CITY OF TSHWANE

WATER AND SANITATION DEPARTMENT

CONTRACT NO: WS 15 2024/25

TENDER FOR THE APPOINTMENT OF A CONTRACTOR FOR THE REPLACEMENT AND COMPLETION OF THE ELECTRICAL AND MECHANICAL COMPONENTS OF TEMBA WASTEWATER TREATMENT WORKS AND UPGRADING OF BABELEGI WASTEWATER TREATMENT PLANT FOR CONSTRUCTION DURATION OF 24 MONTHS FROM THE COMMENCEMENT DATE.

C3.4.5 PARTICULAR SPECIFICATIONS FOR MECHANICAL WORKS

C3.4.5 PARTICULAR SPECIFICATIONS FOR MECHANICAL WORKS

PRELUDE

This particular (standard) specification details the successful supply, manufacturing, factory inspection test at the contractors premises, careful handling / transportation to the clients premises, safe storage as required and successful installation and commissioning of the mechanical works and equipment.

The contractor will furthermore responsible to uphold the mechanical equipment during the Defects Liability Period.

This particular specification should be read in conjunction with the following;

- Associated drawings as issued with the Tender documents; and As-built drawing of current equipment installations
- Doc_Vol2_TSM - Mechanical Technical Schedules
- DOC_Vol1_ Sect C2.2 -Bill of Quantities (Mechanical Scope) ; and
- DOC_PSM_– Project Specifications for Mechanical Works
- Reference Mechanical GA Drawings (As-built and Tender Drawings for information)

Where conflicts in the above-mentioned exits, this should be brought to the attention of the Engineer within a week before the Tender closes.

All materials and equipment to be supplied shall be new and of the best quality available.

All equipment shall bear the SANS mark and be fully compliant with the particular SANS standard.

PPM-GEN.1 CITY OF TSHWANE STANDARD DOCUMENTS

The following City of Tshwane particular specifications bound in sections of this document shall be applicable to the mechanical works related to this particular specification. Any reference to a standard such as SANS refers to the latest applicable edition of that standard which shall be used:

PJ : Refurbishing of Mechanical Equipment

PLC : Chemical Dosing Equipment

PLK : Manufacture and Supply of Valves

PLKA : Sluice and Channel Gates, Adjustable Weirs Hand stops, Stoplogs

PLN : Manufacturing of Steel Pipes

PLQ : Corrosion Protection for Steel Pipes

PLT : In-Line Flow Meters (General)

PLV : Colour Coding

PT : Pumps (general)

PTG : Gearboxes

PTJ : Vertical Shaft Aerators

PTMa : Mechanical Mixers

PTP : Hoisting Equipment

PTQ : Primary Sewage Treatment Equipment

PTR : Sedimentation Tanks

PTU : Chlorine Dosing Equipment

PTZ : Aeration Blower Equipment

PXC : Low Voltage Electrical Motors

PJ : REFURBISHMENT OF MECHANICAL EQUIPMENT

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Item Description

PJ REFURBISHMENT OF MECHANICAL EQUIPMENT

PJ1 SCOPE

This specification covers the requirements for the repair and complete refurbishment of mechanical equipment including Vertical Shaft Aerators, Clarifiers, Mixers, centrifugal pumps, valves, chlorine dosing pumps and related equipment.

PJ2 GENERAL

It is required that certain components of the existing works are to be refurbished.

All equipment identified and specified for refurbishment shall be confirmed in writing by the Engineer prior to commencement of works on each component, and the Contractor shall not proceed with the removal of any piece of equipment for the purposes of refurbishment until such time as an instruction has been issued in respect thereof by the Engineer. In many instances the plant will be required to be kept operational whilst equipment is being refurbished, and hence work in this regard will have to be phased as instructed by the Engineer.

PJ3 REPLACEMENT PARTS

All parts of equipment being refurbished, found to be defective, damaged, or worn beyond the tolerances specified by the original manufacturer shall only be replaced by genuine replacement parts supplied by the manufacturer, or an alternative approved by the manufacturer.

Parts which must be replaced each time the component is dismantled, such as seals and the like, shall be replaced in accordance with the instructions of the manufacturer. Other parts shall only be replaced upon the written instruction of the Engineer.

PJ4 REMOVAL, DISMANTLING, AND INSPECTION OF EQUIPMENT

PJ4.1 Removal and Storage of Equipment

Once an instruction has been issued for the refurbishment of a piece of equipment, then the Contractor shall disconnect the item in question and remove it from the plant, taking due care to do so in accordance with best practice and the manufacturer’s instructions. The Contractor shall ensure that in so doing he does not damage components connected to the item being removed, or any other components of the plant or its premises.

The equipment to be refurbished must be removed to a workshop whose locality shall be made known to the Engineer in writing prior to commencement of the work, and which shall be maintained in a dry, clean and dust free condition for the duration of the refurbishment work to be undertaken. The Engineer reserves the right to inspect the Contractor's nominated workshop at any time. It must be noted that all equipment removed to the Contractor's workshop, or to any other place at any time, always remains the property of the Employer, and shall be cared for as such.

The Contractor shall provide insurance to cover the costs of all equipment removed from the plant against all damages which may be incurred thereto whilst transporting and storing it, working thereon and otherwise taking care thereof.

PJ4.2 Dismantling of Equipment to be Refurbished

The Contractor shall dismantle all items of equipment to be refurbished, to the extent that he can physically inspect all internal and external components for damage, and measure all tolerances prescribed by the manufacturer for the proper operation of the equipment in question.

Equipment shall be dismantled carefully to ensure that no damage is incurred thereto as a result thereof, in accordance with dismantling procedures and sequences which are prescribed by the manufacturer, and in a manner which allows for the careful and dust-free storage or components until they are re-assembled.
The Contractor shall ensure that he has in his possession at his designated workshop all tools and specialised equipment required for the proper dismantling and re-assembly of mechanical components to be refurbished, prior to removal of these components thereto, and commencement of the dismantling process.

PJ4.3 Inspection and Testing of Mechanical Equipment and Reporting Thereon

Once equipment to be refurbished has been dismantled, all components thereof shall be thoroughly inspected for cracks, signs of wear including scratch marks and tears, and other indicators of existing or potential future causes of failure of the component in question, or the item of equipment as a whole.

All moving parts and parts susceptible to friction, wear and tear of any sort must have their performance and tolerances checked in strict accordance with the manufacturer's instructions.

Once all inspections and checks as described above have been undertaken then a report on the results thereof must be compiled and submitted to the Engineer for each piece of equipment. This report must include the following:-

- A full list of all checks and tests undertaken thereon.
- A list of all components requiring mandatory replacement each time the item in question is dismantled, such as seals and the like. All gland seals on pumps must be replaced by mechanical seals and must be included in this list.
- A list of cracks, breaks, wear, tear, and other defects detected, together with a description as to whether each of these can be attributed to normal wear and tear or otherwise and likely causes of defects in the event that they are not attributable to normal wear and tear.
- A list of components which are recommended for replacement, which do not normally require mandatory replacement, together with motivation therefor because of non-compliance with specifications and tolerances, damage, or whatever may be the case. This list must also be accompanied by quotations for the supply and installation of these components by the Contractor.

Once this report is received by the Engineer, he will approve which components may be replaced or otherwise, and the Contractor shall not proceed with the re-assembly of the equipment in question until approval is received in writing from the Engineer therefor.

PJ5 RE-ASSEMBLY OF AND RE-INSTALLATION OF EQUIPMENT

Upon receipt of approval from the Engineer of which components, which do not require mandatory replacement, must be replaced, the Contractor shall order these, together with all items which require mandatory replacement upon dismantling and re-assembly, and reassemble the item of equipment in question, using the new parts as necessary.

As with dismantling, re-assembly must be undertaken strictly in accordance with procedures and sequences prescribed by the manufacturer. The Contractor shall ensure that he only uses specialist tools and equipment for assembly in strict accordance with the manufacturer’s instructions.

Upon completion of the re-assembly of equipment, they shall be transported back to the site and reinstalled, strictly in accordance with the manufacturer’s

instructions, and in such a manner as not to cause any damage to the rest of the plant and its fittings and equipment.

The provisions of this document and all specifications included therein pertaining to the transportation, delivery, off-loading, installation, and commissioning of new equipment shall apply equally to equipment refurbished under this Contract.

PJ6 REFURBISHED PUMPSET TESTS

During re-commissioning of the pumpstations from which equipment has been removed for refurbishment and returned, the Contractor will be required to carry out performance tests on each pump set separately. The Contractor shall provide all necessary instruments required to measure the delivery rate, operating pressure, efficiency, speed, and all relevant electrical measurements in determining absorbed power. Proof of calibration of all instruments will be required.

Should either the measured delivery rate or pump efficiency as determined on site prove to be less than 95% of the value rated by the manufacture under prevailing operating conditions, the Employer shall have the right to refuse acceptance thereof until such time as the Contractor either rectifies the pump set accordingly or supplies a new replacement pump set which satisfies this requirement.

PJ7 REFURBISHMENT OF STRUCTURAL STEELWORK AND PIPEWORK SPECIALS

Where specified, existing structural steelwork elements such as sedimentation tank scraper support bridges, ladders, handrails, lifting apparatus, pipework special fittings and valves will be refurbished. Such refurbishment shall include: -

- Disassembly of structural and pipework assemblies, taking care not to damage the works
- Removal to workshop
- Sandblasting, re-lining and re-coating in accordance with Clause PTV
- Delivery back to site
- Re-assembly, including provision of new gaskets and any new bolts which may be required
- External painting as may be required to suit prescribed colour schemes

PJ8 CORROSION PROTECTION

All refurbished equipment shall be re-coated and protected against corrosion as specified in the relevant Project and Particular Specifications. Painting to be to the colours specified - a complete list of colours has been included as an Annexure to the Specifications.

PJ9 GUARANTEE FOR REFURBISHED COMPONENTS

All components refurbished as part of this Contract shall be fully guaranteed by the Contractor for a total of 3287 hours of operation (considered to be the equivalent of 6 months working time), from the date of the issue of the Taking Over Certificate for such works. Such guarantees shall carry the same force and place the same obligations on the Contractor as if the equipment so refurbished by the Contractor had been supplied as new by him.

PJ10 REPLACEMENT OF PARTS TO BE REFURBISHED

Once the Contractor has removed a component having been designated to be refurbished, and reported the refurbishment requirements thereof to the Engineer, then the Engineer may decide that the costs of refurbishment are unwarranted or excessive, and that the interests of the Employer may be better served by the complete replacement of the component in question with a new component.

In such a case, then the following shall apply: -

If a replacement component is readily available, from either the original supplier, or from another supplier of components of a similar nature and capacity as that to be replaced, then the Contractor will be instructed to obtain a quoted price from the original supplier or approved alternative supplier for the component in question. If the Engineer is satisfied with this quotation, then he shall instruct the Contractor to procure the component in question, for which the Contractor shall be reimbursed at the quoted cost plus his tendered profit and attendance on materials for dayworks and replacement components.

In the event that the component to be replaced is no longer readily available from the original supplier, and no other component of a similar type or capacity is available from any other supplier, then the replacement of the component in question will have to be designed, fabricated, supplied, installed and commissioned by the Contractor, in the same way as if the component was a new component to be provided in accordance with the provisions of the Contractor. In this case the Contractor will be required to provide a cost estimate to the engineer for such service, to be approved in writing before the Contractor proceeds with the implementation thereof.

PJ11 MEASUREMENT AND PAYMENT

PJ11.1 Equipment to be Refurbished

The tendered price and payment made for equipment to be refurbished shall cover full compensation for the following: -

- Disconnecting equipment and removal from the plant.
- Transportation to and from the Contractor's workshop, including insurance of equipment in transit and in storage or being worked upon.
- Provision and maintenance of a workshop in a dry, clean and dust free condition for the purposes of dismantling, inspections, and re-assembly of equipment, including all necessary specialised tools and equipment as prescribed by the manufacturer's instructions, as well as trade best practise.
- Dismantling, inspections, tolerance testing, and reporting on all findings of inspections and tests, including quotations for parts not requiring mandatory replacement.
- Supply of all parts requiring mandatory replacement as required by the manufacturer's instructions upon dismantling, such as seals and the like.
- Re-assembly of equipment including installation of all new parts required and approved by the Engineer.
- Re-installation of equipment in the plant, including connection to pipework and electric control and power supply.

The tendered rate shall not include for new parts not requiring mandatory replacement upon dismantling according to the manufacturer's instructions, but which are to be replaced upon the instruction of the engineer. The costs of such parts shall be paid for out of a separate provisional sum included in the Contract for this purpose.

PJ11.2 Pump Testing

A separate payment item will be allowed for the operations as described in section PJ6 above.

PJ11.3 Refurbishment of Structural Steel Assemblies and Pipework

Separate items will be included in the schedules for each steel and pipework item to be refurbished, the rates for which must include full compensation for all action as described in Section PJ7.

END OF SECTION

PLK : MANUFACTURE AND SUPPLY OF VALVES

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PLK MANUFACTURE AND SUPPLY OF VALVES

PLK 1 SCOPE

This section of the Specification includes the manufacture, testing and supply of valves for the conveyance of raw or potable water at ambient temperatures in pipes under pressure.

PLK 2 STANDARDS

The most recent issues of the following standard specifications will apply for the purposes of this Specification.

SANS 144	:	Cast-iron single door non-return valves
SANS 191	:	Cast steel gate valves
SANS 192	:	Cast steel single door non-return valves
SANS 664	:	Cast iron gate valves for waterworks
SANS 665	:	Cast iron gate valves for general purposes
BS 5155	:	Cast iron and carbon steel Butterfly valves
ISO 2441	:	Pipeline flanges for general use - shapes and dimensions of pressure tight surfaces
SANS 1123	:	Steel pipe flanges
SIS 05 5900	:	Pictorial surface preparation standard for painting steel surfaces

PLK 3 MATERIALS

PLK 3.1 Sluice Valves

PLK 3.1.1 The valve body, bonnet, thrust dome, gate and glands shall be of cast iron or cast steel as specified and depending on the required test pressures.

PLK 3.1.2 The stuffing box shall be of ample depth to afford sufficient space for long period packing and the design shall be such as to allow the gland to be easily and conveniently repacked under pressure.

PLK 3.1.3 Body and gate sealing rings shall be of bronze, gunmetal or stainless steel. RSV gate shall be nitrile rubber covered, and fully encapsulated. The rubber shall not be removed from the guides of the gate.

PLK 3.1.3 Spindles shall be of high grade stainless steel.

PLK 3.1.4 An isolating valve must be able to check the specified water pressure from both sides.

PLK 3.2 Butterfly Valves

PLK 3.2.1 Valve bodies and discs shall be of high-grade cast-iron or cast steel as specified and depending on the required test pressures.

PLK 3.2.2 The disc shaft or stub-shafts shall be of stainless steel located in self-lubricating bearings.

PLK 3.2.3 Sealing rings, seal retaining rings, body seatrings and associated screws shall be of stainless steel.

PLK 3.2.4 A butterfly valve must be able to check the specified water pressure from both sides.

PLK 3.3 Reflux Valves

PLK 3.3.1 Valve bodies shall be of cast iron or cast steel depending on the specification or test pressures.

PLK 3.3.2 Valve doors shall be of cast iron or cast steel.

PLK 3.3.3 The valve body and doors or disc shall be fitted with replaceable stainless steel body and door seat rings.

PLK 3.4 Air Valves

PLK 3.4.1 *Function*

Air valves are required to perform any combination of the following functions:

- Uninterrupted high volume air discharge through a large orifice during pipe filling.
- Uninterrupted high volume air intake through a large orifice during pipe emptying.
- Discharge of pressurised air through a small orifice during normal operation.
- Surge alleviation mechanism during rapid air discharge or rejoining of separated water columns.

PLK 3.4.2 C*losing mechanism, construction and design*

PLK 3.4.2.1 The air release and vacuum break valve shall be of a compact single chamber design with solid cylindrical High Density Polyethylene control floats. Floats of spherical design shall not be accepted. Any hollow float design will not be acceptable due to implosion and distortion making sealing difficult or impossible.

PLK 3.4.2.2 The ends of the cylinder shall be of fusion bonded epoxy powder coated mild steel, secured by means of stainless steel tie roads.

PLK 3.4.2.3 Floats shall be housed in a tubular stainless steel or corrosion protected body, secured by means of stainless steel fasteners.

PLK 3.4.2.4 The seats, spindles, guides, etc shall be of a suitable non-corroding metal with sufficient clearance and shall be designed to prevent abrasion of the ball or float when subjected to frequent operation.

PLK 3.4.2.5 The seats of the orifices shall not have sharp edges and shall be designed so as not to damage the ball or float when subjected to pressure.

PLK 3.4.2.6 The valve shall have an integral surge alleviation mechanism which shall operate automatically to limit transient pressure rise or shock induced by closure due to high velocity air discharge or the subsequent rejoining of separated water columns.

The limitation of pressure rise must be achieved by deceleration of approaching water prior to valve closure.
Relief mechanisms that act subsequent to valve closure cannot react in the low millisecond time span required and are therefore unacceptable.
The performance capability of an integral surge alleviation mechanism shall be substantiated through third party testing, conducted by a recognized authority.

PLK 3.4.2.7 Large orifice sealing shall be effected by the flat force of the control float seating against a nitrile rubber ‘O’ Ring housed in a dovetail groove circumferentially surrounding the large orifice.

Sealing in any other form shall not be accepted due to the vulcanizing of the float or the wedging of the float in the large orifice.

PLK 3.4.2.8 Discharge of pressurized air shall be controlled by the seating and unseating of a small orifice on a natural rubber seal affixed to the control float.

Valves with slotted air release apertures shall not be considered.

PLK 3.4.2.9 The intake/discharge orifice area shall be equal to the nominal size of the valve i.e. a 200 mm valve shall have a 200 mm intake/discharge orifice.

Valves up to and including 200mm NB shall incorporate an over pressure safety feature that will fail without an explosive effect, such as is normally the case when highly compressed air is released suddenly. This feature shall consist of easily replaceable components such as gaskets, seals or the like.

PLK 3.4.2.10 The valve construction shall be proportioned with regard to material strength characteristics, so that deformation, leaking or damage of any kind does not occur by submission to 2 times the designed working pressure.

PLK 3.4.3 ***Testing***

PLK 3.4.3.1 Manufacturers' published performance data must be substantiated by third party testing from a recognized test authority.

PLK 3.4.3.2 A high pressure strength and leak test whereby the valve is filled with water and pressurized to 2 times the rated working pressure which shall be held for a period of 2 minutes. Any leaking, weeping and sweating shall be a reason for rejection. These tests must be on total, completed units including floats.

PLK 3.4.3.3 Any imported valves shall be retested locally in all areas of specification.

PLK 3.4.4 ***Isolating valves for air valves***

PLK 3.4.4.1 Each air valve shall be provided with a suitable double flanged resilient seal gate valve to isolate the air valve from the main.

PLK 3.4.4.2 The isolating valves shall be capable of operating in a horizontal position and shall be provided with a handwheel for operation and gearing is not required.

PLK 3.4.4.3 Each isolating valve shall be provided with a handwheel fitted to the spindle in an approved manner and shall have directional indication so cast into a recess on the

upper surface of the rim that the top of the letter, arrows and rim are at the same level.

PLK 3.4.5 ***Drains***

PLK 3.4.5.1 All air valves be provided with drain cocks so that the body of the valve can be drained when isolated from the pipeline. Cast steel gate valves shall be provided for this purpose.

PLK 3.4.6 ***Pressure gauge fitting***

PLK 3.4.6.1 A 12-mm cast steel full bore gate valve shall be fitted to the spool piece between the isolating valve and the air valve flanges for attaching a pressure gauge.

PLK 3.5 Ring needle valves

PLK 3.5.1 The valve body shall be of spheroidal graphite iron or cast-steel with supporting feet. The body seat shall be of stainless steel and shall be replaceable or may be deposit welded on a removable body section.

PLK 3.5.2 For ring needle valves the piston (plunger) shall be of cast stainless steel with replaceable resilient seal to obtain drop tightness, held in place by a retaining ring of stainless steel and corrosion resistant screws.

PLK 3.5.3 For spherical ball valves, the eccentrically supported ball plug shall be of cast stainless steel or spheroidal graphite iron with replaceable resilient seal to obtain drop-tightness, held in place by a retaining ring of stainless steel and corrosion resistant screws. The valve body shall include an access door to permit adjustment or replacement of the valve seal without dismantling the valve.

PLK 3.6 Manufacture

PLK 3.6.1 ***General***

PLK 3.6.1.1 The design pressure of the valves shall not be less than the pressure specified subject to a minimum of 1 000 kPa.

PLK 3.6.1.2 All valves shall be double-flanged with bolt holes drilled off-centre all in accordance with the requirements of SANS 1123 or as otherwise specified.

PLK 3.6.1.3 The Tenderer shall give as a function of the downstream pressure the maximum acceptable discharge of water through the valves without risks of vibration and

cavitation. The Tenderer shall also submit the head-loss characteristics of the valves.

PLK 3.6.1.4 The design pressure will be hand stamped on the top edge of the flanges of valves in kPa.

PLK 3.6.1.5 If specified, valves shall be supplied with by-passes to be bolted on to the body of the valve and not to the adjoining pipework.

PLK 3.6.1.6 Valves shall be fitted with position indicators if specified. Fully closed, fully open and intermediate positions shall be indicated in corrosive proof and robust design indicators.

PLK 3.6.1.7 Arrows shall be cast on all handwheels together with the wording "OPEN" or "CLOSE". The closing direction shall be clockwise unless otherwise specified.

In the case of cap top valves, an aluminium disc of at least 100 mm diameter and with the same wording and arrows shall be slipped over the spindle and retained by the cap.

PLK 3.6.1.8 All valves shall be supplied complete including bolts, nuts, washers and gaskets in accordance with the class of valve. Bolts shall be of sufficient length to allow not more than three screw threads to protrude outside units after complete tightening of the assembly. Gaskets for flanged joints shall be of compressed asbestos fibre to BS 2815 Grade A and full faced with a minimum thickness of 3 mm for pressures up to and including 1 600 kPa cloth-inserted rubber may be used.

PLK 3.6.1.9 Where isolating valves are required to be equipped with extended off-set spindles, the spindles shall be equipped with sufficient universal joints to ensure satisfactory valve operation. All spindle extensions shall be secured to permanent structures with galvanised clamps to the Engineer’s approval. The rate for such valve items shall include for any required clamps, extensions joint, etc.

Handwheels on such extended spindles shall be mounted on plain-ended spindle or handwheel pedestal as specified or indicated on the construction drawings.

Isolating valve operation:

Cap top ..... CT
Handwheel ..... HW
Electric actuator ..... EA

Pneumatic actuator ..... PA
Handwheel spindle extension ..... HSE
Plain ended spindle extension ..... PESE
Platform-mounted handwheel pedestal ..... PMP
Handwheel pedestal on wall support bracket ..... HPWB
Stub handwheel pedestal on wall support bracket ..... SHWB
Grid-mounted handwheel pedestal ..... GMP

PLK 3.6.1.10 The following information shall accompany the tender:

- Description
- Flange Drilling
- Maximum working pressure
- Maximum unbalanced pressure
- Test pressure
- Manufacturers number
- Material of components
- Gearing
- Accessories

PLK 3.6.2 *Sluice Valves*

PLK 3.6.2.1 Double-flanged, wedge-gate, internal (non-rising) spindle sluice valves of the waterworks pattern are required to comply fully with SANS 191 or SANS 664 where applicable.

PLK 3.6.2.2 Only full-way valves will be accepted (i.e. the gate must be clear of the waterway in the fully open position).

PLK 3.6.2.3 The maximum force required to turn the handwheel at the maximum torque shall not be greater than 100 N per hand at the handwheel run (Total effort = 200 N) when operating at an unbalanced pressure equal to the rated working pressure of the valve. This may be achieved with the aid of gearing of a suitable ratio.

Where gears are used replaceable shear pins shall be provided to prevent damage to the valve if excessive pressure is used.

PLK 3.6.3 *Butterfly Valves*

PLK 3.6.3.1 Horizontal spindle type butterfly valves complete with gearing, handwheels and flanged at both ends with separate bolting for joining to the adjacent pipework is required.

PLK 3.6.3.2 Wafer valves or valves fitted with studs for attachment to the adjacent flanges are not permitted.

PLK 3.6.3.3 Valves shall be drop-tight when closed and metal to metal sealing is not acceptable.

PLK 3.6.3.4 All resilient seals shall be removable and readily replaceable on Site with the valve in position.

PLK 3.6.3.5 Resilient seals shall be retained by corrosion resistant securing elements to prevent corroding in position (e.g. bolts, set screws, etc.)

