishes, holes, chases, surfaces, etc, to an acceptable level where any repair, upgrade and/or service work has been executed.

## **FC 12.12      ELECTRICAL INSTALLATION, WIRING AND CONTROL PANELS**

### **FC 12.12.01      Instrumentation and controls**

All instrumentation and control equipment shall be inspected, tested, repaired, adjusted and where necessary replaced. All repair and service work shall be done strictly in accordance with the manufacturer's specification.

The repair work to the instrumentation and control equipment shall include at least the following:

- (a) Test all equipment for correct operation.
- (b) Inspect, test, service, adjust setting and if necessary repair, and/or replace steam detector.
- (c) Inspect, recalibrate and, if beyond repair, replace steam pressure gauge.

### **FC 12.12.02      Electrical control panels**

All electrical control panels shall be inspected, tested, and repaired, including all equipment inside the control panel. All repair and service work shall be done strictly in accordance with the manufacturer's specification.

The repair work to the electrical control panels shall include at least the following:

- (a) Test all control equipment for correct operation.
- (b) Check and test all MCBs, isolators, contactors, overloads, other type of motor drives, pilot lights, control switches, etc, and readjust all set points; where equipment is found to be faulty these shall be replaced with new approved equipment.
- (c) Check all wiring and connections for proper conducting and replace where hot connections are found.
- (d) Clean out panel interior and exterior, inspect panel body, fascias, doors, paintwork, etc, and repair where necessary.

**FC 13      MAINTENANCE TO INSTALLATIONS AND EQUIPMENT**

[Note: There will be no maintenance work required for this installation and equipment in this contract.]

**FC 13.01      GENERAL**

Monthly maintenance responsibilities for each installation including all units and components as specified, shall commence with access to the site. A difference shall be made in payment for the maintenance prior to and after practical completion of repair work.

Maintenance responsibilities of the completed installation shall commence upon the issue of a certificate of practical completion for repair work, and shall continue for the remainder of the 36-month contract period.

This part of the Contract shall include:

- (a) Routine preventative maintenance;
- (b) Corrective maintenance, and
- (c) Breakdown maintenance,

as defined in Additional Specification SA: General Maintenance, for the specified installations described under FC 01 of this specification.

The maintenance work to be performed and executed shall be done strictly in accordance with Additional Specification SA: General Maintenance, and as specified in Particular Specification PFC and this specification.

The said maintenance work shall be executed in accordance with the relevant codes of practice, statutory regulations, standards, regulations, municipal laws and by-laws and the manufacturers' specifications and codes of practice.

The maintenance schedules and frequency shall be developed under the maintenance control plan to be instituted by the Contractor, as specified in Additional Specification SA: General Maintenance.

All new equipment, components and materials supplied and installed under the maintenance contract shall be furnished with a prescribed manufacturer's guarantee.

The maintenance work and items are to be categorised by the Contractor for each maintenance activity under the following headings:

- (a) Steam and condensate pipework (where applicable)
- (b) Hot-water storage vessels
- (c) Heating equipment
- (d) Lagging and cladding of vessels and piping
- (e) Corrosion protection linings
- (f) Circulating pumps
- (g) Domestic hot and cold-water piping systems
- (h) Electrical controls, panels and wiring.

The Contractor shall be remunerated monthly, based on his performance, for maintaining the complete installation in a perfect functional condition.



**FC 13.02      ROUTINE PREVENTATIVE MAINTENANCE**

The routine maintenance of the installations, systems and equipment shall be done in accordance with Additional Specification SA: General Maintenance and the Particular Specification related to this work.

The routine maintenance work to be performed and executed shall include but not be limited to the items listed in tables FC 13.02/1, FC 13.02/2, FC 13.02/3 and FC 13.02/4 below under the respective headings.

These actions and findings shall be logged and reported on the relevant approved schedules and reports.