PLK 3.6.3.6 The valve-water seal shall be of the following types:

- a resilient seal fixed to the edge of the disc by corrosion resistant securing elements sealing on a stainless steel or bronze insert fixed in the body.

- a resilient seal fixed to the body of the valve by corrosion resistant securing elements sealing on a stainless steel or bronze insert fixed in the edge of the discs.

PLK 3.6.4 *Reflux Valves*

PLK 3.6.4.1 Reflux valves shall be double-flanged, SANS 1551.

PLK 3.6.4.2 Valve bodies and seals shall be free of pockets that will allow dirt accumulation and prevent the doors from closing fully.

PLK 3.6.4.3 Stops or an approved resilient material shall be fitted into the body to prevent the doors from fluttering under full flow conditions.

PLK 3.6.4.4 Valves shall be designed to allow for rapid but non-slamming closing characteristics.

PLK 3.6.5 *Air Valves*

PLK 3.6.5.1 Air valves shall be supplied with double-flanged, wedgegate internal (non-rising) spindle sluice valves for isolation, which unless otherwise specified shall conform in all respects to this specification.

PLK 3.6.6 *Ring needle valves*

PLK 3.6.6.1 Ring needle valves used as auto closing valves shall fulfil the following functions:

- Electrical operation (isolating and control) suitable for opening and closing against the specified pressure and for continuous operation in any intermediate position.
- Automatic as well as manual mode control.
- Automatic reflux action for quick closure by means of drop-weight and hydraulic dash pot in case of power failure or motor protective tripping.
- Adjustable closing time and adjustable closing characteristic.

PLK 3.6.6.2 The totally enclosed flanged-on gearbox shall include the following:

- Either an electo-mechanical unit comprising:
  - a totally enclosed brushless electromagnetic gear clutch for quick closing;
  - a totally enclosed directly mounted electric valve actuator with integral electric controls and auxiliary handwheel for manual operation;
- or an electro-hydraulic unit comprising:
  - an oil hydraulic lift cylinder for opening the valve;
  - a totally enclosed directly mounted electronic driven oil pump and oil reservoir. The oil pump and reservoir may be individually mounted on each valve or a centralised system may be employed to feed more than one valve and/or pumpline;
  - a solenoid operated hydraulic control valve which shall be de-energised to initiate closure of the valve.

PLK 3.6.6.3 Either of the above actuators shall also be provided with:

- limit switches for signalling the “open”, “closed” and intermediate “10%” positions and further control functions as required;
- a directly mounted oil hydraulic dashpot with the necessary control valves for adjusting closing time and operating characteristic;
- means to operate the valve manually;

- valve shaft (stub shafts) of high tensile stainless steel located in bushes of zinc-free bronze;
- a drop weight lever arm of steel with adjustable cast iron drop weight. The lever arm shall be keyed or splined to the shaft.

PLK 3.6.6.4 The overhang shaft carrying the drop weight lever arm shall be supported at its bearing housing from the foundation block.

PLK 3.6.6.5 Travel of the drop weight shall be restrained for reasons of safety at either end of the lever arm.

PLK 3.6.6.6 The control valves shall be arranged for selection of either manual-electric or automatic-electric operation controlled from the pump control console. Push buttons “open”, “close” and “stop” for piloting ghese valves, when throttling is required, shall be incorporated in each pump control console, as well as indicator lamps showing “closed” (green) “intermediate” (amber) “open” (red) positions. In addition, a selector switch “manual/automatic” shall be incorporated, the automatic position being in conjunction with pump starting. A further “test” selector switch shall bew mounted inside the panel to permit manual-electric testing of the equipment without running the pumpset.

PLK 3.6.6.7 In the “automatic” mode the valve shall open automatically from the fully closed to fully open position when the pumpset is started, likewise closing automatically, when the pumpset is to be shut down. In die “manual” mode the valve shall open automatically to at least the “10% open” intermediate position, whereafter manual selection of the valve position shall be enabled.

- Each valve shall be interlocked with the pump starter. When the pump is to be stopped, the valve shall close slowly to prevent water hammer either by means of the electric actuator or by releasing hydraulic pressure in the lift cylinder by means of control valves before the pumpset ios tripped and stopped by interlocked relays.
- Similarly, the valve shall be arranged so that the pump can be started only when the valve is fully closed. The valve shall open only when the starting operation is completed and the motor is up to speed.

PLK 3.6.6.8 The control valves shall have automatic reflux action features to close by drop-weight, controlled by an oil hydraulic dashpot, in the event of power failure or motor protective tripping. The drop-weight shall be released by a solenoid operated clutch or a valve which is constantly energised during pumping operations. Closing time and characteristics shall be adjustable to minimise water hammer.

PLK 3.6.6.9 It shall be possible to energise the “manual” mode only when:

- the associated pump is running.
- the valve is at least 10% open as indicated by the “intermediate” lamp.
- the valve is in the “test” mode

Selection of the “manual” mode shall not affect the automatic reflux action.

When the opening of the valve has been set manually, the valve shall maintain this position in the absence of any further action.

PLK 3.6.6.10 “Test” mode: With both isolating valves closed and electrically interlocked, a test facility shall be provided to enable the maintenance personnel to manually operate the valve without the pumpset running by selection from inside the pump control console.

PLK 3.6.6.11 Valves shall be designed to operate free of cavitation in intermediate positions.

PLK 3.6.7 ***Electric Actuators***

PLK 3.6.7.1 When specified, in the Project Specification the valves shall be fitted with electric, motor-driven flood-proof IP 68 actuators of robust design, capable of closing the valves under all unbalanced pressures.

PLK 3.6.7.2 The Tenderer shall state the maximum torque required to operate the valve in his Tender. In determining this maximum torque an allowance shall be made for any deterioration that could be expected to occur in the bearings during the life of the valve. The actuator shall be capable of transmitting twice this maximum torque without any of its components suffering permanent damage. This shall be proven to the Engineer's satisfaction by workshop tests.

PLK 3.6.7.3 The actuators shall be capable of restraining the valve in any position under all possible conditions of operation, and shall not, in any circumstances, be capable of becoming self-motorised as a result of the dynamic torque loading on the disc or plunger.

PLK 3.6.7.4 All gearing shall be manufactured in accordance with BS 436 Class C and shall be machine cut. All components requiring lubrication shall be adequately lubricated and totally enclosed flood-proof casing fabricated in cast iron and/or die cast aluminium to suit the service weather proof casing whether the valve is to be installed in the open or under cover. Actuators shall also be fitted with mechanical

stops to prevent excessive turning and shall be provided with replaceable shear pins.

PLK 3.6.7.5 Handwheels shall be fitted to all actuators. The direction of rotation to close the valve shall be clockwise when viewed from above the end of the input shaft and from the position of operation. In addition, they shall be clearly and indelibly marked with an arrow showing the direction of closing and the words "Close" and "Toe".

PLK 3.6.7.6 Whether the valve is actuator driven or manually operated, the maximum force required to turn the handwheel at the maximum torque defined above shall not be greater than 100 N per hand at the handwheel rim. (Total effort = 200 N.) For large valves the minimum of complete revolutions of the handwheel to move the valve gate from fully open to fully closed shall not be less than 100.

PLK 3.6.7.7 All electric actuators shall be provided with reversing contactors: local and remote control shall be provided; a device making the local control non-operative shall also be provided on the relevant remote control panel.

PLK 3.6.7.8 After factory tests, the actuators shall be removed from the valve and delivered to Site in separate boxes to safeguard against damage.

PLK 3.6.8 ***Protection***

All materials and workmanship to comply with relevant SANS specifications.

PLK 3.6.8.1 Internal Protection

Internal surfaces of valve bodies and discs shall be grit blasted to a Sa 2½ of SIS 05 50 00 finish. Successive coats of an approved non-toxic epoxy resin paint suitable for spray application (Copon EP 2300 or similar) shall then be applied to give a final dry film thickness of 250 µm. Drying times between successive layers shall be strictly in accordance with the requirements of the paint manufacturer.

As an alternative to the protection as specified above, the Contractor may be required to use either a solventless epoxy paint system or a fusion bonded epoxy powder coating as specified in the Project Specification.

PLK 3.6.8.2 External Protection

External surfaces of valve bodies shall be wire brushed to a A 3 of SIS 05 59 00 standard and painted with one layer zinc chromate primer (dried film thickness 50 µm). This will be followed by two alkyd-based undercoats (each coat 25 µm thick)

and one alkyd-based enamel finishing coat (dried film thickness 25 µm). Final colour will be as specified by the Engineer.

Machined flanges will be painted with a protective coating of shellac or similar.

PLK 3.7 Tolerances

Tolerances as specified in the appropriate SANS or BS standards shall apply to this Contract.

PLK 4 TESTING AND INSPECTION

PLK 4.1 Testing by Manufacturer

The Manufacturer shall carry out all tests to ensure that valve materials conform to the requirements of the relevant SABS or BS Specification. These tests will not necessarily be attended by the Engineer but records must be kept and all test results shall be made available to the Engineer.

PLK 4.2 Testing by Independent Body

The Engineer may appoint an independent recognised body to conduct control tests. Samples required for such tests will be provided by the Manufacturer free of charge and sampling will be done by this body in accordance with the relevant SANS or BS Specification.
The cost of such control tests will be borne by the Employer.

PLK 4.3 Inspection

PLK 4.3.1 Visual, operational and dimensional inspection of valves as well as inspection of protective coatings will be carried out by the Engineer and/or the Manufacturer in the Manufacturers workshops prior to the despatch of valves to site.

PLK 4.3.2 Inspection by the Engineer shall in no way relieve the Manufacturer of any of his obligations to design, manufacture and supply valves strictly in accordance with the Specification.

PLK 4.4 Hydrostatic Testing

PLK 4.4.1 All hydrostatic tests will be witnessed by the Engineer and the Manufacturer will give at least one week prior notification to the Engineer of the proposed dates for such tests.

PLK 4.4.2 Valve bodies will be close end tested to at least 1,5 times the working pressure. Test pressures will be maintained for at least 5 minutes and valve bodies will be water tight in all respects at the test pressure.

PLK 4.4.3 Assembled valves will be open-end tested to 1,5 x working pressure for materials strength and soundness. Valves will be drop tight from both directions over the complete range of pressures from 0 to 1,5 x working pressure.

PLK 4.4.4 Each valve will be supplied with a test certificate certifying that it complies in all respects with the requirements of this Specification.

PLK 5 MEASUREMENT AND PAYMENT

PLK 5.1 General

Tendered prices shall include for the following unless otherwise specified in the Project Specification.

- Protective coatings as specified.
- Couplings and/or jointing material for each type of valve.
- Packing and temporary protection against damage during transport and delivery.
- Temporary storage and maintenance if required.
- Delivery and storage of material on site or in a store as specified.
- Testing and inspections at Manufacturer's works.

PLK 5.2 Valves will be measured per unit of each type

END OF SECTION

PLKA : SLUICE AND CHANNEL GATES, ADJUSTABLE WEIRS, HANDSTOPS, STOPLOGS

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Item **Description** **Page No**

PLKA SLUICE AND CHANNEL GATES, ADJUSTABLE WEIRS, HANDSTOP STOPLOGS

PLKA 1 SCOPE

This Contract covers the supply, delivery, transport, handling, installation, commissioning, testing, adjustment, handling over in complete working order and upholding during the Defects Notification Period of sluice and channel gate complete with operating equipment, handstops, adjustable weirs and stoplogs.

PLKA 2 MATERIALS

The thickness of materials shall be suitable for the duty required and application.

PLKA 3 DESIGN

All parts shall be designed for the duty required, but the minimum factor of safety against structural failure shall not be less than 3, based on the working stress of the material. In the design, due consideration shall be given to the thickness of materials with regard to corrosion and operating conditions. The force required at a handwheel or crank to raise a gate or open a valve shall be in the order of 100 Newton, and the design parameters must be submitted in the Technical Schedule.

PLKA 4 SLUICE AND CHANNEL GATES

The sliding frames, floor seats and gates of wall mounted as well as channel type gates with headframe shall be made of grade 304L stainless steel or as specified.

All gates shall be well guided with no possibility of jamming. The gates shall be held uniformly against the side facings of the frames by the action of adjustable wedges and shall provide drop-tight closure under the conditions listed in the Pipe Schedule. Sluice gates shall be of the standard or flush invert type fitted with renewable seals of a non-biodegradable material on the invert.

Channel gates shall be dimensioned such that their installation in the channels and openings shown on the drawings is facilitated. The channel gates shall be standard items and shall be installed so that headframes shall be flush with vertical channel walls and do not project horizontally into the channel. Vertical sliding frames and floor seat to be cast into concrete so as to leave an unobstructed waterway to dimensions indicated in the schedule. Pre-formed recess details for casting in of frames to be submitted by supplier. Headframe bridge for a channel gate to allow indicated water level to pass under the gate when in UP-position. Some gates to

check indicated water level when in DOWN-position. All nuts, bolts, washers and other components, shall be manufactured from same grade stainless steel specified for gate.

Gates shall be robustly designed and constructed, having vertical and horizontal ribs to withstand pressures from both directions. The matching headframe for channel gates shall be adequately designed to resist distortion, and both the gate and the frame shall have machined seating faces to ensure perfect sealing. The headframe shall extend above the concrete channel, to support the gate in the fully open position.

Seating pressure as well as unseating pressure may act on any channel or circular sluice gate and the sluice gate shall be able to resist these pressures.

Holding down bolts of penstocks fixed against concrete walls shall be made of Grade 304 Stainless Steel.

Channel gates shall be provided with rising spindles as well as approved transparent position indicators as requested.

PLKA 4.1 Adjustable Overflow Tilting Weirs

The adjustable overflow tilting weirs shall comply with the following requirements:

(i) 304L stainless steel manufacture or as specified.

(ii) Stainless steel indicators showing the degree of adjustment of the weirs in mm enclosed in an approved transparent tube.

(iii) Be horizontal after installation with a maximum allowable variation from the horizontal not exceeding 1 mm.

(iv) Be equipped with rounded sideplates and be watertight underneath and at the sides of the frame.

(v) Holding-down bolts, washers, etc. shall be of same grade stainless steel as specified for weir.

PLKA 4.2 Hand Stops

(i) The following requirements shall be applicable to hand stops:

(ii) Supplied with an aluminium frame extending to the top of the concrete or masonry. The frame shall be grouted into a recess in the concrete or masonry. Details of such recess to be submitted by supplier. Hand stop shall be capable of sliding in and out of the frame.

(iii) Hand stop shall seal 100% watertight under all circumstances. This may be achieved with the use of neoprene sealing material.

(iv) Hand stops and frames shall be manufactured from 6 mm aluminium plate and shall be robust and provided with reinforcing elements designed by the supplier to the approval of the Engineer. The reinforcing elements shall effectively prevent buckling under full static head conditions.

PLKA 4.3 Operating Gear

PLKA 4.3.1 Spindles to be extended as required and secured to structure to Engineer's approval.

PLKA 4.3.1.1 Arrows shall be cast on all handwheels together with the wording "OPEN" or "CLOSE". The closing direction shall be clockwise unless otherwise specified.

PLKA 4.3.1.2 Gates shall be fitted with position indicators. Fully closed, fully open and intermediate positions shall be indicated in corrosive proof and robust design indicators.

PLKA 4.3.2 *Channel gate*

Headframe bridge across with handwheel or actuator on rising spindle.

PLKA 4.3.3 *Gates and Tilting Weirs*

Handwheels or actuators installed in the following manner.

- Platform-mounted handwheel pedestal ..... PMP
- Handwheel pedestal on wall support bracket ..... HPWB
- Stub handwheel pedestal on wall support bracket ..... SHWB
- Tee-key on support bracket ..... TKSB
- Grid-mounted handwheel pedestal ..... GMP

PLKA 4.4 Stoplogs

A stoplog set shall comply with the following requirements:

(i) Stoplog sets shall be supplied with stainless steel frames extending to the top of the concrete or masonry. The frames shall be grouted into the recess in the concrete or masonry in such a way that the stoplogs are capable of sliding in and out of the frame. The stoplogs sets shall be watertight under all normal operational circumstances.

(ii) Stoplogs and frames shall be manufactured from stainless steel plate. Each stoplog shall be provided with reinforcing elements designed by the supplier to the approval of the Engineer. The reinforcing shall effectively prevent buckling under full differential static head conditions.

(iii) The maximum vertical dimension of any individual stoplog shall not exceed 150 mm.

(iv) Each individual stoplog in any one set shall have the same vertical and horizontal dimensions.

(v) Each individual stoplog shall be provided with two lifting lugs.

(vi) A neat stainless steel stand or pair of stainless steel hooks shall be installed in close proximity to each installed set of stoplogs for the storing of stoplogs when removed from the frame.

(vii) Each set of stoplogs shall be provided with two portable stainless steel lifting hooks, each fastened with a 200 kg capacity stainless steel anti-loss chain or UV-stabilised 200 kg capacity nylon rope to a suitable bracket on the handrailing or walkway structure. The chain or rope shall be long enough to facilitate easy operation of the lifting hooks. The lifting hooks shall be used to manipulate individual stoplogs by hooking into lifting lugs.

(viii) Enough individual stoplogs shall be supplied in each set to effectively span a minimum distance as shown on the relevant drawings.

PLKA 5 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

PLKA 5.1 Design, Drawings and General

Pay Item ***Unit***

PLKA 5.1.1	Provide design and workshop drawings and design information as specified.	Sum

PLKA 5.2 **Supply and Delivery to Site**

	Pay Item	***Unit***
PLKA 5.2.1	Supply of all material, manufacturing, corrosion protection, assembly and delivery to site of sluice gate, or channel gate, weirs or handstops as described on relevant pipe item schedule	No

PLKA 5.3 **Installation Work**

	Pay Item	***Unit***
PLKA 5.3.1	Sluice gate / channel gate / weirs or handstops as specified on Pipe item schedule	No

The item shall include taking handling on site, safeguarding, installing, aligning, fixing, grouting and repairs to damaged corrosion protection, including all fasteners.

PLN: MANUFACTURE, SUPPLY AND TESTING OF STEEL PIPES

INDEX

Item Description Page No

PLN MANUFACTURE, SUPPLY AND TESTING OF STEEL PIPES

PLN 1 SCOPE

This specification covers the manufacture and supply of bare, electric welded low carbon steel pipes and steel pipe special items for the conveyance of water at ambient temperatures and at medium pressures.

PLN 2 STANDARDS

Pipes and specials shall be manufactured, tested and inspected in accordance with the latest issues of the following standard specifications unless amended in subsequent clauses in this specification.

a) Pipes

SABS 719: Steel Grades A, B and C
SABS 1431: Steel Grades 300 WA
API 5L: Steel Grades, X42, X46, X52, X56 and X60

b) Specials

- Specials of 150 mm nominal diameters and smaller to be manufactured with pipe conforming to SABS 62 (heavy duty) or ASTM Schedule 40 to suit specified pressures.

- Specials larger than 150 mm nominal diameter shall be manufactured from pipes complying with this specification.

- The radiographic technique, adjudication of radiographs and repair of defects shall be in accordance with API 1104.

c) Qualifications of Welders

All manual or semi-automatic welds and repair welds shall only be undertaken by welders qualified under the tests laid down in accordance with API 1104.

d) Non-destructive Tests and Adjudication

- Radiographic inspection: API 1104

- Ultrasonic inspection: API 5L

e) In this Specification reference is made to the latest issues of the following specifications:

SABS 719
API 5L
API 1104
ASME Section V
BS 2971
BS 2633

PLN 3 STRESSES

a) All pipes shall be hydrostatically tested as described in PLN 6.5 to a pressure such as to produce a circumferential tensile stress in the steel of not less than 90% of the minimum yield stress.

b) The design stress for pipes subjected to the specified design pressures shall be 60% of the minimum yield stress of the steel.

PLN 4 PROCESS OF MANUFACTURE FOR PIPES

PLN 4.1 Pipes shall be manufactured by an approved semi automatic submerged-arc welding process or shall be electric resistance welded. Where semi automatic submerged-arc welding is employed, at least one pass shall be made on the inside and at least one pass on the outside. The number of longitudinal weld seams shall not exceed:

a) one seam for pipes up to 1 000mm nominal diameter

b) two seams for pipes larger than 1 000mm and up to 2 000mm nominal diameter

Circumferential welds by semi automatic submerged-arch welding method for factory double jointed pipes shall have at least one pass on the inside and at least one pass on the outside.

PLN 4.2 Welds

SABS 719, BS 2971 and BS 2633 shall generally apply.

For fusion welded pipes and specials, the internal weld bead shall not protrude more than 1mm into the bore of the pipe or special.

For electric resistance welded pipes, the height of upset metal and flash on the inner surface shall not exceed 1,0mm.

For pipes to be jointed by butt welding, the internal weld bead shall be ground flush with the pipe body for a length of 200mm from ends to be jointed.

For pipes to be coupled by flexible couplings, external weld reinforcement or upset metal and flash shall be ground flush with the pipe body for a length of 200mm from the end to be coupled.

PLN 5 DIMENSIONAL REQUIREMENTS

PLN 5.1 Pipes

All dimensions will be in accordance with SABS 719 clause 4.

PLN 5.2 Specials

The tolerances on specials will be in accordance with BS 534, Section 4.

Unless shown otherwise, branch and manifold sections of Tees to have a common centre line and of Scour Tees to have a common invert line.

All dimensions on layout dwgs or item details are outer face to outer face, i.e. overall.

Position dimensions for puddle flanges and restraining flange refers to centre of flanges.

PLN 6 TESTING AND INSPECTION AT MANUFACTURER'S WORKS AND AT SITE

PLN 6.1 General

Factory and Site inspection, supervision of tests and adjudication of test records shall be carried out by an independent Inspectorate.

All tests and inspections at the factory and on site shall be at the expense of the Contractor who shall provide all necessary testing facilities, labour, instruments, equipment and samples that might be required, free of charge.

The Inspectorate shall be afforded every facility during the course of manufacture and testing to enable the inspection to be carried out effectively.

All test samples shall be selected by the appointed Inspectors and all instruments used for testing purposes shall be approved by the Inspectors and if in the opinion of the Inspectors any instrument should require calibration, such instruments shall

be calibrated at the expense of the Contractor by the SABS or such other body as may be approved by the Inspectorate.

No mechanical working or straining of pipes and specials shall be allowed after testing and inspection.

PLN 6.2 Visual Inspection

All finished pipes and specials shall be visually examined and shall be free of injurious defects as defined in API 5L Section 10.7.

PLN 6.3 Non-destructive Inspection

PLN 6.3.1 *Ultrasonic Inspection*

Pipes shall be made by an approved welding process and 100 percent of all longitudinal or spiral welds on straight pipes shall be checked with an approved ultrasonic method capable of continuous and uninterrupted inspection of the weld seam in accordance with API 5L Section 9.10, 9.11 and 9.12 except that the equipment shall be checked with an applicable reference standard at least twice every working run.

PLN 6.3.2 *Radiographic Inspection*

a) Longitudinal Weld Pipe

All electric fusion welded pipes, shall be inspected by radiological methods for a distance of 200 mm from each pipe end.

b) Spiral Weld Pipe

All electric fusion welded pipes shall be inspected by radiological methods for a distance of 100 mm from each end of each length of pipe and of the complete "H" at all scalp and welds including 150 mm of the spiral welds in both directions away from the intersection points with the scalp and welds.

c) Circumferential Butt Welds

100 percent of the length of circumferential butt welds shall be examined unless consistently acceptable results are obtained. Then the number of

welds so to be tested may be reduced by mutual agreement between the Engineer, the Inspectorate and the Contractor.

d) Specials

100 percent of all manual or semi-automatic welds in specials shall be examined radiographically unless consistently acceptable results are obtained. Then the number of welds so to be tested may be reduced.

Where specials cannot be hydrostatically tested, all welds shall be liquid penetrate tested as per ASME Section V.

e) Repairs

Straight Piping:

100 percent of the total length of all repairs shall be examined radiographically unless repairs are done prior to ultrasonic inspection and such repairs pass ultrasonic inspection. Then no radiographic inspection of same is required.

f) Pipes for Rail, Road and River Crossings: 100 percent of the total length of all welds shall be examined radiographically.

PLN 6.4 Hydrostatic Testing

a) Each individual straight pipe shall be subjected to a hydrostatic test in accordance with the methods described in API 5L, Section 5. Test pressures shall be such as to produce tensile fibre stresses in the pipe wall of not less than 90% of the minimum specified yield strength of the steel or shall be 9 MPa whichever is the lesser. Leaks or sweats shall be considered injurious defects.

b) Should it not be possible to hydrostatically test straight piping and/or specials the through liquid penetrate test as per ASME Section V shall be done on all welds over and above the non-destructive tests specified above. This shall only be applicable with the prior written approval of the Engineer.

PLN 6.5 Repair of Injurious Defects

Injurious defects found by non-destructive testing of welds, visual examination, hydrostatic testing or determined by any other means to exceed the limitations in API 5L, Section 10.7 shall be repaired in accordance with API 5L Section 10.8 and 10.9 but subject always to the requirements of this specification.

PLN 6.6 Destructive Testing

PLN 6.6.1 The following destructive tests shall be performed in accordance with SABS 719 clause 7.2 on the first pipe and thereafter on one pipe of each 500 subsequent pipes.

a) Transverse Tensile Test

b) Root Bent Test (Electric Fusion Welds)

c) Flattening Test (Electric Resistance Welds)

PLN 6.6.2 *Sampling for Destructive Tests*

a) **First Sample**

A section long enough to provide all the test specimens and material shall be cut from the selected pipe.

b) **Second Sample**

If the test specimens and material from the first selected pipe fail to pass any of the tests, a section long enough to provide the appropriate specimens for the tests failed by the first sample shall be cut from two further pipes.

c) **Third Sample**

If the test specimen from the second sample fails to pass the test(s) a similar section shall be cut from each of a further ten pipes.

d) **Compliance**

The piping shall be considered as complying with the specification if after testing of the first or the second or the third sample no defect is found.

PLN 7 FLANGES

a) Material shall be steel plates to conform to the requirements of SABS 1123 (1977), unless otherwise specified.

b) Dimensions and drilling shall be in accordance with SABS 1123 (1977) unless otherwise specified. Flanges for 64 bar working pressure shall be in accordance with BS4504:1969. Dimensions not covered by SABS 1123 and BS4504, shall be in accordance with NWS 1676 Revision 0.

c) All flanges shall be of the steel-plate for welding type and shall have flat joint faces unless otherwise specified.

d) Connecting surfaces shall be in accordance with SABS 1123 clause 4.5.

e) Puddle flanges need not be drilled. Where puddle flanges are slanted to an item, special flanges are required. Such flanges need not be circular, but

shall meet the specified pressure rating and must protrude at least 100 mm outside item outer wall.

f) Provide appropriate bolt units, consisting of a standard length bolt, nut and two washers of a material to conform to the requirements of SABS 1123 where applicable, otherwise to the requirements of the Engineer for each set of flanges and for flange adaptor to flange installations.

NB: The shortest standard bolt or stud that protrudes beyond the nut by a minimum of two threads, when the assemblies are fully tightened, shall be used. A washer shall be fitted under all bolt/screw heads and nuts.

g) Gaskets for flanged connections shall be of compressed asbestos fibre to BS 2815 Grade A, ring type with a minimum thickness of 3 mm, unless otherwise specified.

h) Should certain equipment e.g. valves, etc. only be supplied with specific flange drilling, the Contractor must arrange for adjacent flanged items to have the same drilling prior to the manufacture of such items.

i) Some flexible couplings to be restrained by means of a restraining flange. The diameter, number and length of the long restraining bolts as well as any possible pipe wall thickening to be designed by manufacturer for specified pressures. The seal retaining flange on the flexible coupling may be factory machine scalloped to accommodate the long bolts. Provide all the necessary nuts, washers, etc. for the restraining bolts.

Restraining flanges need not have all the bolt holes specified in the applicable flange drilling table. Only those required for the long restraining bolts need to be provided; these holes should, however, comply with the applicable flange drilling table and be spaced equally on the flange PCD and symmetrically around the flange centre lines.

Restraining bolts to be positioned so as to not clash with any stubs specified for an item.

j) Blank flanges for pipes equal to or greater than 400 dia to be provided with two approved lifting handles.

PLN 8 FLEXIBLE COUPLINGS AND FLANGE ADAPTORS

Flexible couplings and flange adaptors shall be the Viking Johnson or Klamflex type.

Manufacture of straight and stepped couplings (SR-C + ST-C) as well as flange adaptors (FA) to be approved by Engineer. Couplings must be able to withstand hydrostatic test pressures of 1.5 times the specified design pressures and coupling flanges must be designed to withstand all stresses due to tightening of the bolts. Rubber rings shall generally comply to SABS 974 Class F. Flexible couplings shall be supplied complete with all necessary bolts, nuts and rubber jointing rings.

Coupling installation gaps to be to approved supplier's specification.

All flange adaptors:

- Studs may not be welded onto flange.
- Flange to be drilled and tapped for threaded studs where applicable.
- Drilling to suit connecting flange.
- NB – specified maximum working pressure to always apply.

PLN 9 MARKING OF PIPES

All pipes and specials shall be clearly hand stamped alongside a longitudinal or spiral weld on one end of the pipe with the following.

a) Grade and thickness of steel
b) Serial number of the pipe or specials
c) Nominal diameter
d) Hydraulic test pressure

PLN 10 INSTALLATION

Pipework shall be manufactured and installed by qualified and competent persons and must be of good trademanship, solidly supported, 100% on line and level, in a proper working order and must comply with the prescribed specifications and accepted engineering practice.

The Contractor shall ensure that pipework has the necessary support during and after installation so that it is at all times correctly aligned.

Any/all damage to corrosion protection during the handling, installation and commissioning of pipework and associated valves and fittings shall be repaired by

the Contractor at no additional cost to the Employer. Repair work shall be executed in terms of the Specification to the approval of the Engineer or appointed corrosion consultant.

PLN 11 MEASUREMENT AND PAYMENT

The supply and installation of steel pipe items shall be measured as follows:

PLN 11.1 Design, Drawings and General

	Pay Item	***Unit***
PLN 11.1.1	Provide design drawings and design information as specified, including As-built drawings and Operation and Maintenance information	Sum

PLN 11.2 Supply and Delivery to Site

	Pay Item	***Unit***
PLN 11.2.1	Pipe items as specified on the drawings or relevant pipe item Schedules	No
PLN 11.2.2	Ancillary equipment such as instrumentation, pipe supports (to be specified)	Sum

PLN 11.3 Installation Work

	Pay Item	***Unit***
PLN 11.3.1	Pipe items as specified on relevant drawings	Sum
PLN 11.3.2	Ancillary equipment such as instrumentation, pipe supports (to be specified)	Sum

PLQ: CORROSION PROTECTION OF STEEL PIPES AND FITTINGS

INDEX

PLQ CORROSION PROTECTION OF PIPES AND FITTINGS

PLQ 1 SCOPE

This specification covers various corrosion protection systems for cast iron, steel and stainless steel pipes and fittings for the conveyance of water at ambient temperatures.

PLQ 2 CORROSION PROTECTION SYSTEMS

The following corrosion protection systems shall apply unless otherwise specified on the drawings, project specifications and schedule of quantities.

PLQ 2.1 Buried steel pipework

a) Pipe diameter up to 150mm

Pipework shall be hot-dipped galvanized unless otherwise specified.

After installation, the pipework shall be protected with a Denso HT Petrolatum tape wrapping system as specified in this specification.

b) Pipe diameter larger than 150mm

Specials, fittings and couplings shall be lined and coated with epoxy paint.

After installation the specials and fittings shall be protected with the Denso Ultraflex 1250/300 and MDP 032 tape wrapping system as specified in PLQ 11.1.

Standard pipe lengths shall be lined with epoxy paint and coated with fusion bonded medium density polyethylene (MDPE) or Bituguard or 3LPE as specified in this specification unless otherwise specified in the Project Specifications or the Bill of Quantities or on the Drawings.

PLQ 2.2 Pipework inside chambers

a) Pipe diameter up to 150mm

Pipework shall be hot-dipped galvanized.

The outside end of fittings cast into the walls of the chamber shall be protected with a Denso HT Petrolatum tape wrapping system.

b) Pipe diameter larger than 150mm

Fittings, specials and couplings shall be coated and lined with epoxy paint.

The outside end of the fitting cast into the wall as well as couplings outside the chamber shall be protected with a Denso HT Petrolatum tape wrapping system.

PLQ 2.3 Pipework exposed to sunlight

a) Pipe diameter up to 150mm

Pipework shall be hot-dipped galvanized.

Pipe surface shall be prepared for re-coatable silver polyurethane acrylic site application.

After installation the pipe shall be painted with re-coatable silver polyurethane acrylic.

b) Pipe diameter larger than 150mm

Pipework shall be lined with epoxy paint.

Pipes shall be coated in the factory with two component inorganic zinc silicate primer (100 micron) plus one coat of silver polyurethane acrylic (60 micron).

A second coat of polyurethane acrylic (60 micron) must be applied on site. The inorganic zinc silicate must be repaired with “single pack zinc rich epoxy primer”.

PLQ 2.4 Exposed pipework inside buildings

a) Pipe diameter up to 150mm

Pipework shall be hot-dipped galvanized.

Pipe surface shall be prepared for re-coatable polyurethane site application.

After installation the pipe shall be painted with re-coatable polyurethane to the Employers colour coding specification.

b) Pipe with diameter larger than 150mm

Pipes, fittings and couplings shall be lined and coated with epoxy paints.

After installation the pipework shall be painted with re-coatable polyurethane to the Employers colour coding specification.

PLQ 2.5 Pipework inside water retaining structures

All stainless steel pipework inside water retaining structures and cast into the walls or floor of water retaining structures shall be lined and coated with epoxy paint.

All stainless steel shall be 316L.

PLQ 3 SURFACE PREPARATION

Contractors must submit information on the cleaning methods to be used in meeting the specified requirements. Contractors must further provide the Engineer with the manufacturer's guarantee that the requirements have been met.

PLQ 3.1 Surface preparation of steel surfaces

All projections, sharp edges, layers that have formed and tool marks must be removed from the surface so that the surface is smooth, and it must be abrasive blast cleaned in accordance with sections 2, 3 and 4 of SABS Code of Practice 064 so that it meets the following requirements:

(a) A grade of cleanliness of Sa 3 of ISO 8501-1 when tested by SABS test method 767.

(b) A surface profile between 60mm and 85mm when tested by SABS test method 772.

(c) Free from dust and debris to at least 0,2% when tested by SABS test method 769.

PLQ 3.2 Surface preparation of galvanized surfaces

Surfaces to be coated shall **not** be passivated.

Galvanized steel surfaces shall be degreased prior to coating, using either a water soluble solvent degreaser in accordance with SABS 1344 and the manufacturer's instructions, or a mild acid-detergent degreasing solution to be approved by the Engineer.
Large areas shall be prepared by sweep-blasting with non-metallic abrasive. Cracking, flaking or any form of de-lamination of the zinc coating due to excessive blast-cleaning shall not be permitted. Removal of zinc by blast-cleaning shall not exceed 10 µm.

Surfaces that cannot be sweep-blasted shall be abraded manually or mechanically with abrasive paper grade 220 or by using non-metallic abrasive pads.

Finally, all dust and debris shall be removed by vacuum-cleaning.

Epoxy primer for galvanised surfaces shall be applied immediately after surface preparation to a minimum dry thickness of 50 µm.

PLQ 3.3 Surface preparation of stainless steel surfaces

Oil and grease contamination shall be removed by:

- Steam-cleaning
- An emulsifiable or aqueous detergent, or
- An alkaline cleaning solution.

Stainless steel surfaces shall be blast-cleaned with stainless steel grit or non-metallic abrasive. The use of steel shot and steel or cast iron grit is strictly prohibited.

The grade of cleanliness shall be at least Sa 2½.

Surface profile shall be in the range of 30 to 50 µm.

Where blasting is impractical, the surface shall be roughened manually with abrasive paper grade 220, disc grinders or flapper wheel abrasive pads. In all instances, clean, uncontaminated equipment must be used.

Dust and debris shall be removed by vacuum-cleaning.

PLQ 4 HOT-DIP GALVANIZING

Unless otherwise specified, steel pipes up to 150 mm dia shall be hot-dipped galvanized. Hot-dip galvanizing to be in accordance with SABS 763 – 1988 except that minimum thickness shall be 55 micorn. Cut ends and small damaged areas shall be repaired by the application of a zinc-rich epoxy (single pack) to SABS 763 (ZINC GALV 1 – Dulux or POLY GALV – Plascon).

Only heavy duty galvanising will be approved and all items to be provided with a SABS approval certificate.

PLQ 5 EPOXY PAINTS

Epoxy paint shall comply to SABS 1217. Surface preparation shall be abrasive blast cleaning to Sa 3 of ISO 8501-1.

The following will be applicable where epoxy paint is specified:

- Lining of pipes with nominal diameter equal or larger than 600 mm and standard pipe lengths of 9,144 m, 12,192 m and 18,288 m:

Solvent free epoxy (Sigmaline 523 or Pipecoat SF or similar approved by Engineer), with a minimum dry film thickness of 400 micron and a maximum dry film thickness of 500 micron.

- Lining and coating if all other pipes, specials and fittings, except where multi-purpose epoxy coating is specified:

  Solvent borne epoxy (Carboguard 891 or Sigmaguard 720 or similar approved by Engineer) with a minimum dry film thickness of 400 micron.

Epoxy paint and the repair kit for the repair of epoxy shall be from the same manufacturer.

Edges with epoxy paint shall have a radius of 3 mm or 50 % of the pipe wall thickness (smaller of two).

Where another type of coating is specified, epoxy paint lining shall continue around pipe edge for each of the following:

- *Flanged end*

  Onto both flange faces, extending for 50 mm (min) onto pipe outer wall beyond flange.

- *Ends suitable for straight or stepped couplings or flange adapters*

  Onto pipe outer wall for 250 mm (min) from pipe end.

- *Ends suitable for flange adapters, incorporating a restraining flange*

  Onto pipe outer wall from pipe end, up to and including both faces of the restraining flange as well as 50 mm (min) beyond the restraining flange.

The following specification shall be applicable to pipes, specials and fittings to be painted with epoxy.

- In the factory:

  Abrasive blast cleaning of complete steel surface to Sa 3 of ISO 8501-1. Apply epoxy paint to 100mm from pipe end.

- On site:

  Abrasive blast cleaning of steel surface to Sa 3 of ISO 8501-1 and 50 mm of painted surface to a surface profile of 60 – 85 microns.

Apply epoxy repair kit from the same manufacturer as the factory applied epoxy to a minimum dry film thickness of 400 micron. The type of epoxy repair kit shall be subject to the approval of the Engineer.

The painted area shall be tested for pinholes and thickness.

PLQ 6 UV-RESISTANT MULTI-PURPOSE EPOXY PAINT

Multi-purpose epoxy shall be of the high build, modified aluminium epoxy mastic type, containing at least 90% solids.

PLQ 7 RE-COATABLE POLYURETHANE

The area to be over-coated shall be abraded with abrasive paper grade 220 to a uniform matt finish.

The surface shall be vacuum-cleaned to remove dust and debris.

Over-coat with a 40 µm minimum layer of Re-coatable Polyurethane in accordance with the Employer's colour code.

PLQ 8 FUSION BONDED, MEDIUM DENSITY, POLYETHYLENE COATINGS (MDPE)

An uniform MDPE coating must be obtained by dipping the already prepared and heated pipe into a fluidified bed of MDPE powder which then fuses directly on to the heated surface.

A coating thickness of between 1,8 mm to 2,3 mm depending on the outside diameter (OD) of the pipe and the service for which it is required must be obtained with the coating extending around the ends of the pipe to underlap the concrete lining for Sinta Joint pipes by a minimum of 25 mm.

- OD < 508 mm : coating thickness = 1,8mm
- 508 mm ≤ OD ≤ 762 mm : coating thickness = 2,0mm
- OD > 762 mm : coating thickness = 2,3mm

Fusion bonded MDPE coatings shall comply to AS 4321 and must meet the applicable SABS requirements for this type of pipe protection. Surface preparation shall be abrasive blast cleaning to Sa 3 of ISO 8501-1.

PLQ 9 POLYMER MODIFIED BITUMEN (BITUGUARD)

Bitugard coating shall be in accordance with SANS 1178 and BS EN 10300, Type A Heavy Duty with a minimum thickness of 4mm.

Surface preparation shall be abrasive blast cleaning to Sa3 of ISO 8501-1.

PLQ 10 THREE LAYER POLYETHYLENE COATING (3LPE)

3LPE coating to be in accordance with CSA Z245.20 - 21 with the following minimum thicknesses:

- Fusion bonded epoxy (FBE) layer: 300 micron
- Adhesive layer: 200 micron
- High density polyethylene layer:
  - Nominal pipe diameter up to and including 250 mm – 2,0 mm
  - Nominal pipe diameter greater than 250 mm but less than 600 mm – 2,5 mm
  - Nominal pipe diameter of 600 mm and greater - 3,0 mm

A polyethylene layer cut back shall be provided at pipe ends as follows:

Pipe ends shall be supplied as bare steel, free of all coating, for a distance of 100 mm (+25/-0mm) from the pipe end. In addition, each pipe end shall be left without polyethylene / adhesive coating so that a 20 mm (+10/-0mm) FBE toe protrudes on the steel beyond the cutback polyethylene coating layer.

The ends of the coating shall be bevelled at 30° to 45°.

Surface preparation shall be abrasive blast cleaning to Sa3 of ISO 8501-1.

After blast cleaning and prior to the application of the FBE layer, the pipe surface shall be pre-treated by acid wash. A method statement for the acid wash supported by product data and the PQT results shall be provided for the review of the Engineer before commencement of the coating process.

PLQ 11 JOINT COATING SYSTEMS

PLQ 11.1 MDPE and three layer polyethylene (3LPE) coating

The unprotected area at welded joints shall be protected as follows:

- The cutback of the coating shall be 100 mm from the pipe ends.
- Chamfer any raised edges or steps in the existing coating.
- The factory applied polyethylene pipe surface to which the cold tape wrapping is to be applied shall be abraded with 40 grit abrasive paper or sweep blasted for 100mm beyond the steel surface toe.
- Abrasive blast clean the steel surface to Sa 3 of ISO 8501-1.
- For 3LPE apply Denso Protal 7200 liquid epoxy to the blast cleaned surface and adjacent prepared factory FBE coating to a minimum dry film thickness of 400 micron.
- The entire joint surface to be wrapped shall be primed with Denso Primer D.

  Priming shall not be carried out further ahead of physical tape wrapping than a maximum of 4 hours.

  Ensure the primer is dust free prior to application of a tape wrap system. If the primer has become severely contaminated with dust, a re-prime shall be carried out. Heavy contamination with sand or dirt shall require cleaning of the surface with a manufacturer recommended cleaning solvent (e.g. Denso Cleaning Solvent) and re-application of the primer.

  Allow approximately 30 minutes drying time or until the primer is tacky to the touch.

- The inner wrap shall consist of a 100 mm wide conformable polyethylene backed modified bitumen mastic tape, compliant with the requirements of SANS 1117 type C (DENSO ULTRAFLEX 1250/300)

  Peel back approx. 0,5 m of interleaving. Align the edge of the 100 mm wide tape 50 mm onto the primed, factory applied, polyethylene pipe coating. Press down firmly.

  Before spiral wrapping commences, a full circumferential wrap of tape is applied by hand with sufficient tension to narrow the width of tape between 1 and 2 mm.

  Whilst maintaining tape tension as described above, the tape shall be applied spirally. Remove interleaving as wrapping proceeds.

The tape shall be applied to ensure that a minimum 25 mm overlap shall be achieved.

- The outer wrap shall consist of a 100 mm wide medium density adhesive polyethylene compliant with the requirements of SANS 1117 Type B&D (DENSO MDP 032).

  Centre 100 mm wide outer-wrap tape on the edge of the applied inner wrap tape on the factory applied coating. Press down firmly. Before spiral wrapping commences, a full circumferential wrap of tape is applied by hand with sufficient tension to narrow the width of tape between 1 and 2 mm. Whilst maintaining tape tension as described above, the tape shall be applied spirally.

  The tape shall be applied to ensure that a minimum 55% overlap shall be achieved.

  The tape shall be applied to a minimum width of 50 mm beyond the applied inner tape-wrapped area onto the primed shop applied coating.

  Ensure that the tape is in full contact with the underlying surface with no wrinkles, fish-mouths or bubbles.

- Holiday detection shall be carried out in accordance with NACE RP0188.

Damaged areas on MDPE coatings shall be repaired in accordance with the specifications and guidelines of the coating manufacturer.

PLQ 11.2 Polymer Modified Bitumen (Bituguard) Coating

The unprotected area at welded joints to be coated with Denso Primer D and wrapped with Densotherm HD heat applied bitumen wrapping with a minimum thickness of 5 mm.

Surface preparation shall be abrasive blast cleaned to Sa3 of ISO 8501-1.

PLQ 12 DENSO HT PETROLATUM TAPE WRAPPING SYSTEM

Denso HT Petrolatum tape wrapping system shall be used for the wrapping of buried flange and flexible joints and buried galvanized pipes and where specified in the Specifications, Bill of Quantities or Drawings.

PLQ 12.1 General

Surface preparation shall be abrasive blast cleaning to Sa3 of ISO 8501-1.

Chamfer any raised edges or steps in the existing coating.

Apply Denso Priming Solution.

Apply Denso HT Tape of appropriate width uniformly in a spiral fashion to give a 55% overlap on the pipe and for not less than 200 mm along the length of the intact factory coating.

Apply uniform tension to ensure the tape is smooth and free from wrinkles. Do not apply excessive tension that will stretch the tape nor insufficient or uneven tension that will give rise to air bubbles and wrinkles.

PLQ 12.2 Flexible couplings and flanges

Apply Denso Mastic so as to create a smooth profile suitable for over-wrapping. Wrap a suitable width of Denso HT Tape over the coupling. Ensure that there are not air voids under the tape. Apply a double layer of Denso Layflat polyethylene sheeting over the whole length of the repair and for 100mm beyond each end of the repair. Tape the ends of the Layflat with two complete turns of 100 mm wide adhesive Denso PVC tape to seal the ends.

Denso fabric backed mastic blanket can be used as an alternative for Denso HT Tape. After priming, pack potential air void areas such as under the bolts with Denso Mastic. Place the mastic Blanket in position and press it into all air voids. Start under the pipe and work upwards. Over wrap the Mastic Blanket with two layers of Denso Layflat sheeting and secure the ends with 100mm wide adhesive Denso PVC tape.

If the pipe runs through very wet soils it is recommended that Denso S105 Paste be used in preference to Denso Priming Solution and the couplings be wrapped with Denso PVC Self Adhesive Tape using a 55% overlap in place of the Layflat Sheeting.

PLQ 12.3 Welded joints and straight pipe lengths

After completion of Denso HT Tape wrapping and approval by the Engineer, apply 0,3mm adhesive PVC outerwrap with 55% overlap over the whole length of the wrapping and for 100mm beyond each end.

PLQ 13 CUT BACK AT PIPE ENDS

The exposed grit blasted bare steel surface at the ends of pipes, specials and fittings to be welded on site shall not be painted with any product in the factory and shall be protected against corrosion after installation.

PLQ 14 ADDITIONAL EXTERNAL PROTECTION FOR PIPES CAST INTO CHAMBER WALLS

After the concrete has cured for 7 days, wire brush or scabble the exterior and interior surfaces of the wall to remove laitance. Dry brush to remove all loose powder.

Mix ABE Super Laykold and water (1:1 ratio) and apply as a primer to the concrete and the pipe surfaces. After 1 hour apply a thick coat of ABE Super Laykold to the concrete and the pipe and immediately embed 250mm wide ABE non-woven polyester membrane “SBP” into the Super Laykold. After 3 hours apply another coat of Super Laykold.

This additional protection is required on the inside and outside of chamber walls.

There must be no contact between the steel pipe and the chamber reinforcement.

PLQ 15 TESTING

Dry Film Thickness (DFT) tests shall be performed on samples of coated and galvanised pipes, such tests are to be witnessed and certified by a suitably qualified Corrosion Specialist, minimum qualification NACE 2 or equivalent.

Further to the above a peel test must be performed on a sample of the coated surfaces to check for coating adherence on the steel surface.

Should any of the tests fail, the pipe must be sand blasted to remove the coating, as specified, and coating to be applied and tested again.

PLQ 16 MEASUREMENT AND PAYMENT

Corrosion protection and painting shall not be measured separately. The price for corrosion protection and painting shall be deemed to be included in the price for the pipe, fitting or special.

PLT: FLOW METERS (GENERAL)

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PLT FLOW METERS

PLT 1 SCOPE

This section of the Specification deals with the supply, delivery, installation and commissioning of:

(a) in line ultrasonic flow meters;
(b) clamp on ultrasonic flow meters
(c) flanged mechanical turbine meters
(d) electromagnetic flow meters.