TABLE FC 13.02/1: WEEKLY ACTIONS AND MAINTENANCE

ITEM	MAINTENANCE DESCRIPTION	ACTION RESPONSIBILITY	ACTION
1	Inspect equipment, components and installations for any visible defects, leaks, damages and/or pending faults.	Contractor	Check/Record
2	Check and record all pressure gauge temperature and flow meter readings, and readjust equipment if necessary.	Contractor	Adjust/Check/Record
3	Check operation of pumps, heating equipment and controls for correct functioning.	Contractor	Check/Record
4	Check electrical control panels for any faults.	Contractor	Check/Record
5	Report any faults, defects, leaks, damages, etc, to Engineer.	User Client	Check/Record/Report

TABLE FC 13.02/2: MONTHLY ACTIONS AND MAINTENANCE

ITEM	MAINTENANCE DESCRIPTION	ACTION RESPONSIBILITY	ACTION
1	All as listed under table FC 13.02/1	Contractor/ User Client	Check/Record Adjust/Repair/Report
2	Blow down all dirt pockets and record.	Contractor	Service/Record
3	Clean out all stainers and record.	Contractor	Service/Record
4	Check all valve gland seals and packings for leaks and replace and repair if necessary.	Contractor	Check/Service/Repair /Record
5	Check, inspect and repair if necessary all expansion joints for leaks and damages.	Contractor	Check/Repair/Record
6	Check all safety devices for correct operation and repair and replace where necessary.	Contractor	Check/Service/Repair /Record

ITEM	MAINTENANCE DESCRIPTION	ACTION RESPONSIBILITY	ACTION
7	Check and test all electrical control functions and operations. Repair and report any faults and defects.	Contractor	Check/Service/Repair /Record
8	Complete logbook and report.	Contractor	Report

TABLE FC 13.02/3: FOUR-MONTHLY ACTIONS AND MAINTENANCE

ITEM	MAINTENANCE DESCRIPTION	ACTION RESPONSIBILITY	ACTION
1	All as listed under tables FC 13.02/1 and FC 13.02/2.	User Client/ Contractor	Check/Record/Adjust/ Repair
2	Service, repair, clean, replace seals gaskets, reset and/or replace worn parts as directed by the manufacturer of all steam traps (where applicable).	Contractor	Check/Service/Repair /Report
3	Service, repair, replace glasses and gaskets where necessary and clean all sight glasses.	Contractor	Check/Service, Repair, Report
4	Repair lagging and cladding where necessary.	Contractor	Check/Repair/Report
5	Repair all steam leaks.	Contractor	Check/Repair/Report
6	Repair all water leaks.	Contractor	Check/Repair/Report
7	Inspect and test all heating equipment Repair where necessary.	Contractor	Check/Repair/Report
8	Inspect all hot -water storage vessels for any leaks and packing faults. Repair if necessary.	Contractor	Check/Repair/Report
9	Test, inspect and repair all pumps.	Contractor	Check/Service/ Repair/Report
10	Lubricate all lubrication points in accordance with the manufacturer's specification.	Contractor	Check/Service/ Report
11	Complete logbook and report.	Contractor	Report

TABLE FC 13.02/4: ANNUAL ACTIONS AND MAINTENANCE

ITEM	MAINTENANCE DESCRIPTION	ACTION RESPONSIBILITY	ACTION
1	All as listed under tables FC 13.02/1, FC 13.02/2 and FC 13.02/3.	User Client / Contractor	Check/Record/ Adjust/Repair
2	Drain, clean out, inspect and repair all defects and linings on hot-water storage vessels.	Contractor	Inspect / Test / Service / Repair
3	Inspect and repaint all equipment where required.	Contractor	Inspect / Test / Service / Repair
4	Remove, strip, service, repair, adjust and replace where necessary all pressure control and safety valve equipment.	Contractor	Service / Repair / Adjust / Report
5	Complete logbook and report.	Contractor	Report

**FC 13.03      CORRECTIVE MAINTENANCE**

This corrective maintenance of the installations, systems and equipment shall be done in accordance with Additional Specification SA: General Maintenance and the Particular Specification related to this work.

The Contractor shall inspect and check all equipment, materials, systems and installation for any pending breakdowns, maladjustments or anomalies of equipment.

The Contractor shall report and take actions to correct such defects.

**FC 13.04      BREAKDOWN MAINTENANCE**

Breakdown maintenance of the installations, systems and equipment shall be done in accordance with Additional Specifications SA: General Maintenance.

All breakdown problems experienced shall be acted upon within the time limitations allowed in the General Maintenance specifications.