PLT 2 IN-LINE ULTRASONIC FLOW METERS

PLT 2.1 General Requirements

An in-line ultrasonic flow meter will consist of:

i) Two machined, stainless steel, weld-on sockets with inserted perspex windows, which are held by two plastic flanges secured with stainless steel bolts and spring washers.

The tenderer shall be responsible for the welding of the sockets on to the pipeline, as well as making good all corrosion protection according to applicable specifications.

ii) Two 1 MHz sensing units, connected via co-axial cables of 50 ohms, with a minimum length of 12 m, to the transmitter.

The sensing units are to be removable under full pressure, while the pipeline is operating.

Both sensing units shall be electrically isolated from the pipeline.

i) A transmitter that shall have two output circuits:

(1) One circuit for the 4-20 mA output signal to drive an indicator, and if later required a recorder, with maximum load capacity of 1 000 ohm.

(2) The second circuit to drive a 24 V integrator, with a 2% zero flow cut off.

All power requirements other than 230 V will have to be provided for by the successful Tenderer.

The transmitter shall have facilities to adjust for the various pipe diameter and flow rates.

PLT 3 CLAMP-ON ULTRASONIC FLOW METERS

PLT 3.1 General Requirements

Single channel flow meters operated in transit time or time-of-flight mode shall be provided unless otherwise specified. The flow meter provided shall be capable of measuring the instantaneous flow in a pipeline and give the accumulated flow. The installation shall comprise at least two (2) sensing units (transducers) that are connected via co-axial cables and connected to a signal conversion unit. The signal unit shall be locally programmable and shall be supplied complete with programmer unit. The signal converter shall further more have a LCD display for instantaneous flow and totalize flow and shall have a 4-20 mA and pulsed output for remote indications. The signal converter unit will be mounted in an outdoor type cubicle, which will be supplied and installed under the electrical portion of the Contract.

Welding of transducers onto the pipe will not be allowed.

The IP rating for the housing of the transducers shall be *submersible.*

The mountings on the transducers shall be manufactured by stainless steel.

The location of the flow meter installation shall be indicated on the relevant drawings, together with the following general information:

- Pipe outer diameter
- Pipe material
- Pipe wall thickness
- Internal lining
- Average thickness of internal lining
- Fluid to to be measured
- Distance between transducers and signal converter

The operating temperature for all equipment shall be minimum -10°C and maximum 55°C.

PLT 3.2 Flow Accuracy

The flow accuracy (velocity) shall be ± 1% of reading for pipe diameter greater than 150mm and flow velocities greater than 0.3 m/s. For pipe diameters smaller than 150mm, the flow accuracy shall be ± 3%.

The overall rangeability or turn-down ration shall be at least 400:1.

The repeatability for clamp-on transducers shall be 0.2 to 0.5% of full scale reading.

PLT 3.3 Calibration

The Contractor shall allow for the calibration of the flow meter one month after installation by Technology Services International of Eskom enterprises. A certificate of calibration shall be submitted to the Engineer, acceptance of wich signifies final completion of the installation.

PLT 3.4 Guarantee Period

The ultrasonic flow meter shall be guaranteed for a period of at least **24 Months** from date of **successful commissioning.**

PLT 4 FLANGED MECHANICAL TURBINE METERS

PLT 4.1 Equipment Preferred

All mechanical turbine meters shall shall be type Sensus or similar and approved.

PLT 4.2 Accuracy

All mechanical meters supplied in terms of this Contract shall perform to an accuracy of better than ± 2% error over the meters operating range i.e. between Q_t (transitional flow) and Q_n (continuous flow). The performance characteristics of the meters offered shall be equal to or better than the values tabled below:

Size (DN) (mm)	Q_{min} (m^3/h)	Q_t (m^3/h)	Q_n (m^3/h)	Q_{max} (m^3/h)
40	0.3	0.8	40	60
50	0.3	0.8	50	90
80	0.5	0.8	120	200
100	0.8	1.8	230	300
150	1.8	4	450	600
200	4	6	800	1200
250	6	11	1250	1600
300	12	15	1400	2000
400	25	50	2000	3000
500	45	60	3000	4500
600	100	180	3300	6500
800	210	320	6000	12000

PLT 4.3 General Requirements

Meters must be fitted with dry dial registers, which comprise 6 digit cyclometer-type totalizers, registering in kiloliters (kl) or m³. These registers must be sealed to prevent

ingress of dirt or moisture. The registers, which are to be fitted as standard, must be able to provide one high frequency opto-type pulse output function and two low frequency reed-type pulse output functions. All flow meters shall be provided complete with frequency converter unit and opto coupler. The frequency converter unit will be mounted in an outdoor type cubicle, which will be supplied and installed under the electrical portion of the Contract.

No consideration will be given to meter types, which necessitate the use of special tools or fitment of any form of gland in the process of connecting pulser units, or, meters which require a register-change to switch from one volume unit per pulse to another. Dismantling of registers for this purpose will not be acceptable. Tenderers are to provide full details of these aspects with their tenders.

Cover bolts must be of stainless steel material to facilitate easy removal of mechanisms. Meter bodies must be coated with a high quality sintered epoxy powder coating, both internally and externally, to provide maximum protection against corrosion.

Although most of the meters will be installed horizontally, it must be possible to install the meters vertically (with flow in the upward direction) or in an inclined position (with flow in the upward direction), should site conditions make this necessary.

Tenderers must provide full details of the minimum lengths of straight pipe required upstream and downstream for each size of meter offered, to ensure that the accuracy of the meters remain within the stated limits, under normal operating conditions. Preference will be given to meter types requiring a minimum of straight pipe upstream and downstream, as installation space and lay lengths are at a premium.

The performance of the meters offered shall not be affected by outside magnetic influences.

Details of head loss across the meters offered shall be provided by the Tenderer.

PLT 5 ELECTROMAGNETIC FLOW METERS

PLT 5.1 General Requirements

All electromagnetic flow meters supplied under this contract shall be for high measuring accuracy i.e. ± 0.5% of reading plus 0.05% of full scale. The repeatability or reproducibility of measurement shall be ± 0.1% of full scale. The meter shall have a long term zero stabiity of ± 0.2% and linear variation shall be less than 0.2%.

Electrodes shall be manufactured from a high quality metal and shall be removable for cleaning purposes. Removal of electrodes with the line under pressure is preferred.

The minimum downstream and upstream unrestricted straight pipe run required for the specified measurement accuracy shall be stated by the Tenderer.

Although most of the meters will be installed horizontally, it must be possible to install the meters vertically (with flow in the upward direction) or in an inclined position (with flow in the upward direction), should site conditions make this necessary.

The flow meter shall be eqipped with a separate mountable signal converter unit complete with sufficient length of signal cable. The signal converter shall be locally programmable and shall be supplied complete with programmer unit. The signal converter shall further more have a LCD display for instantantaneous flow and totalized flow and shall have a 4-20 mA and pulsed output for remote indications. The signal converter unit will be mounted in an outdoor type cublicle supplied under the electrical scope of the Contract.

Electromagnetic meters and converters shall be suitable for outdoor installation and shall be adequately protection against lightning.

PLT 6 DIGITAL INDICATOR/INTEGRATOR

The display shall be a 6-digit, 0.56” (14.2mm) High Red L E D, giving a maximum display of 999999. The decimal point shall be selectable.

A flashing display shall be given during totaliser overflow.

The indicator/integrator shall be powered by 230 V AC at 50 Hz.

The indicator/integrator shall be constructed in such a way that it can be calibrated to the required flow and also by means of a selector button, display the accumulated quantity of water released.

The front bezel shall meet NEMA 4/IP65 requirements

The manufacturer of the indicator/integrator shall comply with ISO 9001 and proof of this to be submitted with the tender documents.

The indicator/integrator shall have a lock-out facility to limit operator entry to the programmable settings and totaliser.

The totaliser shall have a programmable time base with a scale factor of 0.001 to 100.0 and a low-end cut-out.

The remote indicator/integrator if required is to be fitted into an IP 66 enclosure in such a way that the flow reading is clearly visible with space available for the labelling and surge protection as specified.

PLT 7 INSTRUMENT PANELS

All panels will comply with the minimum requirements for an IP 65 rating.

All cable entries will be fitted with the appropriate cable gland. All cable glands will comply with IP 68.

Each enclosure is to be fitted with an M10 brass bolt and two nuts that will act as an earth bar. All surge protection in the enclosure to be grounded onto this bolt.

a) Local indicator/integrator

An instrument panel is required to house the flow meter power supply unit if required, indicator/integrator and surge protection and shall comply with the following:

1. At least 500 mm high, 400 mm wide and 200 mm deep.
2. Constructed from polycarbonate.
3. The door shall be removable and have concealed hinges and captive, stainless steel hinge pins.
4. Be fitted with a plain painted metal chassis of at least 2.5 mm thick.
5. Be fitted with a polyester internal door for mounting of the totaliser.
6. The external door shall be fitted with a window that allows sight of the totaliser.
7. The external door shall have an extruded polyurethane seal fitted to a groove.
8. Only two closure points that are situated outside the sealed area. At least one of the closure points shall be lockable with a cylindrical barrel type lock and two keys shall be supplied for this lock.
9. Shall be wall mountable with 4 stainless steel brackets giving a space of at least 10 mm between the enclosure and the wall.

b) Remote indicator/integrator (if required)

An instrument panel is required to house the remote indicator/integrator and surge protection and shall comply with the following:

1. Constructed from polycarbonate.
2. The door shall be removable and have concealed hinges and captive, stainless steel hinge pins.
3. Fitted with a polyester internal door or stand-offs for mounting of the totaliser.
4. The external door shall be fitted with a window that allows sight of the totaliser.
5. The external door shall have an extruded polyurethane seal fitted to a groove.
6. Only two closure points which are situated outside the sealed area. At least one of the closure points shall be lockable with a cylindrical barrel type lock and two keys shall be supplied for this lock.

7. Shall be wall mountable with 4 stainless steel brackets giving a space of at least 10 mm between the enclosure and the wall.

PLT 8 SURGE PROTECTION

Single phase 230 V AC medium protection units that are certified to withstand surges of up to 75kA.

Two wire, 230 V AC fine protection units that are certified to withstand surges of up to 40kA.

Two wire, 24 V AC fine protection units that are certified to withstand surges of up to 40kA.

Two explosion proof, pipeline spark gaps rated to withstand surges of up to 100kA, complete with pipeline mounting brackets and a fly lead of at least 300mm.
All surge protection units must be grounded to a common earth point in the panel that houses the ultra sonic flow meter. If a nut and bolt arrangement is used it shall be at least an M10 and shall be made of brass. Care has to be taken to ensure that the nut and bolt do not negate the IP 65 rating of the enclosure.

PLT 9 SIGNAL CABLE

All signal cable to be 1,5 mm², 4 core, twisted pair, braided screened cable.

PLT 10 EARTHING

The successful Tenderer is to supply 70 mm^2, stranded copper cable as well as lugs that will fit the cable and an M10 bolt to connect between the equipotential bar and earth mat.

The successful Tenderer is to supply 16 mm^2, green PVC insulated, stranded copper cable to connect between the common earth at the instrument panel and the equipotential bar.

PLT 11 EQUIPOTENTIAL BAR

An equipotential bar with cover must be suitably mounted within each flow meter chamber. Modular terminals should be provided to accommodate 3 connections of up to 16 mm², 3 connections of 16 - 95 mm² and 3 for flat connections up to 30 mm wide.

PLT 12 LABELS

Two types of labels are required. One for the site and installation name, the other giving details of the flow meter characteristics.

Labels to be manufactured from plastic engraved stock with white lettering on a black base.

Lettering to be 10 or 6 mm high x 5 and 3 mm wide and labels to be at least 105 mm X 30 mm.

All labels to be fitted with at least two strips of 12 mm wide double sided tape that run for the total length of the label.

PLT 13 GENERAL REQUIREMENTS

All screws, brackets, cable saddles, nuts, bolts, washers etc. used in the installation of the equipment shall be from stainless steel.

Before delivery to site all equipment and all parts supplied under this contract will be checked and certified at the supplier's workshop to ensure that they are in working condition by a delegated representative of the client.

PLT 14 COMMISSIONING

The equipment as supplied under this Contract shall be commissioned after **one fault free month** of operation.

If during this month the equipment or any part thereof should fail the successful Tenderer shall repair the equipment at his own expense and once again leave the equipment to operate for one fault free month before commissioning. All costs incurred shall be for the successful Tenderer's account. This cycle to continue until one fault free month has been attained.

END OF SECTION

PLV: COLOUR CODING

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PLV COLOUR CODING

PLV 1 SCOPE

This Specification has been adopted to ensure the colour coding of electrical equipment, mechanical plant and pipework located on the City of Tshwane's Wastewater Treatment Works shall conform to the ruling Occupational Health and Safety Act or alternatively to the city of Tshwane's preference.

The Specification comprises of **three** parts, namely:

(a) SANS Code of Practice 10140-3, Identification colour marking – Part 3 : Contents of pipelines: 2003

(b) A table (Table 1) which supplements SANS 10140-3, above, in order to provide greater detail or clarity on the colour marking of pipelines conveying fluids commonly found on the treatment works

(c) A table (Table 2) which gives the colours adopted for certain electrical equipment and mechanical plant.

Throughout the Specification the colours used shall match the corresponding colours given in SANS Specification 1091, National Colour Standards for Paint: 2004 (as amended).

Table 1 : Colour Coding of Pipework on City of Tshwane's Wastewater Treatment Works

Contents of Pipeline	Basic Colour	Colour Coding Indicator	
		Single Band	Second Band
Water, non-drinkable			
Cooling water	Brilliant Green		
Final treated effluent		White	
Recycled effluent		Black	Dark Violet
Air saturated effluent		Black	Dark Violet
Filtrate		Black	Aquamarine
Wash Water		Black	
Scum water		Black	Dark violet
Dewatering Liquors		Black	Dark Violet
Overflow from P.S.T's		Black	Crimson
Overflow from Clarifier		Black	Dark Violet
D.A.F Underflow		Black	Crimson
Supernatant Liquor		Black	Avocado
Overflow Gravity Thickener		Black	Crimson
Fire Fighting			
Boiler feed		Cornflower	
Hydraulic power		Salmon Pink	-
Poly-electrolyte		Light Grey	-
Raw sewage		Middle Brown	-
Settled sewage		Mid-grey	-
Thickener overflow from:			
Primary sludge		Crimson	-
Activated sludge		Canary Yellow	-
Digested sludge		Maroon	-
DAF liquors		Canary Yellow	Turquoise Blue
Filtrate		Ultramarine	-

Contents of Pipeline	Basic Colour	Colour Coding Indicator	
		Single Band	Second Band
Washwater		Black	-
Scum water		Dark Violet	Crimson
Treated effluent		Dark Violet	-
Dewatering liquors		Black	Ultramarine
Acids	Jacaranda		
Ferric chloride		Crimson	
Ferric sulphuric		Artic Blue	
Alkalis			
Lime Slurry	Dove Grey		
Gases			
Sludge gas	Light Stone	Jacaranda	
Steam	Pastel grey	Aluminium	Clad/lagging
Nitrogen	Light Stone	Black	Light Grey
Hydrogen	Light Stone	Black	Signal Red
Methane (digested)	Light Stone	Turquoise Blue	
Carbon dioxide	Light Stone	Light Grey	
Chlorine/Hypochloride	Canary Yellow		
Oxygen	White		
Compressed Air	Artic Blue		
Ventilated Air	Artic Blue		
Vacuum Air	Artic Blue		
Instrument Air	Artic Blue		
Sludges			
Anaerobically digested	Middle Brown	Maroon	
Anaerobically digested: thickened		Maroon	Light Grey
Raw Sludge	Dark Violet		
Lime treated	Dark Brown	Dove grey	
Primary	Dark Brown	Crimson	
Primary thickened	Dark Brown	Crimson	
Digester supernatant liquor	Middle Brown	Salmon Pink	
Activated : mixed liquor	Royal Blue	Canary Yellow	
Activated : gravity thickened	Royal Blue	Canary Yellow	Dark Violet
Activated : return sludge	Royal Blue	Canary Yellow	Middle Brown
Activated : DAF overflow/float	Royal Blue	Canary Yellow	Turquoise Blue
Activated : primary	Royal Blue	Canary Yellow	Crimson
Activated : digested	Royal Blue	Canary Yellow	Maroon
Activated : waste	Royal Blue	Canary yellow	
Pasteurised	Light Brown		
Oil			
Diesel oil	Black	White	
Hydraulic oil	Golden brown	Salmon Pink	
Lubricating	Golden brown	Brilliant Green	
Transformer	Golden brown	Crimson	
Other Liquids			
Polyelectrolyte	Golden Yellow	Jacaranda	
Cooling liquid	White		

Notes: This table supplements SANS 10140-3: 2003
All codes are in relation to SANS 1091: 1975

Table 2: Colour Coding of Electrical Equipment and Mechanical Plant

Item	Colour	Remarks	Code to SANS 1091
Electrical panels : (external)	Light Orange	NOSA	B.26
Electrical panels : (external) emergency power on	Signal Red		A.11
Electrical panels : (Internal)	White		G.80
Coupling guards and motor guards	Golden Yellow	SANS 10140-2	B.4
Motor cowls	Light Orange	Historical	B.26
Electrical motors, pumps and compressors	Deep Pastel Green		H.28
Gearboxes	Navy Light Grey	NOSA: See also “Small Gearboxes”	G.35
Blower	Deep Pastel Green	NOSA	H.28
Baseplates	Olive Drab		
Cranes	Golden Yellow		B.4
Valve bodies		See SANS 10104-3, Clause 4.2	
Valve hand-wheels			
Small gearboxes	To be same colour as prime mover		

Machined Components

All machined components shall be protected by “Tectyl” or similar proprietary coating after manufacture. The coating shall be sufficiently durable to prevent corrosion during storage and installation and shall be removed using the manufacturers recommended solvent after final adjustment of the equipment. Final paining shall be carried out in accordance with the system specified.

PT: PUMPS

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Item **Description** **Page No**

PT PUMPS

PT 1 SCOPE

This section of the Specification includes the manufacture, testing, protection, supply and off-loading of pumps and base-plates used for the pumping of raw or potable water at ambient temperatures as stated. Pump duties shall be in accordance with the Project Specifications. Electrical motors do not form part of this section of the Specification. This section of the Specification must be read in conjunction with the Project Specification.

This general specification shall be applicable to all pumps. Additional requirements for submersible pumps, axial flow pumps and self-priming-type centrifugal pumps, if required, have been included under clauses PT-7, PT-8 and PT-9.

PT 2 INTERPRETATIONS

PT 2.1 Abbreviations

For the purposes of this Specification the following abbreviations will apply:

BS	-	British Standards Institution
SABS	-	South African Bureau of Standards
DIN	-	German Standards Institute
ISO	-	International Organisation for Standardisation
SIS	-	Swedish Standards

PT 2.2 Standards

Pumps shall comply with this Specification and with the current and most recent issues of the following standards where applicable:

BS 970	Wrought steel in the form of blooms, billets, bars and forgings
BS 1400	Copper alloy ingots and copper and copper alloy castings
BS 3100	Specification for steel castings for general engineering purposes
BS 3468	Austenitic cast iron
BS 4360	Specification for weldable structural steel

BS 4675	Mechanical vibration in rotating and reciprocating machinery
BS 4999	General requirements for rotating electrical machines
BS 5316	Acceptance tests for centrifugal, mixed flow and axial flow pumps
ISO 9906	Hydraulic performance tests of centrifugal pumps
BS 4504	Flanges and bolting for pipes, valves and fittings
SABS 1123	Steel pipe flanges
SIS 05 59 00	Pictorial surface preparation standards for painting steel surfaces

PT 3 MATERIALS

PT 3.1 General

All materials shall possess qualities adequate for the purpose for which they are to be used. All materials and properties claimed for these materials shall, unless specified otherwise in this document, comply with the requirements of the most recent edition of the appropriate South African or other internationally recognised standard specification.

For each type of equipment, the Manufacturer shall indicate the materials used for each of the proposed sub-assemblies. The equipment shall be manufactured using new prime quality materials taking into account the latest technical innovations.

All components shall have a surface finish in relation to their importance, their position and their intended purpose.

Rolled steels and all castings shall be clean and free of blisters, porosity, shrinkage, holes, cracks or other flaws that may be detrimental to their use.

The Tenderer shall indicate in his tender the proposed materials for each component of the assembly.

PT 3.1.1 *Castings*

No repair of cast components will be permitted without the prior approval of the Engineer.

The filling of casting defects shall be carried out by approved highly qualified welders only, according to approved welding techniques.

Any cast component requiring filling at any fabrication stage after the first anneal shall be subjected to further annealing treatment unless stipulated otherwise.

Cast components shall not be warped or distorted in any way and shall not show any increase in dimensions (beyond that shown on the fabrication drawings) likely to cause interference with other components in the erection of the item of equipment for which they were made. The structure of cast components shall be homogeneous and free of non-metallic impurity. If, at critical points of a cast component, there is too great a concentration of impurities, the component shall be rejected.

PT 3.1.2 *Pump Casings*

Pump casings shall be of cast iron of at least Grade 220 to BS 1452 or stronger cast steel. The grade of material proposed should be selected appropriate to the quality of water to be pumped as specified in the Project Specification.

PT 3.1.3 *Impellers*

Impellers shall be cast in either phosphor bronze (PBI according to BS 1400 or 1C according to SABS 200), aluminium bronze (AB1 according to BS 1400 or 1E according to SABS 200) or chrome steel (316C11 according to BS 3100, or DIN1.4313), unless otherwise specified in the Project Specification. Cast iron or leaded gunmetal shall not be permitted. Bronze components shall be zinc-free.

PT 3.1.4 *Pump Shafts*

Pump shafts shall be of EN 26 steel to BS 970 or similar.

If a Tenderer wishes to propose an alternative material this should be motivated with details of the benefits to be achieved.

PT 3.1.5 *Stainless Steel*

The stainless steel used shall be of the type easily jointed or fitted by electric welding. Stainless steel which cannot withstand the effects of welding or associated heat treatment will not be accepted. Austenitic grade stainless steel is preferred.

PT 3.1.6 *Fasteners*

Fasteners shall be stainless steel unless otherwise specified.

All high tensile bolts and studs used shall bear the letters HTS stamped or engraved on the end. Washers shall be provided under all bolt heads and nuts. The threads of bolts and studs shall be cleaned and coated with a graphite/grease, copper based or other approved compound before assembly. The threads of all bolts and studs used with the equipment supplied shall be to the same standard. The length of bolts should be such that at least two threads protrude beyond the nuts, but not more than four threads. The threaded end of all bolts must point to the downstream direction of flow.

The Tenderer shall indicate in his tender the materials proposed for each part of assembly.

PT 4 PLANT

The Tenderer shall satisfy the Engineer of the sufficiency of the manufacturer's workshops to handle the manufacture, testing and protection of the pumps strictly in accordance with the Specification.

PT 5 MANUFACTURE

PT 5.1 General

PT 5.1.1 Preference will be given to Pumps with a shaft rotational speed not exceeding 1500 r/min.

PT 5.1.2 Pumps shall be of the highest quality and suitable for continuous operation over long periods with the minimum of maintenance at high sustained efficiency.

PT 5.1.3 End-suction pumps constructed on the back pull-out principle shall be provided with spacer pump motor couplings to enable the pump bearing housing, shaft and impeller to be removed without disturbing the pipework or alignment.

PT 5.1.4 The proposed layout of the pump station is indicated on the drawings accompanying the tender documents. They shall be studied carefully and all alterations to the lay-out, pipework or buildings required to suit the pump offered, shall be set out clearly in letters and drawings accompanying the tender offer. The final layout shall be agreed upon by the Contractor and the Engineer prior to the commencement of manufacture of any of the equipment. Complete work drawings shall be supplied by the Contractor for approval.

All equipment offered as well as all work carried out, shall comply fully with the requirements of the Occupational Health and Safety Act 85/1993 and the Machinery and Operational Safety Act 6/1983.

PT 5.1.5 Taking into consideration specific speed calculations, efficiencies and reliability of the pump sets the proposed pump types shall be justified in the Tender. Double-Suction Axially Split Casing Pumps will be preferred unless otherwise specified in the Project Specification.

PT 5.1.6 Arrangements incorporating multiple pump units coupled in series to achieve the duties specified in the particular specifications will not be favourably considered unless otherwise specified.

PT 5.1.7 The arrangements of impellers shall be such as to reduce the residual axial thrust to a minimum. Designs incorporating a double suction will be preferred.

PT 5.1.8 A design and arrangement of the pump casing which ensures that it is not necessary to disconnect the delivery pipework for the purpose of removing or replacing the complete rotating element will receive favourable consideration.

PT 5.1.9 Suction and delivery details: The orientation of the suction and delivery pipes shall be such as to facilitate maintenance whilst being designed for minimum losses and no air traps.

PT 5.2 Pump Characteristics

PT 5.2.1 The pumps shall have stable, non-overloading characteristics. Closed valve pressure shall be at least 25% higher than the duty pressure.

PT 5.2.2 The Tenderer shall submit with this Tender for each pump offered the following characteristic curves:

with respect to flow (in ℓ/s)

- total head; in metres (0% to 120% of duty flow)
- power absorbed; in kilowatts (50% to 120% of duty flow)
- efficiency; (0% to 120% of duty flow)
- net positive suction head (NPSH) requirements: recommended, 0% head drop, and 3% head drop relative to pump shaft centre line, in the case of horizontal spindle pumps;

with respect to speed:

- torque requirements rated in absolute units.

PT 5.2.3 The Contractor may be called upon to provide further curves at the request of the Engineer, especially for starting and stopping analysis, in connection with surge analysis in the rising mains.

PT 5.2.4 The efficiency curve shall be flat over a wide range in order to provide efficient working with various pump operating conditions. It shall conform to the requirements of the Project Specification.

PT 5.2.5 Unless specified to the contrary, the proposed pumps shall be able to operate without perceptible signs of cavitation in the full range of the operating envelope specified, pump sets running singly or in parallel. Throttling shall not be allowed. Should there be any doubts, the Contractor shall be called upon to carry out an inspection of the pumps and

carry out NPSH tests to prove the equipment, at the Contractors expense. If the pumps are found to be faulty, the Contractor shall be given a 8 weeks to remedy the problem. Thereafter if the Contractor is unable to resolve the problem it shall be cause for rejection.

PT 5.3 Pump Castings

PT 5.3.1 No welding, burning, filling or plugging of defective castings shall be permitted without the Engineer's permission in writing, following an inspection of the defects.

PT 5.3.2 The inspection and testing of castings and test bars shall be in accordance with BS 3100.

PT 5.3.3 The dimension and drillings of the suction and discharge flanges integral with the pump casings shall be to SABS 1123 to design pressures specified.

PT 5.3.4 The pressure rating of the delivery flanges shall be at least equal to the maximum suction static pressure, plus the pump shut-off pressure. The minimum pressure rating of the flanges shall be 1 MPa (10 bar).

PT 5.3.5 All pump casings shall be hydrostatically tested at the Manufacturer's workshop and in the presence of the Engineer or his Representative. The test pressure applied shall be equivalent to 1,5 times the pump shut off head, or alternatively twice the duty head specified, which ever is the greater.

PT 5.3.6 Suitable lifting rings shall be provided on the casings.

PT 5.3.7 The pump casings should be fitted with suitable replaceable stationary bronze wear rings. These wear rings should be appropriately heat treated for operation in conjunction with the impeller, or impeller wear ring material selected.

PT 5.4 Impellers

PT 5.4.1 The castings shall be free of blow-holes and other defects. No welding, burning, filling or plugging of defective castings shall be permitted without prior approval being obtained from the Engineer in writing, following an inspection of the defects.

PT 5.4.2 All water passages shall be machined to a smooth finish. Water passages which cannot be machined shall wherever possible be hand ground and filed to template.

PT 5.4.3 Each impeller shall, after final machining and dressing, be independently statically balanced and the completely assembled rotating element with coupling shall be dynamically balanced.

PT 5.4.4 The first critical speed of the rotating element shall be at least 1,3 times the running speed.

PT 5.4.5 All impellers shall be fitted with wear rings of same material as approved for impellers. These rings shall be secured to the impeller non-corroding screws and be mechanically locked.

PT 5.5 Pump Shaft, Sleeves and Diffusers

PT 5.5.1 Pump shafts shall be of an approved material, and of sufficient dimensions to transmit the power to which they will be subjected without undue torsional or bending stresses and deflection.

PT 5.5.2 The shafts shall be stress-relieved after initial machinery, and ground to final size.

PT 5.5.3 The shafts shall be suitably designed for the reception of the impeller which shall be adequately secured to the shaft in such a manner as to be readily removable without damage to either the shaft or the impeller.

PT 5.5.4 The Contractor shall ensure that both the critical speed and torsional oscillation characteristics of the combined pump and motor rotating elements are satisfactory for all possible conditions of operation.

PT 5.5.5 The shafts shall be adequately protected with replaceable sleeves of an approved bronze or other similar approved non-corrodible material at all areas where wear and/or corrosion could possibly be expected. The replaceable shaft sleeves exposed to the pumped water shall be manufactured from a material compatible with the impeller material selected. These sleeves shall be readily removable without causing damage to either the shafts or the sleeves.

PT 5.6 Shaft Coupling

PT 5.6.1 The pump and motor shall be connected by a flexible coupling in such a manner that it shall not uncouple whichever way the impeller maybe rotating.

PT 5.6.2 The coupling shall accommodate small axial, lateral and angular misalignments without imposing undue stresses on the shaft and bearings. Refer to PT8.3.

PT 5.6.3 The coupling shall be enclosed in a stationary solid-plate guard to the Engineer's satisfaction.

PT 5.7 Pump Bearings and Lubrication

PT 5.7.1 *Bearings and Lubrication*

If anti-friction bearings are fitted a design life of at least 40 000 operating hours is required. The bearings in the pump casing together with its lubricating systems shall be suitable for the particular circumstances. The particular type and system offered by the Tenderer shall be fully specified.

PT 5.7.2 The pump rotating element shall be positively located in the axial direction. If specified, thrust bearings shall be of the tilting pad-type (Michell or similar).

PT 5.7.3 Journal bearings consisting of white metal lined bronze sleeves split on the horizontal centre-line and lubricated with an oil ring shall be preferred.

PT 5.7.4 All bearings shall be suitable for shaft rotation in both directions.

PT 5.7.5 Preferably the same type of bearing will be chosen for motor and pump.

PT 5.7.6 If not, the necessary allowance shall be made when aligning pump and motor.

PT 5.7.7 Adequate provision shall be made for the cooling of oil for bearings, particularly as the pumps may run continuously in ambient temperatures of the order of 40°C.

PT 5.7.8 Oil reservoirs of sufficient capacity shall be fitted with easily accessible oil level indicators, clearly marked to indicate the standing and running oil levels.

PT 5.7.9 All internal surfaces in continuous contact with the lubricating oil such as oil reservoirs, piping, etc, shall be thoroughly cleaned either chemically or by shot blasting and protected by a method to be approved by the Engineer until such time as the system is charged with oil. No site welding of oil circulating pipes will be permitted.

PT 5.7.10 The entire lubricating system shall be fail safe with alarms set to indicate automatic change-over to the stand-by unit.

PT 5.8 Glands and Seals

PT 5.8.1 *Reliability*

Reliability of glands is of prime importance. Pumps incorporating low pressure glands where the pressure at the glands does not exceed the main suction supply pressure will be preferred to pumps with shaft glands exposed to higher pressures.

PT 5.8.2 *Glands*

Low pressure glands of the conventional stuffing box pattern utilising packing rings one each side of lantern rings will be acceptable for the first stage of the pumps. Lantern rings shall be easily removable. The shaft sleeves shall be ground with a polished finish on the wearing surface, and the gap between the sleeve and the follower shall be such that the packing will not be extruded into the gap. Make and type of packing shall be to the approval of the Engineer.

PT 5.8.3 It will be the responsibility of the Contractor to provide filters if the quality of the water necessitates filtration. The flow of water to or from the glands shall be clearly visible.

PT 5.8.4 ***Mechanical seals***

If mechanical seals are called for, they shall require no separate water supply and shall be suitable for the water to be pumped. Seal selection shall be done in collaboration with the seal manufacturer and proof that this has been done may be requested.

If, in the opinion of the seal manufacturer, the quality of the water is such that a flush would be required to the seals, Tenderers are required to provide for a suitable system. Such a system shall be self contained and inclusive of all necessary separators, filters, connections and auxiliary pipe work to provide the required flow to the seals at the appropriate pressure. The auxiliary pipe work and fittings should be in a suitable grade of stainless steel.

Mechanical seals shall be balanced and proved to be suitable for the water pumped. Spare wearing components shall be supplied and delivered when the pump is installed, the cost being included in the price of the pump.

PT 5.8.5 The Tenderer shall supply with his Tender, full details of all pump seals and glands incorporated showing clearly all proposed materials, finished clearances, etc.

PT 5.9 Pump Vent and Drain Fittings

PT 5.9.1 Stainless Steel vent cocks shall be provided and fitted at all local high points on each pump casing. These cocks shall be of adequate size to enable the entrapped air to be released freely. Stainless Steel pipes shall be neatly led from priming cocks, gland and casing drain points to a suitable main tundish. Galvanised drainage pipework of adequate size shall be provided and installed to collect the wastewater from each pumpset and to lead it to the drain leading to the pumphouse sump.

PT 5.10 Base-plate

PT 5.10.1 The pump and motor base-plate shall be rigid. The upper face of each base-plate upon which the pump and motor are located, shall be machined flat and smooth to ensure that the pump is supported properly directly to the base-plate, without the use of spacers. Provision must be allowed to align the motor correctly to the pump through the use of suitable shims or spacers, the combined height of which should not exceed 3 mm. Drawings of baseplates shall be submitted for approval before manufacture.

PT 5.10.2 For every motor, two jacking bolts at right angles with a lock nut shall be provided at every corner.

PT 5.11 Monitoring Devices

PT 5.11.1 Unless specifically stated in the Project Specification, one or more of the following monitoring items shall be required:

Full details of the sensing equipment (thermocouples, etc.), and of the associated control and monitoring or indicating equipment shall be submitted with the tender offer. Evidence shall also be submitted that adequate spares and services are readily available in this country.

PT 5.11.2 *Temperature Sensors*

Either thermocouples or resistance temperature detectors shall be installed, depending on which is more suitable to the duty and application.

Location of temperature probes:

a) Separate temperature probes shall be installed at the sleeve and/or rolling bearings of each pump and motor and at the gland housings of the pump to monitor the temperatures at these points.

b) The probes shall be spring-loaded to ensure positive contact with the bearing shells or gland stuffing boxes.

c) Each probe shall be clearly identified by means of an engraved marking on the sheath and shall be individually calibrated. Test certificates covering the calibration results of all temperature probes shall be submitted to the Engineer.

d) Temperature detectors offered, shall be suitable for operation in conjunction with temperature indicating, monitoring, alarm and trip equipment of Conlog or equivalent design.

e) If grease lubricated bearings are offered, the Tenderer shall indicate if temperature detectors can in fact be used. If temperature detectors are not feasible, the Tenderer shall indicate alternative means of monitoring bearings.

f) Pockets for standard mercury filled glass thermometers shall be provided adjacent to all pockets serving temperature indicating instruments. Pockets for standard thermometers shall have chained covers to prevent the ingress of dirt when not in use and shall be so arranged as to permit the accurate measurement of the bearing temperature. The pockets shall contain a small amount of oil and shall therefore be orientated within 30° of the vertical, horizontal pockets are not acceptable.

g) Each pump casing shall be fitted with a thermo switch, Fenwall, or equal approved make to safeguard the pump in the event of inadvertent sustained operation against a closed discharge valve. The thermo switches shall be calibrated to close when the temperature of the water in the pump casing exceeds 40°C.

PT 5.11.3 *Pressure gauges*

a) Each pump set shall be equipped with two 150 mm dial diameter flush mounting pressure gauges. The gauges shall be calibrated in kilopascal and the angle shall suit the particular application. The gauge shall be filled with glycerine, and the bubble shall be out of the range of usual reading. The gauges shall be of a type that is possible to recalibrate (dead-weight method) and reset on Site.

b) These meters shall indicate water pressure in kilopascal and shall have a range at least 50% higher than the normal duty point. However, in all cases the gauges must have a range at least 30% higher than the shut off, or maximum, head which the pump is capable of generating with the system conditions taking into consideration the maximum static suction pressure possible.

c) The meters for the suction side of pumps shall be compound gauges and shall be capable of indicating a negative pressure of up to 100 kPa. However, in all cases the gauges must have a range at least 30% higher than the maximum static suction pressure possible.

d) All pressure gauges shall be supplied and installed complete with isolating Steel cocks, copper or stainless steel piping, etc. and fitted with a pulsation snubber in stainless steel.

Due to the quality of the water, those submitting tenders should satisfy themselves of the reliable operation of the gauges. Where necessary they must include for the pressure gauges to be fitted with diaphragms. Pipes to pressure gauges neatly supported between tapping point and pressure gauge. Pedestals to the Engineer's approval shall be supplied at a suitable position to house the pressure gauges.

PT 5.11.4 *Pump set vibration sensors*

a) Suitable vibration sensors shall be mounted on each pump set to stop it on detection of excessive vibration. The sensors shall be situated as close as possible to those bearings where the highest vibration levels are encountered.

b) The monitoring of vibration shall be made via a suitable timing device in order to avoid tripping when starting the pump set or during other transitory conditions.

c) The pumps shall comply with the requirements of BS4999.

PT 5.11.5 *Automatic air vents*

If an automatic air vent is specified for the pump casing, it shall be fitted with an indicator to show the open and closed positions of the air vent. The air vent shall be suitable for remote operation and the control of the air vent shall be mounted on the control panel inside the pump house.

PT 5.11.6 *Gland leakage detection*

A device to monitor gland leakage shall be supplied and fitted with adjustable alarm contacts designed to close when gland leakage rises to a pre-set value.

PT 5.11.7 *Wear limit switch*

Multistage pumps should be fitted with a wear limit switch to protect the pumps against damage after normal wear of the wearing rings have taken place after a period of operation.

PT 5.12 Corrosion Protection

PT 5.12.1 *Internal protection*

Final coat colours to be confirmed by Engineer prior to delivery to Site. Submersible pumps shall preferably be FBE protected.

All traces of rust, slag, silica or other contaminants shall be removed by mechanical wire brushing. Abrasive blast clean all interior surfaces to SA 2½ (near white) metal finish to the Swedish Standard SIS 05 59 00. The blast profile shall fall within the limits 40 - 60 microns.

A thorough vacuuming of the interior surface shall be carried out to remove all traces of the abrasive grit before application of internal surface finish.

Apply by brush, or airless spray, three coats of an approved two part epoxy coating, or equivalent, to give a dry film thickness of between 50 and 70 microns per coat. The intermediate coat shall be a different colour to the first and final coats. The total minimum dry film thickness for the complete system shall not be less than 150 microns.

PT 5.12.2 *External protection*

All sharp edges, laminations and protrusions shall be removed by mechanical grinding, whereafter all traces of rust, slag, silica or other contaminants shall be removed by mechanical wire brushing. The entire surface shall be degreased using a suitable water emulsifiable degreaser. Surfaces shall be left clean and dry prior to coating.

One coat of zinc phosphate high build primer shall be applied (Plascon Code UC 183 or similar) by airless spray to a dry film thickness of 75 µm, and left 8 hours to dry.

The primer shall be followed by one coat of universal undercoat, (Plascon Code UC 1 or similar) applied by brush, roller or airless spray to a dry film thickness of 30 µm. This coat shall be left to dry for 16 hours.

The final coat shall be one coat of universal gloss enamel, (Plascon Code G or similar) applied by brush, roller or airless spray to a dry film thickness of 25 µm. This shall be left to dry for 20 hours. Colour will be as directed by the Engineer.

PT 5.12.3 *Designation and Information Plates*

Each pump shall be supplied with an information plate - preferably chromium plates - secured to the pump casing in a visible position indelibly marked with the following details :

- Maker's name, pump type and serial number
- Year of manufacture
- Rated duty of pump in litres per second
- Head in metres at rated duty
- Pump speed in revs per minute
- Impeller diameter
- Mass of completely assembled pump in kilogram
- Types and sizes of Bearings
- Letters and figures shall be engraved, or embossed, not stamped

PT 5.13 Inter-changeability

Where two or more similar pumpsets are required, the pumps and motors shall be interchangeable in all respects.

PT 5.14 Operating and Maintenance Manual

Three copies of the Operating and Maintenance Manual shall be supplied by the Contractor not later than at the time of commissioning of the installation. This manual will be a prerequisite for commissioning of the plant and a separate manual shall be compiled for each installation.

PT 5.14.1 *Contents*

The manual shall cover the following aspects in detail, with illustrations and drawings:

a) Index: Each volume shall have an index following the title page. If there is more than one volume, the first volume shall contain a master index.

b) A Brief description of the plant and installation.

c) Pre-commissioning checks: These shall be clear, concise, easy to follow and shall include pre-start checks (e.g. check oil and water, remove locking pin, etc.), safety checks (e.g. personnel cleared from vicinity of water outlets, guards in place, etc.).

d) Detailed operating instructions: These shall be clear concise, easy to follow and shall include starting procedure, running checks (e.g. no vibration, pressures normal), shut-down procedure, emergency shut-down procedure and action to be taken in response to alarm signals.

e) Proposed preventative maintenance schedules and programme covering all plant and equipment; the Maintenance chart.

f) Fault diagnosis and repair procedures: These shall include details of all servicing, replacement and repairs which Artisans or Operating personnel would be expected to carry out on Site. In this section the reader may be referred to suppliers brochures elsewhere in the Manual for specific detail.

g) Schedule of manufacturing drawings.

h) Detailed schedule of plant components giving material specifications, part numbers, etc. Where possible, drawings shall be positioned opposite the appropriate text.

i) Sub-contractor's/Supplier's brochures and instructional literature.
The requirements for the Operation and Maintenance Manual for electric motors are covered elsewhere.

j) Mothballing procedure.

k) Schedule of lubricants.

PT 5.14.2 ***Non availability***

Commissioning will not be performed and payments will be deferred if complete. Operating and Maintenance Manuals are not available at the time of commissioning.

PT 5.15 Drawings and Documentation

PT 5.15.1 ***Drawings***

The drawings included in the Tender Documents are the Engineer's proposal for the plant lay-out. Proposed alternatives by the Tenderer indicated on drawings submitted by the Tenderer, shall be considered in allocating the contract. General arrangement drawings must be provided for all equipment.

PT 5.15.2 Before any work is carried out by the Contractor and within six weeks after date of order, the Contractor shall submit detailed working drawings to be approved by the Engineer. Approval of these drawings does not relieve the Contractor from his responsibility for the correctness of the drawings.

PT 5.15.3 Fully dimensioned outline and layout drawings of all plant and equipment shall be supplied including ancillary equipment, giving fully particulars as to the sizes and positions of all anchor bolts, bolt holes and other recesses; vents and drains; oil, gland or cooling and service water; anchor blocks, supports, foundations and embedded parts, including all necessary clearances around items of equipment and the lifting requirements and any other information which may effect the construction of the Pump Station structure.

PT 5.15.4 The magnitude and direction of the thrust forces to be resisted by the foundations or anchor blocks shall be clearly given.

PT 5.15.5 Detailed dimensioned outline drawings of each electric motor, junction box and control console shall be included, showing the position of each panel, clearance space required and the height of each cable gland above the floor.

PT 5.15.6 The above-mentioned information shall be binding once it has been approved by the Engineer. All costs due to alterations made after this approval will be invoiced to the Contractor. The Contractor will be required to formally approve the civil and electric cable routing drawings made by others.

PT 6 TOLERANCES

The tolerances as specified in the Project Specification or the appropriate SABS or BS Standards, shall apply.

PT 7 SUBMERSIBLE PUMPS

PT 7.1 Equipment required

The number and position of all submersible pump sets to be supplied under the Contract shall be stated in the Project Specification.

PT 7.2 Pump/Motor Unit Design and Construction

The pump and motor shall be fully submersible in up to 40 m deep water and shall be a single unit with no shaft coupling between the pump and motor. The pump unit shall automatically and firmly connect to a special discharge connection. The pump, attached to a chain, shall be guided down from the top of the station by two guide bars to the discharge connection at the bottom of the wet well. There shall be no need for personnel to enter the wet well to secure the pump in position. Sealing of the pump unit to the discharge connection shall be accomplished by a machined metal-to-metal watertight contact or o-ring type seal situated in the pump discharge flange for ease of replacement. No portion of the pump/motor unit shall require any support directly on the floor.

Pump casing shall be from grey cast iron to BS 1452 Grade 260 with smooth surfaces devoid of blow holes or any other irregularities. The pump volute shall be non concentric in design with smooth passages large enough to pass solids and foreign material as

indicated in the Project Specification. All bolts, nuts and washers shall be of 304 Stainless Steel. All external and internal metal surfaces in contact with the pumped liquid excluding Stainless Steel or brass, shall be corrosion protected in the factory by epoxy paint or powder coating as described in the Project Specification or General Corrosion Specification.

Sealing design of major components shall incorporate metal to metal contact between machined surfaces. Critical mating surfaces where watertight sealing is essential shall be machined for and fitted with O-rings. Fittings will comprise controlled compression O-rings in two planes and O-ring contact of four sides without the requirements of a specific torque limit. Rectangular sectioned gaskets requiring a specific torque or the use of sealing compounds shall not be considered.

PT 7.3 Cooling System

The fully submerged motor shall be adequately cooled by the surrounding liquid without the need for external cooling liquid.

If required in the Project Specification, a water jacket shall encircle the stator housing of the motor, thus providing heat dissipation for the motor in case of the motor not being completely submerged in liquid. Impeller back vanes shall provide the necessary circulation of the liquid through the water jacket. The cooling media channels and ports shall be non clogging by virtue of their dimensions. External cooling and seal flushing shall also be provided. The cooling system shall provide for continuous pump operation in ambient temperatures of up to 40°C.

PT 7.4 Cable Entry Seal

The cable entry seal shall be tight for a depth of up to 40 metres. The cable(s) shall preferably enter the motor terminal chamber through a loose cast iron sleeve which shall be attached to the cable end in the factory. All cavities between the four cores of the cable and the inside of the sleeve shall be completely filled with approved resin. The sleeve shall have at least a single groove for an o-ring machined into its outer surface. This sleeve shall fit into a machined cavity in the motor terminal chamber and a watertight seal shall be provided by the O-ring. The sleeve shall be equipped with a flange and shall be held in place by Stainless Steel bolts with washers.

Alternative cable entry seal systems may be considered. Details of the cable entry seal shall be provided in the tender offer.

PT 7.5 Bearings

The pump/motor shaft shall rotate on two permanently greased bearings. The non locating upper bearing shall be a single row roller bearing. The lower bearing shall be a double-row angular contact locating bearing to compensate for any axial and radial forces.

PT 7.6 Mechanical Seal

Each pump shall be provided with a tandem mechanical shaft seal system between the pump and motor, consisting of two independent seal assemblies. Seals shall operate in an oil reservoir that hydrodynamically lubricates the lapped seal surfaces at a constant rate. The lower primary seal unit located between the pump housing and the oil chamber, shall contain one stationary and rotating corrosion resistant tungsten carbide ring. The upper unit located between the oil chamber and the motor housing shall contain one stationary and one rotating corrosion resistant tungsten carbide ring. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment. It shall not depend on direction of rotation for sealing. For special applications other seal face materials shall be available. Each pump shall be provided with an oil chamber for the shaft sealing system. The drain and inspection plug shall be accessible from the outside.

PT 7.7 Pump/Motor Shaft

The pump and motor shaft shall be a single unit. The pump shaft is an extension of the motor shaft and shall be from 304 Stainless Steel or EN54 or better. The shaft shall not be in contact with the pumped liquid.

PT 7.8 Impeller

The impeller shall be of 304 Stainless Steel or better and shall be dynamically balanced. The impeller shall be double shrouded and non-clogging. Impellers shall be capable of handling silt, solids and other matter found in the pumped liquid (see the Project Specification for details). Where possible a full vaned, non-vortex type impeller shall be used for maximum hydraulic efficiency, thus reducing operating cost. The impeller shall be keyed to the shaft, retained with an Allen bolt in the impeller. The inertia of the rotating unit shall be provided.

PT 7.9 Wear Rings

An easily replaceable wear ring system shall be used to provide sealing between the volute and the suction inlet of the impeller. The casing wear ring shall be made of brass and shall be held in position by press fit or Allen screws. The impeller wear ring shall be fitted to the suction inlet of the impeller and shall be made of the same material as the impeller. The ring shall be held in position by heat shrink fit or Allen screws.

PT 7.10 Ancillary requirements

Any/all ancillary requirements and additional mechanical items shall be stated in the Project Specification.

PT 8 AXIAL FLOW PUMPS

PT 8.1 Equipment required

The number and position of all axial flow pump sets to be supplied under the Contract shall be stated in the Project Specification.