All breakdown maintenance shall be done in accordance with the relevant specifications, standards, regulations and codes.

The Contractor shall have access to the necessary spares, equipment and tools for any possible breakdowns.

## **TECHNICAL SPECIFICATION**

### **HE EXTERIOR LIGHTING SYSTEMS**

#### **CONTENTS**

HE 01	SCOPE
HE 02	STANDARD SPECIFICATIONS, REGULATIONS, CODES AND ADDITIONAL SPECIFICATIONS
HE 03	OPERATING AND MAINTENANCE MANUALS
HE 04	TEST AND INSPECTION FOLLOWING COMPLETION OF REPAIR WORK
HE 05	LOGGING AND RECORDING PROCEDURES
HE 06	QUALITY ASSURANCE SYSTEM
HE 07	RE-COMMISSIONING OF INSTALLATION
HE 08	REPAIR WORK TO EXTERIOR LIGHTING INSTALLATIONS AND KIOSKS
HE 09	AREA LIGHTING: TECHNICAL DETAILS
HE 10	SECURITY FENCE LIGHTING: TECHNICAL DETAILS
HE 11	STREET LIGHTING: TECHNICAL DETAILS
HE 12	MAINTENANCE OF EXTERIOR LIGHTING SYSTEMS AND DISTRIBUTION KIOSKS

#### **HE 01 SCOPE**

**HE 01.01** This specification comprises all aspects regarding the maintenance of external lighting systems. External lighting comprises:

- i) Area lighting
- ii) Security lighting along perimeter fences
- iii) Street lighting

**HE 01.02** This specification shall form an integral part of the maintenance and servicing contract document and shall be read in conjunction with Part C, the Additional Specifications included with this document.

#### **HE 02 STANDARD SPECIFICATIONS, REGULATIONS AND CODES**

**HE 02.01** The latest edition, including all amendments up to date of tender of the following specifications, publication and codes of practice shall be read in conjunction with this specification and shall be deemed to form part thereof.

#### **HE 02.02 SANS Specifications**

02.02.01	SANS 10400	National Building Regulation
02.02.02	SANS 10142	Wiring code
02.02.03	SANS 10225	Lighting masts
02.02.04	SANS 1277	Read lighting luminaires
02.02.05	SANS 1088	Spigot entries
02.02.06	SANS 1749	Glass polyester poles
02.02.07	SANS 1250	Capacitors, ballasts & lamps
02.02.08	SANS 1279	Floodlight luminaires
02.02.09	SANS 1777	Daylight switches
02.02.10	SANS 763	Galvanised coatings
02.02.11	SANS 1266	Discharge lamps
02.02.12	ARP 035	Streetlighting maintenance

**HE 02.03      Department of Public Works Specification PW 774**

**HE 02.04      Occupational Health and Safety Act of 1993: Construction Regulations, 2003 as promulgated in Government Gazette No 25207 and Regulation Gazette No 7721 of 18 July 2003.**

**HE 02.05      Manufacturer's specifications and installation instructions**

**HE 02.06      Additional requirements**

Equipment and material supplied and installed shall be new and unused.  
Luminaires and control gear shall bear the SANS stamp. The Contractor shall ensure that all safety regulations and measures are applied and enforced during repair and maintenance work on cabling, wiring, luminaires, lighting poles and high masts.

### **HE 03            OPERATING AND MAINTENANCE MANUALS**

**HE 03.01**      The Contractor shall be responsible for the compilation of a complete set of Operating-and-Maintenance manuals.

This shall be done in accordance with the Additional Specification SB – Operating and Maintenance manuals.

All information shall be recorded and reproduced in electronic format as well as supplying the Engineer with seven sets of hard copies.

**HE 03.02**      Over and above what is specified in the Additional Specification – SB Operating and Maintenance manuals, the Operating and Maintenance Manual to be compiled shall be structured and shall at least include the following:

**03.02.01      Description of Installation**

Complete system description of the lighting system. This shall be done for each lighting installation individually. The system description shall contain detailed information regarding the supply configuration (Distribution board, cabling, distribution kiosks, pole mounted distribution board), the switching arrangement (timers, photocells, override facilities) and the lighting (luminaire detail, lamp detail) as well as the earthing and lightning protection arrangement.