PT 8.2 Impeller

The maximum rotational velocity of the pump impeller shall be submitted with the tender. After assembly of the finished impeller, shaft and mounting flange but before dispatch to Site, the assembled unit shall be dynamically balanced at twice the maximum operating speed of rotation and in addition shall be tested for centricity and correct angular attachment of impeller and flange to shaft, all in the presence of the Engineer or his representative.

PT 8.3 Bearings

All bearings shall be designed for a life of at least 100 000 hours at a B10 rating. In addition, the bearings on the output shaft shall be capable of withstanding the resultant forces caused by the combination of radial and axial loads (imposed by the stirrer) acting simultaneously, and shall be selected such that the following condition is complied with:

$$\frac{\text{actual radial load}}{\text{permissible radial load}} + \frac{\text{actual axial load}}{\text{permissible axial load}} = \text{less than } 1{,}0$$

(where the 'permissible' loads are the manufacturer's figures for 5 000 hours at a B10 rating). Tenderers shall indicate what these forces are and how they are accommodated.

Casings shall be made of close grained cast iron and shall be designed such as to prevent moisture from entering.

PT 8.3 Bolts

Holding down bolts and jacking bolts which are to be built into concrete work for securing the plant shall be supplied and installed under this section of the Contract. Grouting up of these bolts will be done by the construction contractor after completion of the setting up of the plant by the Contractor under this Contract.

PT 9 SELF PRIMING CENTRIFUGAL PUMPS

PT 9.1 Equipment required

The number and position of all self priming centrifugal pump sets to be supplied under the Contract shall be stated in the Project Specification.

PT 9.2 General requirements

The pumps shall be of the self priming centrifugal type and shall be horizontally mounted and fitted with a Vee-belt drive assembly. The speed shall not exceed 1 450 rpm.

The casings of the pumps shall be high quality close grained cast iron to BS 1452. Means shall be provided in the casing to gain complete access to the pump interior to permit the clearance of blockages and to provide simple access for service and repairs.

All openings, internal passages and internal recirculation ports shall be large enough to permit the passage of a sphere 75 mm in diameter.

The pump shaft shall be contained within a bearing pedestal of ample size to contain heavy duty ball thrust bearing and radial bearing of adequate size to withstand all imposed loads. The bearing shall be oil lubricated, with the bearing pedestal cooled by pumped liquid.

The pump shaft shall be sealed against leakage by a mechanical seal. The seal faces and seat shall be self-aligning.

An air release system shall be provided to release air from the pump casing at its highest point and the pipe shall discharge into the sump. This is to be made of resistant material to the corrosive atmosphere of sewage.

The pumps shall be mounted on base plates of rigid construction, provided with suitable openings for pouring in grout and all necessary holding down bolts to secure the foundations. Concrete work will be finished to approximately 20 mm below the underside of the base plate and when erecting the pump and motor, the Contractor shall arrange for setting each unit to exact line and level by means of steel wedges. Thereafter the contractor will grout in the holding down bolts and grout the base plate to the satisfaction of the pump supplier.

PT 9.3 Ancillary requirements

Any/all ancillary requirements and additional mechanical items shall be stated in the Project Specification.

PT 10 INSPECTION, TESTS AND COMMISSIONING

PT 10.1 General

PT 10.1.1 Contractors shall, if requested make available for inspection, their internal Quality System Manual, their Standard Procedure Manual and their Works Instructions. Preference shall be given to Contractors who have been audited and found to satisfy the requirements of the ISO 9000 Quality system.

PT 10.1.2 Inspection and tests required of the Contractor include the tests and inspections in the workshops and the inspections and tests at Site.

PT 10.1.3 Depending on the results of the tests and inspections, penalties may be applied and, in certain cases, part or all of the equipment may be rejected, as set out hereinafter.

The cost of all tests and inspections shall be included in the Tender. For instance, the cost of commissioning and testing at Site shall be stipulated in the Price Schedule under the section provided or included as part of the cost of erection. (Except for the cost of power and water consumed.) No claim for travelling expenses or further time required for testing will be allowed.

PT 10.1.4 Tenders shall fully acquaint themselves with the properties of the water to be pumped. Any wear of portions of the pump or ancillary equipment that will affect its operating efficiency during the Period of Maintenance will result in the pump set being rejected.

PT 10.1.5 Signs of cavitation pitting on pump parts will not be acceptable.

PT 10.1.6 Leakage from any oil, water or air circuit will not be acceptable.

PT 10.1.7 Leakage at the glands shall be controlled to the minimum required and drained to the Pump Station sump.

PT 10.1.8 Operation of pumps shall be free from undue vibrations throughout the full range of normal running conditions. Vibration levels should not exceed the limits determined by VDI 2059 for good vibration behaviour.

PT 10.1.9 In no case shall temperature-rise above the ambient temperature reach or exceed 40°C for any mechanical component. For temperature-rise of bearings see Clause PT 5.7.7.

PT 10.1.10 In the case of routine tests concerning standard equipment or material quality control tests, not attended by the Engineer or his Representative, tests reports or certificates in duplicate shall be submitted to the Engineer.

PT 10.1.11 The Contractor shall notify the Engineer or his Representative in writing two weeks in advance, of the place and dates at which the equipment may be inspected and tested.

PT 10.1.12 The Engineer or his Representative will inform the Contractor of his intention to attend the test or the inspection and propose a date which suits him. If the date preferred by the Engineer is later than ten days after the first possible date, the Contractor shall be entitled to perform the test or inspection without the presence of the Engineer.

PT 10.1.13 If on any agreed date the equipment to be inspected or tested is not ready and the test or inspection has to be postponed the Contractor shall be held responsible for the travelling and/or living expenses of the Engineer and/or his Representative.

PT 10.1.14 When tests and inspection have met the satisfaction of the Engineer or his Representative a certificate of Workshop Acceptance will be issued by the Engineer. The Contractor shall not pack and dispatch to Site any equipment before receiving the relevant "Certificate of Workshop Acceptance."

PT 10.1.15 The Engineer's acceptance shall in no way relieve the Contractor of any obligation with regards to the Specification.

PT 10.2 Tests

PT 10.2.1 *Performance tests*

Each pump complete with its driving unit shall be tested at the Manufacturer's works, or other location approved by the Engineer to "Class B" requirements of BS 5316 Part 2, and the efficiency carefully measured. Variations from the actual running conditions of the pumps are allowed as defined in the standard. Unless otherwise explicitly mentioned, cavitation tests are required at works.

PT 10.2.2 The tests shall be witnessed by the Engineer or his Representative and details of the tests and the results obtained, duly signed by the appointed Witness, shall be submitted to the Engineer before despatch of the pumping units from the Manufacturer's workshop.

PT 10.2.3 The rotating elements of the pumps and motors shall be dynamically balanced before assembly. The residual unbalance should be better than ISO 1940 grade G 6.3. The good balance of the whole pump set will be checked by measuring the absolute vibration on pump and motor bearing housings.

PT 10.2.4 Tests shall be performed with the pump set on sound foundations, similar to those expected at Site.

PT 10.2.5 Measurements shall be taken in the three axes at each bearing, i.e. axial and two radial components at right angles to each other.

PT 10.2.6 Performance and vibration tests as described above are to be performed before installation on Site for all pump sets larger than 22 kW. If these tests are impractical or impossible at the pump manufacturer's works, Tenderers must state this in their Tender and explain the reasons why it is so. The Engineer may be prepared to consider alternative proposals for testing provided these proposals are submitted with the Tender and are clearly described and defined. If this is not done, the Tenderer will arrange to have the tests performed in another workshop at his cost.

PT 10.2.7 All pieces of equipment subject to water, oil or air pressure shall be pressure tested at a pressure not less than one and a half times the design pressure.

PT 10.2.8 Each piece shall withstand the hydrostatic test pressure without exhibiting signs of sweating, undue deformation and stressing, or defect of any kind.

PT 10.2.9 Hydrostatic testing shall be done with blank flanges bolted on the flanges of the piece. The use of tie-bolts or other forms of restraint applied across the blank flanges to restrain the bodies from deflecting under the applied test pressure will not be permitted without the Engineer's approval.

PT 10.2.10 The hydrostatic test pressure shall be maintained for a period of at least 10 minutes.

PT 10.3 Performance Test Results

PT 10.3.1 *At Works*

a) The overall percentages of efficiency as calculated from the tests should not be less than the appropriate guaranteed figures at the duty points by more than 3%.

b) The measured flow rates should not differ from the guaranteed deliveries at any point other than the duty points on the characteristic curves as supplied by the Tenderer by more than 5%.

c) The NPSH requirement should be met for the specified duty point. Where requested by the Engineer additional tests will be required to demonstrate the pump performance at run out conditions, or where the NPSH available is critical.

d) Peak to peak vibration displacement shall not be more than 10% higher than the required displacement.

e) The Contractor will be allowed a period of four weeks to carry out any amendments to the plant which he may consider necessary to meet the guaranteed figures. Any period granted for design amendments shall not extend the Contract Period.

f) Further tests shall then be carried out at the Contractors expense and if the test results in question are still not within the limits specified, the Engineer shall have the right to:

- either reject the entire plant and recover all monies already paid to the Contractor,

- or, let the Contractor continue with the installation of the pump sets which may be subjected to penalties or rejection as defined hereinafter when the performances tests at Site are performed.

PT 10.3.2 *At Site*

At the time of performance tests at Site:

- should the test results obtained for either efficiency, flow rate, NPSH or vibration still vary beyond the limits indicated in clause PT 7.3.1 above, the Contractor will again be allowed a further four weeks to make such amendments as may be considered necessary and if after these amendments have been made the test results in question are still not within the figures which have been guaranteed, the Engineer reserves the right, according to circumstances, to reject the plant entirely.

- any other discrepancies, abnormal wear or malfunctioning of plant which may be observed during the Acceptance Tests shall be corrected by the Contractor without delay.

- the date of completion shall be the date on which the Acceptance Tests at site have been satisfactorily completed and the plant is in a fully operational state in accordance with the Specification.

PT 10.3.3 Any period granted for design amendments shall extend the Period of Maintenance by a corresponding amount.

PT 10.4 Commissioning

(See pro-forma form to be completed, bound in at the back of the Project Specification).

a) On completion of mechanical and electrical erection and as soon as water is available and other circumstances permit, the Contractor shall arrange for the commissioning of all units of the pumping plant in the presence of the Engineer. The Contractor shall ensure that his equipment is suitably prepared before giving the Engineer fourteen days notice in writing of the date of commissioning.

b) Before the commissioning, the Contractor shall satisfy himself and subsequently prove to the Engineer that all items on the following checklist have been checked and are functioning correctly:

- Visual check of general appearance of plant.
- Check power supply to motor available.
- Determine the direction of rotation.
  a) Remove coupling.
  b) Correct if necessary.
- Check if pump is turning freely by hand.
- Check axial float of pump.
- Check thermocouple operation/calibration if required.
- Check if pump requires gland packing (Mech. seal flushing).
- Check pumps and motors for correct grade and quantity of bearing lubricants (oil/grease packed).
- Alignment of pump and motor.
- Suction isolating valve open (bypass open).

- Control valve/reflux valve closed.
- Delivery isolating valve open.
- Check if discharge line is full of water.
- Bleed off air on pump and pipe works.
- Cooling water flow to bearings if installed.
- Check balancing water if required.
- Monitoring and operating equipment are functioning correctly.
- Test run of pump.
    a) Number of recommended start - stop of motor.
    b) Bearing temperature (motor and pump).
    c) Pump speed.
    d) Suction pressure.
    e) Discharge pressure.
    f) (Volts) (Amps) (kW).
    g) Quantity pump is pumping.
    h) Vibration levels.
    i) Rundown time of pump and motor.
    j) Simulate an emergency shut-down of pump.
    k) Check pump and pipework for water tightness.

NOTE: The Contractor to ascertain from the Pump Manufacturer whether the items on the check list are sufficient for the successful commissioning of the pumpsets.

c) The pumpsets shall be run without interruptions separately for at least 4 hours or such further time as may be required to reach stable operating conditions (particularly, motor temperatures shall be stable).

d) If the prescribed duration cannot be achieved, the initial commissioning shall take place at a date to be agreed upon by the Contractor and the Engineer. It is to be borne in mind that the penalties for late delivery shall be linked with the initial commissioning.

e) After the above commissioning, the plant shall be run under approved supervision for not less than two months before the Acceptance Tests are conducted. The Contractor must satisfy himself that the operators are in a position to operate the plant safely and correctly should he be absent from Site during this period.

f) Commissioning shall not be considered to be complete until complete O&M manuals have been supplied and the plant is capable of continuous operation by fully trained operators of the Employer and until two months have elapsed and the plant has passed the Acceptance Tests as specified.

g) The Acceptance Tests shall be performed only if and when every item of the whole Contract is fulfilled and if and when each piece of equipment, including the

monitoring and control devices, is working properly. The Engineer is entitled to postpone the Acceptance Tests if any part of the Contract is not to his satisfaction or if the plant has not been successfully operated for at least 200 hours.

h) The Certificate of Commissioning for the equipment is issued by the Engineer only when the results of the Acceptance Tests, recorded in a report prepared and submitted by the Contractor, are found satisfactory.

i) Final Operation and Maintenance Manuals shall be made available before the Certificate of Commissioning is issued.

j) The Defects Liability Period (or Guarantee Period) commences at the date of the Certificate of Commissioning.

k) During the first 14 days of operation of the scheme, the Contractor shall be on site to rectify any problems with the scheme within 24 hours of being telephonically notified. During the remainder of the maintenance period, the Contractor shall within 14 days of being notified, commence rectifying any possible problems that the Employer may encounter with the equipment supplied under this Contract.

l) Should the Contractor fail to meet the above requirements, the Employer may appoint others to undertake the necessary repair work at the Contractor's cost.

m) After the satisfactory conclusion of the Acceptance Tests on Site and the issue of the Certificate of Commissioning, the Contractor shall guarantee the satisfactory operation and functioning of the entire plant covered by the Certificate of Commissioning for a period of twelve months measured from the date of the Certificate of Commissioning.

n) The Contractor shall make good, free of all charges, any defects arising during this Period of Maintenance including the replacement of all defective parts and their installation and recommissioning. This guarantee shall apply to all defects arising during proper use of the plant, due to faulty design or maintenance instructions, inferior materials or poor workmanship.

o) Maintenance by the client's personnel during the Defect Liability Period shall be limited to cleaning and lubrication only as instructed by the Contractor. All other maintenance or adjustments shall be carried out by the Contractor.

p) The Final Certificate will be issued by the Engineer when the Defects Liability Period has elapsed and all Contractual obligations have been met in accordance with the General Conditions of Contract.

PT 11 INSTALLATION OF PUMP SETS

PT 11.1 Couplings

All pumps are to be matched for coupling to their respective motors. Couplings shall impose no restriction on normal end play or expansion and shall be provided with a removable guard, painted red. The direction of rotation shall be indicated with a clear arrow painted on the exterior of the coupling guard. The latter shall be designed thus to render reversed mounting impossible.

PT 11.2 Grouting of Base-Plates

Base-plates shall only be grouted after the alignment of pump sets has been approved. The Contractor must provide details of the grouting procedure he intends to utilise. Grouting of base-plates shall be done by the Contractor and he shall ensure full grout penetration between each pump base and relevant base-plate.

PT 11.3 Pump Set Alignment

PT 11.3.1 *General*

It is accepted that all new pump sets have been aligned on the base-plates in the factory. A certain amount of base-plate deformation is possible during transit and installation. Therefore, the alignment shall be rechecked on site following a hot run as specified hereafter.

Two main checks are to be carried out, viz.

a) angular alignment and
b) radial alignment of the pump shaft

The checks are to be done on all pump sets.

PT 11.3.2 *Preparation*

Before any check, the following preparations shall be performed:

- Final grouting to the base-plate shall be completed.

- Driving unit shall be isolated from the power supply. The Contractor shall ensure that no damage can be caused by turning either unit (driving or driven unit).

Couplings should be fixed to their respective shafts and the segments must be free to move relative to each other. Where the method of coupling is too tight to allow free movement between the two half-couplings the rims should be marked so that readings can be taken when the two marks are in line.

PT 11.3.3 *Alignment Checks (See attached Data Sheet)*

Angular Alignment
(See Fig 1)

i) Clamp two clock gauges diametrically opposite coupling pin holes of the driving or driven half-coupling, the plunger ends resting on the back of the opposite half-coupling.

ii) With one gauge at the top and one at the bottom set both gauges to zero.

iii) Turn both couplings through 180°. If the alignment is correct, the readings on the gauges should be numerically the same, although not necessarily zero.

iv) Adjustment should generally be made on the outboard end of the pump.

v) Turn both couplings through 90° and set the clock gauges to zero. Repeat step iii).

Note: This method does not require axial location of either half coupling.

Intersection of Axis (Radial Alignment)
(See Fig 2)

i) Clamp one clock gauge into one of the coupling holes in the driving or driven half-coupling, the plunger end of the clock gauge seating on the rim of the other coupling.

ii) Rotate the couplings together and note the readings at each quarter turn.

iii) Adjust the position and heights of the units until uniform clock readings are obtained.

Note: Where the operating temperature of a unit has the effect of lifting the centre line of one machine in relation to the other, allowance in the height of the appropriate machine must be made. Height adjustment must be in accordance with the manufacturer's specifications.

PT 11.3.4 ***Tolerances***

i) **Angular Alignment**: The angle between two half-couplings shall not be more than 0,01° for speeds up to 1500 rpm. This corresponds to a variation of 0,05 mm and 0,02 mm between readings on a 300 mm diameter coupling.

ii) **Radial Alignment**: If readings vary by more than 0,10 mm (i.e. 0,05 mm eccentricity) for 1500 rpm adjustments shall be made.

PT 11.3.5 *Grouting of Base-Plates*

i) A gap of approximately 25 mm is provided between the base-plate and top of the foundation.

ii) Following approval of initial pump set and pipework alignment, the Contractor shall erect suitable formwork along the base-plate perimeter and shall grout the entire aforesaid gap, foundation bolt pockets and base-plate volume up to the top surface of the base-plate. appropriate grout holes shall be provided on the base-plate surface for this purpose. The Contractor shall timeously, prior to erection, submit to the Engineer full details of the grout type required, which should attain a design compressive strength of 30 MPa within 10 days.

iii) Prior to execution of final shaft alignment checks, the grouting operation shall have been completed, the grout adequately cured and all foundation bolts tightened.

iv) Final alignment control checks to be performed in the presence of the Engineer (or his appointed representative), immediately following a hot run.

v) Alignment Control Sheets will be completed for every unit checked, and will be signed by both the Engineer and the Contractor. The original copy will be kept by the Engineer and a duplicate by the Contractor.

vi) For alignment control sheet, see annexures to specifications.

PT 11.3.6 *Installation of Dowel Pins*

Following approved alignment of pump sets, suitable dowel pins shall be fitted to facilitate correct re-location of pump sets.

PT 11.3.7 *Manufacturer's Certificate of Approval*

Following wet commissioning of pump sets, the pump manufacturer or his approved supplier shall check the installation and when satisfied shall issue to the Engineer a certificate approving installation in compliance with the manufacturer's specifications.

The Contractor shall furthermore, upon commissioning, perform vibration tests in the horizontal and vertical planes of each and every bearing housing. The results are to be endorsed by the pump and motor manufacturers for acceptability and handed to the Engineer within 14 days from the commencement of the Defects Liability Period.

It is further required of the Contractor to perform same measurements upon each and every maintenance visit during the Defects Liability Period. The results shall be logged and shall be endorsed by the pump and motor manufacturers for acceptability and handed to the Engineer within 7 days after each maintenance site visit.

PT 12 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

PT 12.1 Design, Drawings and General

	Pay Item	*Unit*	
PT 12.1.1	Provide design drawings and design information as specified.		Sum
PT 12.1.2	Provide operating and maintenance manuals and “as built” drawings as specified.	Sum	

PT 12.2 Supply and Delivery to Site

	Pay Item	*Unit*	
PT 12.2.1	Pump and motor set complete with pump, motor, couplings, foundation steelwork and baseplate as specified.		No
PT 12.2.2	Ancillary equipment associated with pump installation as specified	Sum	

PT 12.3 Installation Work

	Pay Item	*Unit*
PT 12.3.1	Pump and motor set complete on base plate The item shall include taking delivery of materials on site, handling safeguarding, installing, painting, grouting and aligning	No
PT 12.3.2	Ancillary equipment associated with pump installation as specified	Sum

PT 12.4 Commissioning

	Pay Item	*Unit*	
PT 12.4.1	Testing and commissioning of pumps and appertaining pipework.		Sum

PT 12.5 Provision of additional spare equipment

	Pay Item	*Unit*
PT 12.5.1	Supply and delivery of specified equipment to the store facility of the Employer	Sum

ALIGNMENT CONTROL SHEET

CLIENT: ……

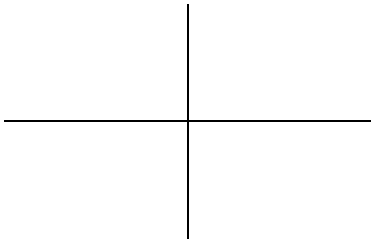
CONTRACT NO: ……

STATION: …… MACHINE TYPE:
……

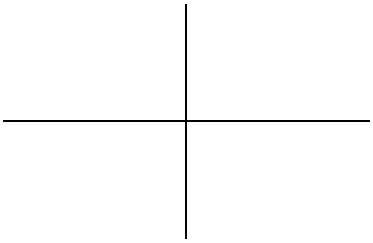
UNIT NO: …….. REF NO:
……..

ALIGNMENT BETWEEN: ……

FACE TO FACE



PERIPHERAL



METHOD OF ALIGNMENT: Dial indicator

READINGS GIVEN IN: mm

ALIGNMENT OF GEAR FITTED TO: .....

MEASUREMENTS TAKEN ON: .....

WHICH SHAFT ROTATED: .....

VIEWED FROM: .....

DISTANCE BETWEEN SHAFT ENDS: .....

WHEN SHAFT IN WHICH AXIAL POSITION: .....

REMARKS: Suction / Delivery pipes connected.
All foundation bolts tightened / loose.
Final grouting done / not done.

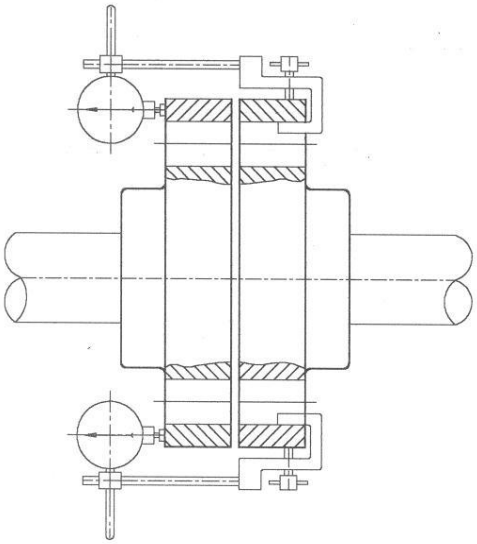
.....

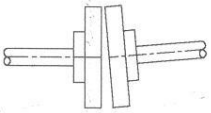
.....

Date: …….. Time:…….

……. …….

CONTRACTOR ENGINEER

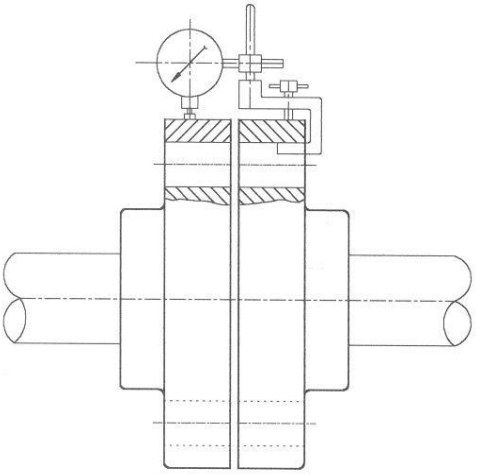


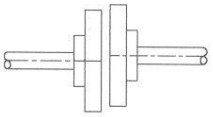


FOR DETECTING THIS TYPE OF ERROR

TO CHECK THE PARALLELISM OF AXES (ANGULAR ALIGNMENT)

FIGURE 1





FOR DETECTING THIS TYPE OF ERROR

TO CHECK INTERSECTION OF AXES (SHAFTS IN LINE AT COUPLING END)

FIGURE 2

ALLIGN

P R O F O R M A - COMMISSIONING

No	Remarks	Pump Speed	Power	Pressure Suction	Pressure Dis-charge	Temperatures (□C)			
						Pump		Motor	
		R.P.M.	Amps	[kPa]	[kPa]	D.E.B.	N.D.E.S.	D.E.B.	N.D.E.B

CONTRACT NO. :	DESCRIPTION OF CONTRACT:
DATE OF COMMISSIONING :	
COMMISSIONED BY :	PUMP MANUFACTURER :
WITNESSED BY :	PUMP MODEL :

END OF SECTION

PTG: MECHANICAL GEARBOXES

INDEX

Item Description Page No

PTG MECHANICAL GEARBOXES

PTG 1 SCOPE

This specification covers the detailed design parameters, manufacture, supply, installation, test and commissioning of complete Gearboxes. The Specification shall be read in conjunction with the Project Specification.