**03.02.02      Commissioning Data**

Complete commissioning, test and inspection data of lighting system.

This shall be done for each lighting installation individually. The commissioning data will comprise start-up and running current measurements at each termination point e.g. distribution board, kiosk and mast. Full data on lamps fitted with installation dates.

**03.02.03      Operating data**

- a)      Safety precautions to be implemented.
- b)      Operation of lighting systems; automatic, manual and bypass switching.

**03.02.04      Maintenance instructions**

- a)      Projected frequency of lamp replacement per lighting system.
- b)      Procedure to verify operation of photocell – controlled circuits.
- c)      Procedure to verify operation of timer – controlled circuits.
- d)      Trouble shooting diagram.
- e)      Luminaire details, including manufacturers brochures / pamphlets, order number, list of components and lamp specification.

- f) Schedule of serviceable components per lighting system. These schedules shall include lamps, starters, ignitors, ballasts, lenses, etc.

#### **HE 04 TESTS AND INSPECTIONS PRIOR TO PRACTICAL COMPLETION OF REPAIR WORK**

**HE 04.01** It is the responsibility of the Contractor to provide all labour, accessories and properly calibrated and certified measuring instruments necessary to record the following parameters:

- 04.01.01 Phase voltages
- 04.01.02 Current per phase
- 04.01.03 Illumination levels in lux
- 04.01.04 Insulation testing at 500V
- 04.01.05 Earthing resistance testing by means of wheatstone bridge instrument

The Contractor is responsible for the arrangement of such tests. He shall give at least 72 hours notice to the Engineer prior to the test date.

#### **HE 05 LOGGING AND RECORDING PROCEDURES**

**HE 05.01** The Contractor shall as part of this Contract institute a Recording system as part of his Maintenance Control Plan as defined in the Additional Specification SA – General Maintenance. This shall consist of a Record book which shall be utilised to log and record all faults, system checks, breakdowns, maintenance visits, inspections etc.

**HE 05.02** The logbook shall be stored in a safe place inside the prison maintenance supervisor's office and shall only be utilised by the Contractor and Engineer. A copy of the monthly entries and recordings into this logbook shall be submitted by the Contractor together with his monthly report to the Engineer.

This logbook shall be structured to at least include the following:

- 05.02.01 Monthly lamp inspection and maintenance actions.
- 05.02.02 Bi-annual inspection and testing of lighting systems.
- 05.02.03 Annual earthing test report.
- 05.02.04 Breakdown / call out reports.

#### **HE 06 QUALITY ASSURANCE SYSTEM**

**HE 06.01** Following formal approval of his Quality Assurance system by the Engineer, the Contractor shall implement the approved QA system.

**HE 06.02** Records of this QA system shall be kept throughout the duration of the contract and shall be submitted to the Engineer as required by the Department.

#### **HE 07 RE-COMMISSIONING OF INSTALLATION**

**HE 07.01** On practical completion of the repair work and lamp replacement, the lighting installations shall be put into operation.

**HE 07.02** Lighting installations shall be energised for a minimum continuous period of 96 hours immediately prior to the Engineer's Practical Completion inspection to verify lamp stability and reliability of power reticulation

**HE 08 REPAIR WORK TO EXTERIOR LIGHTING INSTALLATIONS**

- HE 08.01** The various lighting systems shall be repaired as part of installation H during the first phase of the repair and maintenance contract
- HE 08.02** The scope of the repair work shall include, but shall not be limited to the activities listed below.
- HE 08.03** The Contractor shall record the repair actions in tabular format before the Contractor's responsibility for maintenance commences.
- HE 08.04** Repair work shall be executed within the approved period for repairs.
- HE 08.05** New equipment and material shall be supplied with a written guarantee confirming a defects liability period of 12 months from date of practical completion. These guarantees shall be furnished in favour of the Department of Public Works.
- HE 08.06** The following measurement and payment items shall apply for repair work

<u>Item</u>	<u>Unit</u>
-------------	-------------

- |                    |   |                      |
|--------------------|---|----------------------|
| <b>HE 08.06(a)</b> | <b><u>Excavate in all materials for trenches, backfill, compact and dispose of surplus material</u></b> | <b>m<sup>3</sup></b> |
|--------------------|---|----------------------|

This rate shall apply to all the excavations.

The unit of measurement shall be the cubic metre of material excavated in trenches, classified according to the depth and width specified listed. The width classification shall be in accordance with the authorised dimensions and the depth classification in accordance with the total depth of the trench and not with the depth range in which the material is situated before excavation. The depth of excavation shall be measured to the underside of the bedding.

The tendered rate shall include full compensation for clearing and grubbing the trench areas and the temporary removal of improvements from the line of the trench, for excavating the trench, preparing the bottom of the trench, separating material unsuitable for backfill, keeping the excavations safe, dealing with any surface or subsurface water, measuring, classification and keeping of all records and for separating topsoil and selected backfill material where necessary.

The rate shall furthermore cover the costs of installing the 150mm sand bed and 200mm sand cover, backfilling, compacting and disposing of the surplus material.

<u>Item</u>	<u>Unit</u>
-------------	-------------

- |                    |   |                      |
|--------------------|---|----------------------|
| <b>HE 08.06(b)</b> | <b><u>Extra over item HE 08.06(a) for excavating in hard material</u></b> | <b>m<sup>3</sup></b> |
|--------------------|---|----------------------|

The unit of measurement shall be the cubic metre of material excavated and classified as hard, in accordance with the classification set out hereunder.

The tendered rate shall be paid over and above the rate tendered for excavation in respect of items HD 08.06(a) in full compensation for the additional cost of excavating in hard material instead of soft.

The tendered rate shall include full compensation for any overbreak as well as the additional backfilling required, reinstating the trench bottom, and for any other incidentals resulting from overbreak.

The materials excavated shall be classified as follows for payment purposes:  
Hard material:

Material which cannot be excavated efficiently except with the use of pneumatic tools, blasting or wedging and splitting, and shall include boulders exceeding 0,15 m<sup>3</sup> in volume.

Soft material:

All material not classified as hard material.

Notwithstanding the above classification, all material excavated from previously constructed fills, embankments, pavement layers and from above existing services shall be classified as soft material.

The decision of the Engineer as to the classification of the material shall be final and binding and any objection as to the classification shall be made before the excavation has been backfilled.

<u>Item</u>	<u>Unit</u>
<b>HE 08.06(c)    <u>Extra over item 3.10.1.1 for excavating by hand in all materials</u></b>	m <sup>3</sup>

The unit of measurement shall be the cubic metre of trench material excavated by means of hand tools as instructed or authorised in writing by the Engineer where the use of conventional excavating equipment is either impractical or likely to cause damage to services, trees or property or where the electrical Contractor has to excavate by hand where he cannot excavate by machine.

The volumes of the trench excavation will be computed from the length and the depth to the bottom of the specified bedding layer and the minimum base widths specified in the drawings. The rate shall cover the cost of complying with the safety and protection requirements specified except where particular items are scheduled to cover particular costs for the excavation.

The tendered rate shall be paid extra over the rates tendered for item HE09.06(a).1 in full compensation for the additional expense of excavating by means of hand labour instead of conventional trenching equipment.

<u>Item</u>	<u>Unit</u>
<b>HE 08.06(d)    <u>Extra over item HD09.06(a) for using backfill material obtained from sources provided by the Contractor</u></b>	m <sup>3</sup>

The unit of measurement shall be the cubic metre of imported backfill material.

Item HD09.06(d) above will not be measured for payment unless importation has been ordered in writing. The volume will be computed from the trench width and the depth from ground level to the top of the sand bed cover as shown on the tender drawings. The rate for material from designated borrow pits shall cover the cost of excavation and selection of suitable material, the moving of the material to the backfilling site, and the disposal of the material that becomes surplus as a result of the importation, all within 0,5 km.

The tendered rate for item HE09.06(d) paid extra over item HE09.06(a) shall cover the cost of the acquisition of the material and of the disposal of the surplus material resulting from the importation together with all the costs of transporting the material to the site regardless of distance.