PTG 2 INTERPRETATIONS

PTG 2.1 Abbreviations

In this Specification the following abbreviations will apply: -

ANSI : American National Standards Institute

ASTM : American Society for Testing and Materials

BS : British Standards Institution

SANS : South African National Standards

SIS : Swedish Institute of Standards

DIN : Deutsch Industry Normen

ISO : International Organisation for Standardization

ASME : American Society of Mechanical Engineers

SAECC : South African Electrolytic Corrosion Committee

AGMA : American Gear Manufactures Association

PTG 2.2 Standards

All design standards for the mechanical gearboxes shall be subject to the latest amendments and editions of the following standard specifications: -

BS 5304 : Code of practice for safeguarding of machinery
SANS 9096-1: 1994 : Testing of welders, where applicable to the type of welding required

BS 292 Part 1: 1987 : Dimensions of ball bearings, cylindrical and spherical roller bearings

SANS 10162-4 : Structural use of Steel Part 4: The design of cold-formed stainless steel structural

SANS 1044-3 : Welding Part 3: The fusion of steel (including stainless steel): Tests for the approval of welding procedures

SANS 10044-4 : Welding Part 4: The fusion welding of steel (including austenitic

stainless steel): Tests for the approval of welders working where weld procedure approval is not required.

SANS 10064	:	The preparation of steel surfaces for coating
SANS 10111-2-1	:	Engineering Drawing Part 1: General principles Engineering Drawing Part 2: Geometric Tolerancing Section 1
SANS 10341	:	Installation and maintenance of bearings – General guidelines
SANS 1700-5-9	:	Fasteners Part 5: General requirements & material properties Section 8: Corrosion resistant stainless steel fasteners-Bolts, Screws & Studs
SANS 1700-5-10	:	Fasteners Part 5: General requirements & material properties Section 8: Corrosion resistant stainless steel fasteners-Nuts
ISO 281	:	Rolling bearings -- Dynamic load ratings and rating life
BS 4999	:	General requirements for rotating electrical machines. Specification for standard dimensions
SIS 05 59 00	:	Pictorial Surface Preparation Standards for Painting Steel Surface

PTG 2.3 General Requirements

This specification must be read in conjunction with the following specifications: -

PLV:	Colour Codes
PLQ:	Corrosion Protection

PTG 3 GEARBOXES

PTG 3.1 Design Parameters

The Tenderer shall submit with his Tender a catalogue of the make of gearbox offered and indicate how the selection of gearboxes was made.

Unless otherwise stated, the gearboxes shall be directly mounted to the motor. The gears shall be helical gears which are used in applications with high speeds, large power transmission and low noise levels.

Gear drives shall be sized to ensure that the running load peak does not exceed the endurance limits of the components.

Gearboxes shall have an efficiency of not less than 96% on two stage reduction and 95% on three stage reduction.

Simple cooling may be by convection from the gearbox casings but without assistance from cooling fins or fans. Adequate other cooling means shall be provided as applicable. The exterior of the gearbox shall be free from dust or moisture traps. Access for inspection purposes shall be allowed for in the design of the gearbox casing. Maintenance free oil lock seals on the high-speed

shafts shall be a standard design feature.

The bearing span shall be suitably selected for vertical gearbox application and shall promote shaft support for the intended application. Rigid lateral load distribution shall be by means of a standardized pinioned arrangement reducing noise and vibration.

A rigid half coupling shall be shrunk onto the output shaft of the gearbox and shall be secured by an additional keep plate and bolted connection in a recognised manner.
Substantial eye bolts shall be provided for all reasonable lifting purposes.

The gearboxes shall carry the manufacturer's identification details together with the rated shaft speeds, output power and maximum ambient operating temperature.

The gearboxes shall conform to the relevant British Standards and AGMA ratings with respect to the following requirements:

(a) The design ambient temperature shall be 45°C.

(b) The noise at 100% of the full output power and 45°C ambient shall not exceed 90 dBA as measured 1 m in distance from the equipment.

(c) The gearing shall give double the life of the bearings when subjected to similar loadings.

The design of the shaft shall be such that the following calculation shall be adhered to:

$$\frac{\text{Actual Radial Load}}{\text{Permissible Actual Radial}} + \frac{\text{Actual Axial Load}}{\text{Permissible Axial Load}} \text{ shall be} \leq 1{,}0$$

Calculations shall be submitted. Failure to do so may render the Tender invalid.
Tenderers shall state in their tenders whether external oil filters, flow and pressure switches are included in their offer.

A stainless-steel ball valve and extension drain pipe and plug shall be provided to facilitate oil changes by the maintenance staff. The termination of this drain shall be accessible from the operating platform.

PTG 3.2 Gears

The gears shall be high efficiency case hardened helical gears and rated in accordance with the AGMA Code of Practice 420.04 for continuous operation. The gears shall be manufactured from high cast iron to BS 1542 Class 220 or an equivalent standard.

Semi-hardened and subsequently machined gears will not be accepted. Pinions shall be manufactured in accordance with AGMA 390.02 Class 12.

PTG 3.3 Service Factor

The service factors indicated in the table below shall be based upon the installed power:-

Process Units	**Service Factor**

Rotating Bridges: Sedimentation & Clarifier Tanks	1.5
Rotating Scraper System: WAS Thickeners & Fermentation Tanks	1.75
Aerators	2.25
Mixers	2
Screw & Plunger (Elutriation) Pumps	2.25
Centrifugal Pumps	2
Dosing Pumps	2
Mechanical Screens	2

PTG 3.4 Bearings

Roller bearings shall be used throughout. Taper roller bearings shall be used to sustain radial and thrust loads. Bearings shall be designed for a design life in excess of the indicated hours in the table below, in accordance with ISO.281. Bearings for the output shaft shall be designed to withstand bending, up thrust, down pull and radial loads imposed by the turbine. Tenderer's shall indicate what these forces are and how these shall be accommodated.

The Contractor shall ensure the lubricant used for the initial filling and specified in the maintenance manual, is adequate for prolonged operation in ambient temperatures of up to 45°C without overheating.

Process Units	**Design Life**	**Operation**
Rotating Bridges: Sedimentation & Clarifier Tanks	L10 for 75 000	Continuous
Rotating Scraper System: WAS Thickeners & Fermentation Tanks	L10 for 75 000	Continuous
Aerators	L10for 100 000	Continuous
Mixers	L10 for 100 000	Continuous
Screw & Plunger (Elutriation) Pumps	L10 for 100 000	Continuous
Centrifugal Pumps	L10 for 100 000	Continuous
Dosing Pumps	L10 for 100 000	Continuous
Mechanical Screens	L10 for 75 000	Continuous

PTG 3.5 Lubrication

The gearboxes shall be constructed with a dry well for the low speed shaft bearing to avoid complete drainage of oil in the event of an oil seal failure. Provision to monitor the oil level must be provided. The bearing shall be grease lubricated with the greasing point easily accessible.

A stainless steel ball valve and extension drain pipe and plug shall be provided to facilitate oil changes by the maintenance staff. The termination of this drain shall be accessible from the operating platform.

PTG 3.6 Gearbox / Motor Coupling

The coupling shall be fully rated to transmit the motor full load power and tested to prove static and dynamic balance. The coupling shall accommodate small axial, lateral and angular misalignments without imposing undue stresses on the shaft and bearings. The coupling shall be enclosed in a stationery solid-plate guard to the Engineers satisfaction.

PTG 3.7 V-belt

V-belts shall be designed to withstand the high tension and high power drives, shall be long wearing, tough and trouble free. The V-belt cover shall be oil, heat and ozone resistant in order to protect the inner components. The compression section shall provide excellent gripping action and a high coefficient of friction, but shall also allow an initial start-up clutching action in order to eliminate power spikes and excessive bearing loading. The moulded cogs shall provide optimum flexibility with minimal build up of heat.

PTG 3.8 Flexible Couplings

Flexible couplings consist of two types: gear type and multiple disc/diaphragm type. The gear type uses gear teeth to make them flexible and is either grease lubricated or oil lubricated depending upon their size. Diaphragm couplings do not require any form of lubrication and the flexibility is created by a series of multiple discs or a diaphragm made of spring steel and flexes as the shaft rotate.

Misalignment of the coupling is to be prevented by proper alignment of the coupling by means of a taper gauge or set of feeler gauges and a straight edge or dial indicator. Two types of misalignments are encountered by flexible couplings: Angular misalignment and parallel misalignment. Any adjustment to correct the misalignment in one direction may affect the other direction and both the angular and parallel alignment shall be checked after each adjustment.

A periodic check of the coupling alignment shall be performed.

PTG 3.9 Housing

The gearbox shall be manufactured high strength cast iron which enables the gearbox to be used in harsh environments.

A breather designed to prevent moisture from entering the housing of the gearbox, shall be fitted to each unit supplied under this contract. Breather unit allowing continues oil spillage due to the overfilling of the gearbox shall not be accepted.

Oil level sight glasses (fully protected and UV resistant) shall be provided with levels marked for running and filling minimum and maximum positions respectively. These shall be arranged for easy viewing and shall take into account the angle of mounting.

PTG 3.10 Shaft

The Input and output shafts shall be of sufficient dimension in order to avoid excessive torsional or bending stresses and deflection. The impeller shall be secured to the shaft in such a way that it can be readily removed without any damage to the impeller and the shaft.

The shafts shall be protected by replaceable sleeves manufactured from non-corrosive material. The shaft shall be manufactured from stainless steel.

PTG 4 SPARES AND TOOLS

The Tenderer must submit on the appropriate schedule a priced list of spare parts which nit is recommended should be kept by the water treatment plant for maintenance of the plant. Spares which the Management decides to order must be manufactured simultaneously with the rest of the equipment and be subject to the same tests for dimensions, tolerances, strength, etc. All spares must be packed separately and the cases appropriately marked. All spares must be new and unused.

A full range of spares must be kept available for not less than 15 years.

Tenderers must submit a provisional price (where applicable) for a complete set of spanners, keys and tools required for the operation, adjustment and overhaul of the plant supplied. All spanners, keys and tools shall be new and unused.

PTG 5 PROOF OF MAINTENANCE

The period of maintenance will extend over a period of 12 months calculated from the Completion as defined in the Appendix. However, should a portion or all of the plant and equipment fail / or require rectification during this period, the Engineer reserves the right to extend the Period of Maintenance in respect of such portion or all of the plant and equipment for a further period of not more than 12 months calculated from the date of Commissioning of such plant and equipment after rectification

PTG 6 METAL PREPARATION AND CORROSION PROTECTION

Refer to Particular Specification G02: Corrosion Protection

PTG 6.1 Weld Protection

The corrosion protection of welds will entail pickling and passivating. The following procedure shall apply:

- Blast clean with non-metallic grit, or grind or wire brush, using dedicated grinders or stainless steel wire brushes to achieve the required smooth profile or remove scale.

- Pickle with a thixotropic paste containing 15-20% nitric acid and hydrofluoric acid, for a contact

time of 15 to 20 minutes. Rinse copiously with clean water.

- Repeat the above process, if necessary to remove all discolouration
- Passivate with 10% nitric acid, or proprietary passivating paste, for a contact time of 10 to 15 minutes, keeping the surface wet during this period.
- Rinse copiously with clean potable water until washings are neutral.
- OPERATIVES SHALL WEAR PROTECTIVE APRONS, GLOVES AND SAFETY GLASSES DURING THIS PROCEDURE. SPLASHES ONTO THE SKIN SHALL BE WASHED WITH WATER IMMEDIATELY AFTER CONTACT. A WEAK SOLUTION OF BICARBONATE SHALL BE KEPT AVAILABLE FOR NEUTRALIZATION.

The pump and nozzle assemblies shall be sandblasted and finish coated with a stainless steel pigmented epoxy paint.

PTG 7 COLOUR CODES

The standard final colour codes for equipment supplied under this Contract shall be in accordance with Particular Specification PLV: Colour Codes.

PTG 8 QUALITY MANAGEMENT (QM) AND QUALITY ASSURANCE

QM shall be categorised as ‘critical and major’ for this section of the Project.

PTG 8.1 Manufacture

Tenderers shall submit with their tender a detailed Project Quality Plan, stating how they control the flow of paperwork from commencement of the Project through final handover to the Client, a sample of their Quality Control Plan, (QCP) and Project Quality Plan, (PQP) both during the course of the Project, manufacture and finally, installation.

The successful Tenderer shall submit a QCP covering all aspects of the manufacturing process, indicating held points to allow the Engineer opportunities to evaluate the equipment for compliance to this specification.

All items of equipment shall be subject to inspections by the Engineer during design and manufacture per these QCP’s.

In general, it is anticipated that this Project shall be in accordance with the relevant ISO 9000 requirements.

PTG 8.2 Installation

The successful Tenderer shall submit a QCP covering all aspects of the installation of each item of equipment to be installed under this Project. The Engineer shall be afforded every opportunity to certain stages of completion of the installation to ascertain compliance with the Specifications and to witness the Contractor’s site activities at the Engineer’s discretion.

PTG 9 SYSTEM PERFORMANCE

Works testing

Each item of equipment shall be subject to inspection and testing prior to despatch from the works. All performance test results shall be made available to the Engineer for verification or when the QCP's require intervention or hold points for inspection.

Gearboxes shall be subject to testing under operating conditions for at least 12 hours on the test bed. All results shall be available for inspection.

Before commissioning

- Check for correct oil level in gearboxes
- Ensure all HD bolts are torqued down correctly.
- The alignment and levelling of each assembly shall be checked and the results shall be available for inspection by the Engineer.
- The electrical functions and control shall be checked by a responsible inspector prior to attempting to start any motor on this Project.

After Initial Commissioning

- Ensure all oil pumps and flow or pressure switches are functional

PTG 9.1 Before Expiry of the Defects Liability Period

The Engineer requires the Contractor to visit the site every quarter to inspect for the correct operation of the installed equipment. A report after each visit shall be submitted in writing

PTG 10 MEASUREMENT AND PAYMENT

Measurement and payment will distinguish between supply/delivery and installation/commission as well as per installation point. The respective tender rates shall cover all costs from supply to commission of each gearbox but excluding the electrical power supply and electrical cable connection.

The tendered rates or sums shall cover the cost of drawings and instructions for anything not specifically mentioned but obviously required, (e.g. all ancillaries, including all bolts, fastenings and brackets, safety guards and any work or material required for the proper installation of such equipment) to enable the equipment as described to be installed and/or function safely and correctly as specified. No claims whatsoever for extras will be allowed on the grounds that a necessary piece of equipment or a part thereof is not specifically mentioned.

Item	**Unit**
Complete Gearbox Assemblies	No

The rate tendered shall include for the design, drawings, quality assurance, materials, corrosion protection, labour, gearboxes, transport etc for the provision of the gearboxes when specified.

The electrical connections shall be done by others.

Should the Contract require the removal of existing equipment, differentiation between the various sizes of equipment to be removed shall be made. The costs shall include for the electrical disconnections, lifting equipment, labour, etc. to successfully remove the unit measured.

PTJ: VERTICAL SHAFT AERATORS

INDEX

Item Description Page No

PTJ VERTICAL SHAFT AERATORS

PTJ 1 SCOPE

This section of the specification includes the manufacture, delivery, transport, handling, protection, storage, installation, successful commissioning and upholding during the Defects Notification period of vertical shaft mechanical aerators.

PTJ 2 MATERIALS

All materials shall possess qualities adequate for the purpose for which they are to be used. All materials and properties claimed for these materials shall, unless specified otherwise in this document comply with the requirements of the most recent edition of the appropriate South African or other internationally recognised standard specification.

For each type of equipment, the Manufacturer shall indicate the materials used for each of the proposed sub-assemblies.

The equipment shall be manufactured using new prime quality materials taking into account the latest technical innovations.

All components shall have a surface finish in relation to their importance, their position and their intended purpose.

Rolled steels and all castings shall be clean and free of blisters, porosity, shrinkage, holes, cracks or other flaws that may be detrimental to their use.

PTJ 3 EQUIPMENT REQUIRED

PTJ 3.1 Aerators

Vertical shaft aerators shall be designed not only to act as surface aerators but also as an efficient circulator capable of drawing mixed liquor from the base of a cell and distributing it over the surface ensuring continuous and complete mixing.

The aerator shall be capable of operating efficiently at various depths of flow through the aeration tank and the Tenderer shall submit full details of the variation in oxygen input of the aerators offered over the full range of immersion depths for which the particular aerators were designed to operate. At maximum stated immersion depth, the motors shall draw 100% of the rated power.

Due to the variation in expected oxygen demand the aerators shall be required to operate over immersion depths that vary by at least 200 mm. A hand-operated overflow weir shall be supplied to regulate the water level in the aeration tank in order to ensure efficient oxygenation of the mixed liquor in the tank.

The Contractor shall be responsible for the design (size and configuration) of the aerator impeller, spindle shaft, gearbox and associated mechanical components required to achieve the specified oxygen transfer and mixing requirements at site conditions. Unless otherwise specified in the Project Specification, the aerator impeller and spindle shaft shall be mild steel coated with an appropriate epoxy in terms of the Specification (refer to Particular Specifications PLQ and PTV).

The aerators must be installed on the platforms as shown on the drawings. Any additions or modifications required shall be stated in the tender.

Preference will be given to aerators having a good pumping action when operating at a low rotational velocity. The tip speed of the aerator blades shall not exceed 5 m/s and any offers exceeding this shall be deemed as not complying with the specification.

After assembly of the finished aerator cone, shaft and mounting flange, but before being dispatched to Site, the assembled unit shall be dynamically balanced at twice the maximum operating speed of rotation and in addition shall be tested for centricity and correct angular attachment of cone and flange to shaft. These tests shall be done in the presence of the Engineer or his representative and at least two weeks notice shall be given to the Engineer prior to the tests. Should any offer deviate from this requirement, full details of tests to be performed shall be submitted with the tender.

The Tenderer shall supply all relevant information for the proper adjudication of the units, giving information regarding the motor rating, impeller size and shape, the blade pitch, the tip speed, the pattern of flow in the basin, shaft length and diameter as well as construction taking into full account the specified medium, the ambient temperature, the height above sea level, tank geometry and the water depth in the tank.

PTJ 3.2 Gearboxes

Gearboxes shall be designed specifically for use with vertical shaft aerators and shall be capable of withstanding bending moments, thrusts and other tensions that could result due to the long shaft between the aerator and the gearbox. All gears shall be cut, hardened and ground. Semi-hardened and subsequently machined gears will not be acceptable. The gearbox shall be provided with a removable cover in the housing to facilitate the changing of gears.

This shall be accomplished without disturbing the motor alignment or draining the lubricating oil.

The casing and support stand shall be manufactured from close-grained cast-iron and so designed that the housing assures complete protection against moisture entering of all working parts and life-long alignment of shafts, bearings and seals.

Lubrication of upper gears and bearings shall be either by splash type lubrication or through feed lines from an oil pump driven directly by one of the gear shafts and fitted with an external pressure gauge. The oil will then flow downwards to lubricate the final reduction gearing and bearings. The lubricating oil shall be retained in the housing by means of a dry well which shall encircle the output shaft to avoid complete drainage of oil in the box in the event of an oil seal failure. The lower output shaft bearing situated in the dry well shall be grease-lubricated with the grease-nipple located in a readily accessible position.

Gearboxes shall be designed for continuous operation 24 hours per day. Mechanical power ratings (AGMA) shall be not less than 2 x installed power, and the efficiency not less than 96% when the aerator is running at peak power consumption.

Worm gears will not be considered. Gearboxes shall be provided with hot dipped galvanised steel jacking bolts allowing at least 100 mm adjustment up and down.

PTJ 3.3 Shafts and Bearings

The aerator and gearbox output shafts shall be manufactured from mild steel or other similar and approved material, coated with an appropriate epoxy resistant to the corrosivity of sewage. The gearbox output shaft shall be designed so that it is of sufficient size and rigidity to positively guarantee complete isolation of gearing from the aerator shaft loads and thrust conditions.

All bearings shall be designed for a life of at least 100000 hours at a B10 rating. Proof of such rating shall accompany the tender. In addition, the bearings on the output shaft shall be capable of withstanding the resultant forces caused by the combination of radial and axial loads (imposed by the aerator) acting simultaneously, and shall be selected such that the following condition is compiled with:

$$\frac{\text{actual radial load}}{\text{permissible radial load}} + \frac{\text{actual axial load}}{\text{permissible axial load}} \leq 1$$

(where the "permissible" loads are the manufacturer's figures for 5000 hours at a B10 rating) Tenderers shall indicate what these forces are and how they are accommodated.

The output shaft shall be fitted with a standard mechanical seal closely positioned to the lower bearing, reducing shaft run-out and deflection to a minimum. The seal shall be balanced and sleeve-mounted.

The aerator shaft shall be coupled to the output shaft by means of a rigid coupling. This type of coupling shall be designed to drive by friction between the coupling faces in order to avoid the necessity to place the bolts in shear for the required coupling capacity.

Tenderers shall submit a detailed description and a clearly labelled cross sectional drawing of the aerators with their tenders as well as all other details of the aerator, motor, couplings, bearings, a catalogue of the make of gearbox and how the gearbox selection was made. **Failure to submit the above information will render the tender incomplete and as such liable to rejection.**

PTJ 3.4 Motors

The general requirements for low voltage electrical motors are included in Specification for electrical and electronic works.

PTJ 4 INSTALLATION

PTJ 4.1 Bridge Mounted Aerators

The aerators shall be mounted in such a way as to facilitate ease of maintenance. An access opening will be provided through the mounting platform adjacent to the gearbox installation for access to the aerator impeller.

PTJ 5 TESTING AND COMMISSIONING

Tenderers shall provide proof or sufficient evidence of oxygenation capacities and oxygenation efficiencies (for instance by submitting a report on performance by some recognised testing organisation) and must state clearly how aerator performance was assessed. Failure to submit this information will lead to the rejection of the tender on the grounds of incompleteness.

On completion of installation, the aerators shall be thoroughly tested at minimum and maximum water level for speed of rotation, energy input, resistance to bending of shaft and overall efficient operation of the complete mechanical and electrical system. The Contractor shall provide free of charge for testing purposes a kW meter to measure the energy absorbed by each aerator.

Oxygenation efficiency where called for in the Technical Schedules shall be expressed as kilograms oxygenation capacity per kilowatt-hour i.e., as the mass of oxygen measured in kilograms which the aerator can introduce over a period into a body of completely de-oxygenated water divided by the power input to the motor over the same period, measured in kilowatt-hours at Standard Conditions of 760 mm Hg and 20°C.

In situ oxygenation efficiency tests may be conducted once the plant is operating effectively and Tenderers shall price the Provisional Item in the Schedule of Quantities for conducting such tests.

The tests shall utilise the steady state method as follows:

In the aeration of activated sludge mixed liquor, at a temperature of T°C, the following relationship holds:

$$\frac{dC}{dt} = K_{(T)} (C_{s(T)} - C) - r$$

where $\frac{dC}{dt}$ = rate of change of oxygen concentration (mg/l/hr)

$K_{(T)}$ = oxygen transfer co-efficient in mixed liquor at T°C (hr^{-1})

$C_{s(T)}$ = saturation concentration of oxygen in mixed liquor at T°C and at the ambient barometric pressure (mg/l)

r = oxygen uptake rate of the mixed liquor (mg/l/hr)

If it is assumed that, under normal operating conditions, a state of equilibrium exists in the system then

$$\frac{dC}{dt} = 0,$$

and $K_{(T)} (C_{s(T)} - C) = r$

i.e. $$K_{(T)} = \frac{r}{(Cs(T) - C)} \quad \text{.....(1)}$$

The value of $C_{s(T)}$ to be used in equation (1) is calculated from the following relationship:

$$C_{s(T)} = \frac{468 - 2{,}65S}{31{,}6 + T} \times \frac{(P - pw)}{(760 - pw)} \quad \text{.....(2)}$$

where $C_{s(T)}$ = saturation concentration of oxygen in mixed liquor at T°C and P mm pressure (mg/l)

S = dissolved solids in mixed liquor (parts per 1 000)

T = temperature of mixed liquor (°C)

P = barometric pressure (mm Hg)

pw = saturation vapour pressure of water at T°C (mm Hg)

In equation (1), r and C can be determined, and $C_{s(T)}$ can be obtained from equation (2) above, so that the value of $K_{(T)}$ can be calculated. It's value of 20°C can then be obtained by the use of the following relationship:

$$K_{(T)} = K_{(20)} \times 1{,}02^{(T-20)}$$

i.e. $$K_{(20)} = K_{(T)} \times 1{,}02^{(20-T)}$$

From the value of $K_{(20)}$, the in situ oxygenation capacity of the aeration system in a particular basin, as defined above, is calculated as follows.

$$OC = K_{(20)} .C_{s(20)} .V \times 10^{-3} \text{ kg/hr}$$

where $C_{s(20)}$ = saturation concentration of oxygen in mixed liquor containing 1000 mg/l dissolved solids, at 20°C and 760 mm pressure (mg/l)

= 9,02 mg/l

V = volume of mixed liquor in basin under consideration (m^3)

The actual test procedure shall be proposed by the Contractor and must meet with approval from the Engineer before it is implemented.