	<u>Item</u>	<u>Unit</u>
HE 08.06(e)	<b><u>Supply and Install Cable Sleeves</u></b>	m
	The unit of measurement shall be the linear length in meter of cable sleeves supplied and installed.	
	The tendered rate shall include full compensation for the supply, delivery, handling and installing the cable sleeves including all the required couplings, steel draw wires and plugs.	
	<u>Item</u>	<u>Unit</u>
HE 08.06(f)	<b><u>Supply and Install Plastic Warning Tape</u></b>	m
	The unit of measurement shall be the length in meter of plastic warning tape supplied and installed.	
	The tendered rate shall include full compensation for the supplying, handling and laying the plastic warning tape.	
	<u>Item</u>	<u>Unit</u>
HE 08.06(g)	<b><u>Supply and delivery of low-voltage cable</u></b>	m
	The unit of measurement shall be the length of low-voltage cable supplied.	
	The tendered rate shall include full compensation for the manufacture, supply and delivery of the specified cable to the site.	
	Separate items shall be scheduled under this payment item for each size and type of cable required.	
	<u>Item</u>	<u>Unit</u>
HE 08.06(h)	<b><u>Lay LV-cable</u></b>	m
	The unit of measurement shall be the linear length in meter of LV-cable installed.	
	The tendered rate shall include full compensation for the handling, inspecting, laying, cutting and testing the cable. Cables shall be measured linearly over all lengths laid. Separate items shall be scheduled for each size and each type of cable laid.	
	<u>Item</u>	<u>Unit</u>
HE 08.06 (i)	<b><u>Termination of LV-cables</u></b>	No
	The unit of measurement shall be the number of LV-cable terminations.	
	The tendered rate shall include full compensation for providing the cable glands, shrouds and lugs, the cost of handling, fitting and cutting the cable. Separate items shall be scheduled for each size and type of cable.	
	<u>Item</u>	<u>Unit</u>
HE 08.06(j)	<b><u>Supply bare copper earth conductor</u></b>	m
	The unit of measurement shall be the length in meter of bare copper earth conductor supplied.	
	The tendered rate shall include full compensation for procuring, furnishing and laying the specified earth continuity conductor.	

	<u>Item</u>	<u>Unit</u>
HE 08.06(k)	<b><u>Installation of bare copper earth conductor</u></b>	m
	<p>The unit of measurement shall be the length in meter of bare copper earth conductor installed.</p> <p>The tendered rate shall include full compensation for procuring, furnishing and laying the specified earth continuity conductor.</p>	
	<u>Item</u>	<u>Unit</u>
HE 08.06(l)	<b><u>Terminate and connect bare copper earth conductor</u></b>	No
	<p>The unit of measurement shall be the number of bare copper earth conductors terminated and connected.</p> <p>The tendered rate shall include full compensation for supplying all the material required to terminate and connect the bare copper earth conductors and the connecting thereof to the earth bars.</p>	
	<u>Item</u>	<u>Unit</u>
HE 08.06(m)	<b><u>Jointing of low-voltage cable</u></b>	No
	<p>The unit of measurement shall be the number of LV-cables joints.</p> <p>The tendered rate shall include full compensation for the cost of providing the kits, the cost of cutting the cable, handling and fitting the kits and the cost of testing the joints.</p>	
	<u>Item</u>	<u>Unit</u>
HE 08.06(n)	<b><u>Re-lamp luminaire</u></b>	No
	<p>The unit of measurement shall be the number of luminaire lamps replaced.</p> <p>The tendered rate shall include full compensation for the supply and installation of the lamp according to the manufacturer's instructions.</p> <p>Separate items shall be scheduled for each type of lamp.</p>	
	<u>Item</u>	<u>Unit</u>
HE 08.06(o)	<b><u>Supply and installation of internal luminaire components</u></b>	No
	<p>The unit of measurement shall be the number of internal luminaire components replaced.</p> <p>The tendered rate shall include full compensation for the supply and installation of the components according to the manufacturer's instructions.</p> <p>Separate items shall be scheduled for each component.</p>	
	<u>Item</u>	<u>Unit</u>
HE 08.06(p)	<b><u>Internal wiring of luminaire</u></b>	No
	<p>The unit of measurement shall be the number of luminaires rewired with silicone insulated wiring.</p> <p>The tendered rate shall include full compensation for the supply and wiring of a luminaire with silicone insulated wiring where the wiring are specified separately.</p>	

	<u>Item</u>	<u>Unit</u>
HE 08.06(q)	<b><u>Supply and install circuit breakers</u></b>	No
	The unit of measurement shall be the number of circuit breakers supplied and installed.	
	The tendered rate shall include full compensation for the supply and installation of the circuit breakers where the circuit breakers are specified separately.	
	<u>Item</u>	<u>Unit</u>
HE 08.06(r)	<b><u>Supply and install isolators</u></b>	No
	The unit of measurement shall be the number of isolators supplied and installed.	
	The tendered rate shall include full compensation for the supply and installation of the isolators where the isolators are specified separately.	
	<u>Item</u>	<u>Unit</u>
HE 08.06(s)	<b><u>Supply and install contactors</u></b>	No
	The unit of measurement shall be the number of contactors supplied and installed.	
	The tendered rate shall include full compensation for the supply and installation of the contactors where the contactors are specified separately.	
	<u>Item</u>	<u>Unit</u>
HE 08.06(t)	<b><u>Supply and install of low tension fuses</u></b>	No
	The unit of measurement shall be the number of fuses supplied and installed.	
	The tendered rate shall include full compensation for the supply and installation of the fuses where the fuses are specified separately.	
	<u>Item</u>	<u>Unit</u>
HE 08.06(u)	<b><u>Supply and install photocell (plug-in type)</u></b>	No
	The unit of measurement shall be the number of photocells supplied and installed.	
	The tendered rate shall include full compensation for the supply and installing of the photocells where the photocells are specified separately.	
	<u>Item</u>	<u>Unit</u>
HE 08.06(v)	<b><u>Supply and install QAT-R type electronic timer</u></b>	No
	The unit of measurement shall be the number of timers supplied and installed.	
	The tendered rate shall include full compensation for the supply and installing of the timers where the timers are specified separately.	

	<u>Item</u>	<u>Unit</u>
HE 08.06(w)	<b><u>Supply and install 0-30A HRC fuses</u></b>	No
	The unit of measurement shall be the number of fuses supplied and installed.	
	The tendered rate shall include full compensation for the supply and installing of the fuses where the circuit breakers are specified separately.	
	<u>Item</u>	<u>Unit</u>
HE 08.06(x)	<b><u>Supply and install end connectors and insulating sleeves</u></b>	No
	The unit of measurement shall be the number of end connectors and insulating sleeves supplied and installed.	
	The tendered rate shall include full compensation for the supply and installation of the end connectors at the light pole or where cables forms a looping system.	
	<u>Item</u>	<u>Unit</u>
HE 08.06 (y)	<b><u>Replace pole</u></b>	
	The unit of measure shall be the number of poles replaced.	
	The tendered rate shall include full compensation for the removal of all equipment from the existing pole, removal of the existing pole from site, ordering, supply and installation of the pole in the position specified.	
	The contractor shall install all existing equipment onto the new pole	
	<u>Item</u>	<u>Unit</u>
HE 08.06 (z)	<b><u>Replace Luminaire diffuser</u></b>	
	The unit of measure shall be the number of luminaire diffusers replaced.	
	The tendered rate shall include full compensation for the removal of the diffuser from the existing luminaire, ordering, supply and installation of the new diffuser as specified according to manufactures instructions.	
	<u>Item</u>	<u>Unit</u>
HE 08.06 (aa)	<b><u>Replace pole mounted brackets</u></b>	
	The unit of measure shall be the number of pole brackets replaced.	
	The tendered rate shall include full compensation for the ordering, supply and installation of the pole bracket including all fixing accessories as specified according to manufactures instructions.	
	The tendered rate shall further include for the removal of all old equipment from the pole and the supply and installation of the new equipment onto the pole bracket including the connection of the equipment.	

Item      Unit

**HE 08.06 (ab) Replace pole cover**

The unit of measure shall be the number of pole covers replaced.

The tendered rate shall include full compensation for the removal of the pole cover from the existing pole, ordering, supply and installation of the new pole cover as specified according to manufactures instructions.

Item

Unit

**HE 08.06(ac) Junction boxes including pole mount brackets.**

No.

The unit of measure shall be the number of junction boxes supplied and installed.

The tendered rate shall include full compensation for the supply and installation of junction boxes brackets and strapping. The junction box must be fitted with a neutral bar earth bar, din terminal rails and CBI circuit breaker clips to accommodate the maximum amount of terminals and circuit breakers.

Item

Unit

**HE 08.06(ad) Remove rust and paint kiosks**

The unit of measurement shall be the total number of kiosks painted.

The tendered rate shall include full compensation for the removal of rust with a anti corrosion agent and the repainting of the whole kiosk.

Item

Unit

**HE 08.06(ae) Label kiosks**

No.

The unit of measure shall be the total number of kiosks labelled.

The tendered rate shall include full compensation for the labelling of kiosks circuit breakers, cable and the warning notification to be installed.

Item

Unit

**HE 08.06(af) Supply and install padlocks**

No.

The unit of measurement shall be the number of padlocks installed.

The tendered rate shall include full compensation for the ordering, supply, engraving and installation of the padlocks, locking devices and seals.

Lock shall be "keyed alike".

Item

Unit

**HE 08.06(ag) Replace distribution meter kiosks.**

No.

The unit of measurement shall be the number of distribution kiosks replaced.

The tendered rates shall include full compensation for the removal, the ordering, supply and installation of the new 6/4 way meter boxes complete with watt hour meters, circuit breakers, gland plate, labelling and concrete foot strip as specified.

**Consumer distribution kiosks****(a) General**

The kiosks shall be of adequate size to accommodate the number of outgoing consumer circuits specified.

The kiosks shall have two sections, namely:

- (i) one section containing all incoming and outgoing switchgear and cables, and
- (ii) one section containing the consumer meters and circuit breakers.

**(b) Fabrication**

The kiosks shall be fabricated from 3CR12 stainless steel of minimum thickness 2,5 mm and shall be mounted on a channel iron steel base.

A metal frame work, manufactured from solid angle iron, channel iron, or 2,5 mm 3CR12 folded sheet steel shall be mounted on the base of the kiosk. The kiosk shell shall be completely independent from the frame and equipment so that the kiosk shell can be removed and replaced without disconnecting any equipment. The kiosk shall be bolted down onto the base by means of four M16 high tensile bolts which shall be accessible from the inside of the kiosk only.

The kiosks shall be weatherproof, vermin and insect-proof and proved against tampering. To prevent the ingress of water onto live equipment, the door entry surrounds shall have a channel shape, at least 12 mm deep, to accommodate the door edge. A rubber or neoprene closer strip shall be so fitted to the edges of each door as to provide a seal to keep rain water and dust out of the kiosk.

The kiosk shall have a pitched roof that slopes downwards at the front and at the back with an overhang of at least 75 mm all round.

The kiosks shall be fitted with a door in the front and at the back of the kiosk. The maximum width per door shall be 600 mm. The doors shall provide free access to the equipment and shall provide a full view of all meters. The doors shall have well returning edges to fit into the channel of the door entry surrounds. Each door shall have three robust solid brass hinges each of length at least 100 mm. The hinges shall be completely concealed. Doors shall be fitted with lever locks. The locking mechanism shall facilitate three point latching at the top, side and bottom of the doors. In the case of double doors the first door shall be locked with two slides on the inside onto the kiosk shell. The second door shall close over a lip on the first one. Nylon door restraints shall be provided. The fixing points of the restraints at the door and the canopy shall be reinforced. The doors shall be earthed bonded to the frame by means of a copper braided strap, tooth washers, bolts and nuts.

Ventilation louvres with approximate size 225 x 150 mm shall be provided on both sides of the kiosk. Each ventilation louver shall be covered on the inside with perforated plates with 2,5 mm holes so that

- it is not possible to push a steel wire through it into the interior of the kiosk, and
- it prevents vermin from entering into the kiosk.

A mounting panel shall be positioned in the centre of each kiosk, fixed to the frame work, for the mounting of the specified equipment.

**(c) Mounting panel**

The mounting panel shall consist of a minimum 3 mm thick mild steel plate.

The one section of the panel shall be equipped with copper busbars mounted on porcelain or similar insulators and of sufficient length to accommodate three 12 mm brass bolts for the connection of distribution cables and six consumer meter connections per phase. The busbars shall be tinned after the drilling of holes. The busbars shall be able to carry 250 Ampere at a current density of not more than