Nevertheless, the following points shall be incorporated in the test procedure:

- the Contractor shall provide four dissolved oxygen meters, of approved make, all standardised and calibrated in accordance with the instructions supplied by the manufacturers.
- the Contractor shall provide all equipment required for conducting the oxygen uptake rate tests.
- the positions of the D.O. probes shall be to the satisfaction of the Engineer.
- the Contractor shall provide all equipment required to assess the power consumption of the aerators during the steady state oxygenation capacity test.
- at least three consecutive tests shall be conducted.
- the Contractor shall provide all test equipment required for assessing the constants to enable the in situ oxygenation efficiencies to be related to Standard Conditions.

Should doubts exist regarding the efficiency of the aerators after installation, the SABS will be instructed to carry out the necessary efficiency tests at the cost of the Contractor. If the oxygenation capacity at the aerators should prove to be less than specified, the Contractor shall, entirely at his own cost, improve the oxygenation capacity to the

capacity specified. If these improvements result in larger aerators with greater electricity demand, the Employer will recover once-only from the Contractor, a sum of money which shall be determined by the cost of the additional electricity required by the aerators and will be calculated as a capitalised sum, taking into account the present cost of electricity, inflation, price rises, interest rates for state loans and redemption period of the loan.

PTJ 6 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

PTJ 6.1 Design, Drawings and General

	Pay Item	***Unit***
PTJ 6.1.1	Provide design drawings and design information as specified.	Sum

PTJ 6.2 Supply and Delivery to Site

	Pay Item	***Unit***
PTJ 6.2.1	Bridge mounted fixed speed vertical shaft mechanical aerator complete with motor, gearbox, fasteners etc.	No

PTJ 6.3 Installation Work

	Pay Item	***Unit***
PTJ 6.3.1	Bridge mounted vertical aerator and motor set complete on base plate The item shall include taking delivery of materials on site, handling safeguarding, installing, painting, fixing, grouting and aligning	No

PTJ 6.4 Commissioning

	Pay Item	***Unit***
PTJ 6.4.1	Testing and commissioning of mechanical aerator	No

PTJ 6.5 In situ oxygenation efficiency tests

	Pay Item	***Unit***
PTJ 6.5.1	Execution of in situ performance test if instructed by Engineer	Rate only

END OF SECTION

PTMa: MECHANICAL MIXERS

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Item Description Page No

PTMAa MECHANICAL SHAFT MIXERS

PTMAa 1 SCOPE

This section of the specification includes the manufacture, delivery, transport, handling, protection, storage, installation, successful commissioning and upholding during the Defects Notification Period of mechanical Mixers.

PTMAa 2 MATERIALS

Construction materials shall be either steel protected against corrosion as specified or else inert corrosion proof materials.

All materials shall possess qualities adequate for the purpose for which they are to be used. All materials and properties claimed for these materials shall, unless specified otherwise in this document, comply with the requirements of the most recent edition of the appropriate South African or other internationally recognised standard specification.

For each type of equipment, the Manufacturer shall indicate the materials used for each of the proposed sub-assemblies.

The equipment shall be manufactured using new prime quality materials taking into account the latest technical innovations.

All components shall have a surface finish in relation to their importance, their position and their intended purpose.

Rolled steels and all castings shall be clean and free of blisters, porosity, shrinkage, holes, cracks or other flaws that may be detrimental to their use.

PTMa 3 EQUIPMENT REQUIRED

PTMa 3.1 Mixers

Mechanical Mixers are required to mix the contents of the anaerobic (if applicable) and anoxic sections of the reactor. The Mixers may either be of the platform mounted vertical shaft type, or submersible. The Mixers are required to keep the organic solids, with a concentration which could vary between 2000 and 10000 mg/l in suspension as homogeneously as possible.

The introduction of oxygen through surface agitation shall be minimised while gently mixing the contents of the tanks. Should any baffles or other appurtances be required, tendered prices shall make provision for this. The horizontal zones of maximum turbulence should preferably be as close to the floor of the tank as possible.

The Contractor shall be responsible for the design (size and configuration) of the stirrer impeller, spindle shaft, gearbox and associated mechanical components needed to achieve the mixing requirements at site conditions. Unless otherwise specified in the Project Specification, the stirrer impeller and spindle shaft shall be mild steel coated with an appropriate epoxy in terms of the Specification (refer to Particular Specifications PLQ and PTV).

The impeller shall be selected such that good pumping action is obtained without any vortex action and Tenderers shall state what pumping action is expected from his equipment at all speeds.

No visible sludge build-up in any section of the tanks will be allowed.

Six random samples will be taken in a specific tank and the individual samples shall have a solid content within 20% of the mean of the six samples.

PTMa 3.2 Gearboxes and Bearings

Gearboxes shall be selected for continuous operation with a power service factor of not less than 2,0 based on installed power. Tenderers shall provide a catalogue of the make of gearbox offered and provide calculations to indicate how the selection of gearbox was made. *Refer to Particular Specification PTG.*

Worm gears will not be considered.

All gears and pinions shall be hardened and ground after cutting.

Gearboxes shall be of a type specifically designed to accommodate bending caused by long overhang of the shaft of the stirrer. Bending of the shaft shall not damage the driving gears or the bearings.

All bearings shall be designed for a life of 100000 hours at a B10 rating. Proof of such rating shall accompany the tender. In addition, the bearings on the output shaft shall be capable of withstanding the resultant forces caused by the combination of radial and axial loads (imposed by the stirrer) acting simultaneously, and shall be selected such that the following condition is complied with:

$$\frac{\text{Actual radial load}}{\text{permissible radial load}} + \frac{\text{Actual axial load}}{\text{permissible axial load}}$$

is equal or less than 1 (where the "permissible" loads are the manufacturer's figures for 5000 hours at a B10 rating). Tenderers shall indicate what these forces are and how they are accommodated.

The gearbox casings shall be designed to prevent moisture from entering. A dry well for the output shaft lower bearing shall be provided to avoid complete drainage of oil in the box in the event of an oil seal failure. The gearbox casings shall be made of close grained cast iron.

Installed motor sizes shall make allowance for gearbox efficiencies and a 10% margin on motor power. Impellers shall be selected to operate preferably in the range of 20 - 25 rpm with a tip speed not exceeding 2 m/s.

Where belt drives are used in the drive train, allowance shall be made for the additional power loss when calculating the minimum size of motor required.

The Tenderer shall supply all relevant information for the proper adjudication of the units, giving information regarding the impeller size and shape, the blade pitch, the tip speed, the pattern of flow in the basin, shaft length and diameter as well as construction taking into full account the specified medium, the ambient temperature, the height above sea level, tank geometry and the water depth in the tank.

PTMa 3.3 Motors

The general requirements for low voltage electrical motors are included in the portion Specification (different volume in some cases) for the supply and installation of electrical and electronic equipment.

PTMa 4 INSTALLATION

PTMa 4.1 Bridge Mounted Mixers

The stirrer shall be mounted in such a way as to facilitate ease of maintenance.

Stainless steel anchor bolts shall be used to fix the mixer to the mounting platform.

PTMa 4.2 Submersible Mixers

Submersible Mixers will be required to be serviced, repaired or refurbished and reinstalled.

PTMa 5 TESTING AND COMMISSIONING

On completion of installation, the Mixers shall be thoroughly tested at minimum and maximum water level for speed of rotation, energy input, resistance to bending of shaft and overall efficient operation of the complete mechanical and electrical system. The Contractor shall provide free of charge for testing purposes a kW meter to measure the energy absorbed by each mixer. If the mixers are unable to satisfy the above-mentioned

criteria, the Contractor shall alter the mixers or add more mixers to satisfy the criteria at his own expense.

PTMa 6 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

PTMa 6.1 Design, Drawings and General

	Pay Item	***Unit***
PTMa 6.1.1	Provide design drawings and design information as specified.	Sum

PTMa 6.2 Supply and Delivery to Site

	Pay Item	***Unit***
PTMa 6.2.1	Bridge mounted fixed speed vertical shaft mechanical stirrer complete with motor, gearbox, fasteners etc.	No

PTMa 6.3 Installation Work

	Pay Item	***Unit***
PTMa 6.3.1	Bridge mounted vertical stirrer and motor set complete on base plate The item shall include taking delivery of materials on site, handling safeguarding, installing, painting, fixing, grouting and aligning	No

PTMa 6.4 Commissioning

	Pay Item	***Unit***
PTMa 6.4.1	Testing and commissioning of mechanical stirrer	No

END OF SECTION

PTP : HOISTING EQUIPMENT

INDEX

PTP HOISTING EQUIPMENT

PTP 1 ELECTRICAL CRANES

The cranes shall each comprise of an appropriate girder crane, traversing hoist, lifting rope for the main hook, control pendant, together with all necessary hoisting, travelling and traversing equipment and cable systems.

The hoisting, travelling and traversing motions shall be electrically operated by separate drives.

The hoist will have at least two falls of rope and will be supplied with a heavy duty rope guide to ensure close and accurate rope lay on the drum. The rope lay on the drum will be such as to ensure the maximum distance between the ropes on the drum at the point of maximum reach of the hook.

Each crane will be controlled by means of a single pendant fitted to the hoist – the cord to the pendant to be of sufficient length to control the hoist from the lowest floor level in the structure.

PTP 2 CHAIN-OPERATED CRANES

The chain operated cranes will run on a single straight traverse beam secured to the underside of the concrete beams at the chlorine store and the concrete roof at Montana pump station and will be chain-operated for lifting and travel. The tendered rate must include for the complete unit i.e. the beam, travelling trolley, hook, chain, chainbox and stop ends. The chain shall be hot dip galvanised.

PTP 3 DESIGN AND RATED CAPACITY

The crane shall be designed to comply with the latest amendments of BS466;1984, BS2573:Part 1:1983 and BS2573:Part 2:1980. The crane shall be suitable in all respects for service in the pump stations and workshop where it will be used for the installation and maintenance of electric-motor-driven pump sets assembled to close tolerances. Provision shall be made for such duties to be performed safely and effectively. The group classification of the mechanism shall be not lower than M3- Maintenance duty.

PTP 4 STRUCTURAL STEELWORK

The permissible stresses and design of the crane structures shall comply with Clause 6.2 of BS466:1984 and BS2573:Part 1:1983.

The crane shall be of approved design giving stiffness in all directions, and suitable gusset plate connections shall be provided where the carriages are secured to the crawl beam members to prevent any distortion or cross-whipping while travelling. The

vertical deflections caused by the maximum safe working load and the test load suspended from the centre of the span shall be stated in the Technical Schedules.

Double traversing rails of adequate strength shall be securely fixed on each crawl beam.

PTP 5 END CARRIAGES

The end carriages shall be of approved design and stiffness in accordance with BS466:1984 and BS2573:Part 1:1983 and suspended via twin set rail wheels from the crawl beams. Provision for easily accessible lubrication shall be made and the type of bearing shall be stated by the Tenderer. Wheel bearings shall be removable. The end carriage shall be provided with suitable buffers to engage with the end stops to the crawl beams.

Steel tyred wheels shall have cast iron or cast steel centres. Tyres shall be supplied in accordance with BS3037.

PTP 6 TRAVERSING HOIST

The framework of the hoist shall provide stiffness in all directions and full particulars of the mechanism shall be submitted for approval. The hoist gear box shall be totally enclosed and arranged for oil bath lubrication. Preference will be given to a centralized group of nipples for grease gun lubrication of all journal bearings.

The hoisting gear shall be so arranged that the main load is evenly distributed on the hoist wheel bearings to avoid distortion due to uneven loading.

Wheel bearings shall be renewable

PTP 7 DRIVES

Machine cut gears of high carbon steel shall be used throughout.

The Contractor shall guarantee that the drive between the hoisting and lowering motor and the drum is non-reversible under the mass of the rated maximum load.

PTP 8 HOISTING DRUMS

The hoisting drums shall be of robust manufacture in fabricated mild steel. The length of the drums shall be capable of taking the full amount of rope without overlapping. At least three full turns of rope shall remain on the drum when the associated hook is in its lowest position. The diameter of the drums and the depth of the machined spiral grooves shall conform with the requirements set out in BS466:1984 for class 4 cranes.

PTP 9 BRAKES

A brake of approved electrical-mechanical type shall be provided on each of the hoisting and lowering systems of the crane and hoist. Each brake shall be so designed that in the event of failure of the electrical supply it shall arrest and hold any load up to and including the test load at any position of the lift. The brake is to be electrically operated and shall be released as soon as the supply is switched on to the hoisting motor. Immediately the supply is switched off, or in the event of a power failure, the brake shall be applied instantly. The brake shall bring the motion, with or without load, to rest without shock.

An electrically operated brake similar to that on the hoist mechanism shall also be provided on the travelling and traversing motions of the crane and hoist.

Braking mechanisms shall comply with BS466:1984 and full particulars shall be submitted with the tender.

PTP 10 ROPES

All crane ropes shall be of special flexible steel wire complying with BS302, BS621 and ISO2408. The length of the ropes supplied shall permit the hoisting conditions to floor levels shown on the drawings.

Duplicate copies of certificates of test and inspection for each rope shall be supplied by the Contractor giving the results of every examination and the nature of the tests carried out.

Particulars of the ropes shall be given in the Technical Schedules, Series 21.

PTP 11 FALL BLOCKS AND HOOKS

The fall blocks shall be of mild steel construction with approved sheaves. The grooves shall be machined in accordance with BS466:1984. The sheaves shall be provided with bronze bushings bored to fit the centre pin and provision shall be made for the proper lubrication of these bearings.

The proportions of the fall blocks and the suspension arrangements shall be such as to ensure that twisting of the blocks does not occur.

The hooks shall be of the swivelling type with safety latch mounted on ball bearings and the material and design shall comply with BS2903 and BS3017 as applicable.

PTP 12 GANTRY I-BEAMS

The gantry rails shall be supplied and installed by the Contractor in accordance with BS 466:1984 Appendix F.

The gantry I-section shall be levelled by means of packing plates between the portal frame and the bracket if required.

The gantry beams have been designed for bending moments and shear loads generated by the following load conditions. Actual load conditions of the proposed crane shall be stated in the Technical Schedules.

Fixed endstops shall be supplied, installed and positioned at each end of the gantry I-beams and a suitable mechanism shall be fixed to the gantry I-beams to ensure that the limit switches on the crane are actuated to stop the long travel motion of the crane prior to any contact with the fixed endstops.

PTP 13 ERECTION AND SITE TESTING

After installation at site the crane will be subjected to the tests specified in clauses 44.2, 44.3 and 44.4 of BS466:1984.

The overload, deflection and performance tests specified in clauses 44.5, 44.6 and 44.7 of BS466:1984 may be carried out either at the Contractor's works or on site. In either case the vertical deflection of the main girders shall be measured to provide compliance with BS466:1984 clause 7.

If the overload tests are to be carried out on site the Contractor shall include for the supply, transport to and from the site, offloading and re-loading of all test weights, cradles and slings, etc, necessary to carry out the tests and the requisite instruments for measuring the deflection.

PTP 14 PAINTING

PTP 14.1 Preparation of surfaces

No paint shall be applied before the work has been inspected and approved; cleaning of metal surfaces prior to painting shall be approved by the Engineer's Representative.

All surfaces except those of machined parts shall be grit or shot blasted in accordance with SANS Specification 10064 : 2005 Clause 2.3.3 followed by vacuum or air cleaning to render a white metal finish equivalent to ASA 2½ of Swedish Standard SIS05 5900-1967.

PTP 14.2 Painting

All steelwork shall be painted at the manufacturers factory with one coat of Plascon zinc chromate primer followed by one coat of Plascon Universal Undercoat and finally one finishing coat of Plascon "Golden Yellow" Universal Enamel SANS colour number B49.

Where surfaces are to be in permanent contact they shall receive one coat of primer and the surfaces brought together and jointed whilst the paint is still wet. All shafts, gears, roller faces etc shall be suitably protected against corrosion.

All surfaces of metal work which cannot be painted in situ shall be thoroughly cleaned before assembly and painted to the satisfaction of the Engineer. The Contractor shall take special care that all internal parts are cleaned thoroughly and wire brushed where necessary before they are erected. Materials stored on site shall be maintained in the same condition as despatched.

After erection all bright parts shall be cleaned and polished and the finished coat of paint shall be touched up where required.

Other items of equipment including electrical panels, isolating switches, etc shall be painted in colours to be decided by the Engineer.

During site painting of the equipment the Contractor shall make provision for the protection of adjacent plant, buildings and floor against damage and the plant and floors shall be covered with protective sheets.

PTP 15 ELECTRICAL EQUIPMENT

PTP 15.1 General Requirements

The electrical supply for the crane will be from a 400 V, 3-phase, 4-wire, 50 Hz RWBR phase rotation system with the star point of the main supply transformer connected to earth and all components shall be suitable for operation at 400 V + 10% - 20%.

The crane motors and brake mechanisms shall be operated by contactors and all motions shall be controlled from a pendant control. The mass of the pendant control shall not be supported by the electric cable; a suitable steel rope shall be provided to support the pendant.

All the electrical equipment, including the down shop conductor system control panel, cabling, wall mounted isolator, pendant controller for the crane shall be supplied. A 400 V, 3 phase, 4 wire power supply cable, protected by a circuit breaker to the main isolator for the crane will be supplied under a separate contract.

The main power supply to the crane through a three-pole circuit breaker supplied and a main isolator for the crane will be supplied under a separate contract. The Contractor shall supply and install the cable between the collector system and the isolator.

All control panels, junction boxes etc shall be located such that safe access is possible irrespective of where the crane is positioned or without having to erect special platforms, scaffolds etc.

PTP 15.2 Motors, Brake Solenoids and Contractors

All motors shall be totally-enclosed fan-cooled IP 55 squirrel cage induction type and shall conform to SANS IEC 34. All motors, unless otherwise approved, shall be fitted with ball or roller bearings. The motors shall be rated for at least 240 starts per hour at a design altitude of 1 800 m above mean sea level, and shall be adequately rated for the duty.

All brake solenoids shall be adequately rated to prevent burn-out under the most arduous operating conditions and if it is considered necessary shall be provided with protective cut-outs connected in the appropriate motor control circuit.

Each motor shall be controlled by a AC4 crane duty rated reversing contactor comprising two 3-phase air-break contactors mechanically and electrically interlocked to prevent simultaneous closing. Thermal time-delay overload elements shall be fitted in each phase for normal motor overload protection. Fault protection shall be provided by means of one suitably rated MCCB for each motor.

Each motor control circuit shall be provided with a separate control miniature circuit breaker and link so that individual control circuits can be isolated for test purposes.

The tender shall include full details of the contactors and thermal overloads offered which shall be suitable for AC 4 crane duty.

PTP 15.3 Pendant Controller

Control of all motions of the crane shall be by means of a pushbutton pendant controller. The control system shall operate on a nominal 110 V single-phase, centre earthed supply derived from a 400 V/110 V double wound transformer.

Individual control pushbuttons shall be provided for each direction of the long travel and cross travel motions of the crane; these buttons shall be held pressed to maintain the required motion.

Individual control pushbuttons shall be provided for each of the hoisting and lowering motions of the crane; the appropriate button shall be held pressed while the crane is lowering or hoisting.

The pushbutton pendant controller shall move independently of the crab, and shall be operated in any position along the span of the crane. The crane shall be operated from the floor level. Full particulars of the method of supporting and moving the pendant controller to any position and the method of adjusting the level of the pendant controller shall be stated in Schedule IV.

An emergency on/off switch shall be provided on the controller to break the control circuits of the crane in the event of any pushbutton sticking.

Full details of the pushbutton pendant controller shall be submitted with the tender.

PTP 15.4 Control Buttons Or Switches

The control pushbuttons for the crane shall be of substantial heavy duty construction and shall be of the best quality that can be obtained for the purpose; sample of the type of pushbutton it is proposed to use shall be submitted to the Engineer for approval.

PTP 15.5 Control Locking Arrangements

A detachable locking key shall be provided for the crane controller and it shall not be possible to operate any of the crane motions unless the key is inserted; the key may be incorporated with the emergency switch specified in subclause TS 2.3. An indicating light shall be provided on the controller to indicate only when the crane control supply is switched on.

PTP 15.6 Control Panels

The crane control panels shall be manufactured from mild steel and shall form a robust enclosure affording IP 55 degree of protection. The panels shall be painted light orange, colour B26 to SANS-1091. The control panels shall be positioned so as to permit safe access from the walkway on the main bridge and without having to position the crane in any special position.

The main circuit breaker on the panel shall be fitted with a door mounted operator that shall be mechanically interlocked such that it shall only be possible to open the door if the main circuit breaker is in the off position.

PTP 15.7 Limit Switches

Limit switches shall be provided for limiting the hoisting, lowering, travelling and traversing motions of the crane. These limit switches shall operate to cut out the appropriate contactor and apply the brakes. Operation of the limit switches shall not necessitate hand resetting of any equipment on the crabs or bridges. An additional limit switch which shall be operated by the fall block lifting a pendant weight shall be provided on the hoist of the crane and shall be set out at the ultimate hoisting position.

One rope fall of the hoist shall be fitted with a suitably rated load limiting switch of the "Liftco" or equivalent pattern. The switch shall be installed in the crane manufacturer's works and set during load testing to trip the hoist mechanism at a load not exceeding 110% of the specified load. The Engineer's Representative shall witness the setting of the switches.

All limit switches shall be mounted on the crane, shall be of substantial heavy duty construction and of the best quality that can be obtained. Details of all limit switches shall be submitted to the Engineer for approval.

The operating ramps for the limit switches for the travelling motion of the crane shall be installed at the ends of the building in positions to be agreed with the Engineer.

PTP 15.8 Down Shop Conductors

An enclosed busbar collector system shall be supplied for the long travel motions of the crane and shall include the supply and erection of collectors and brackets complete with supports from the crane and gantry rails and the drilling of the fixing bolt holes.

Adequate arrangements shall be incorporated for easy maintenance; the Tenderer shall state in the Price Schedule the price adjustment required for the supply of a Vahle PVC-enclosed busbar collector system as an alternative to any other make which may offered. A platform shall be provided to give access to the collectors on the down shop conductors.

The down shop conductor cross-sectional area shall be suitable for the supply connection at one end and a volt drop of less than 2 per cent when the crane is drawing maximum load current at the remote end. The enclosed busbar systems shall be designed and constructed to ensure the minimum amount of maintenance and full details of the down shop conductor systems offered shall be submitted with the tender. See Schedule IV.

The length of the down shop conductor system to be provided shall be determined from the long travel distance given.

The Contractor shall be responsible for the installation and proper alignment of the entire busbar system for both the travelling and traversing motions.

Festoon systems are acceptable for :-
Cross travel motions on the crane.

The independent pendant travel on the crane.

PTP 15.9 Wiring, Terminals and Labels

The terminals and wiring shall be totally enclosed by means of galvanized metal conduit and covers or by other approved means and there shall be no possibility of oil coming into contact with any insulation unless such insulation is of approved oil-resisting type.

Only PVCPVCSWAPVC cable will be considered as an alternative to conduit-protected wiring.

Power wiring shall be carried out in standard phase colours, red, yellow, blue and black for neutral.

All power wiring shall be terminated onto bolted terminals complete with washers, nuts and locknuts and separated by flash barriers insulated for 660 V.

All control wiring shall be terminated by means of approved crimped lugs onto approved klippon or equivalent spring loaded terminals suitable for 6 mm^2 conductors.

All power wiring terminals shall be grouped together and the various terminal groups shall be identified by means of engraved sandwich board labels attached by means of cheese-head brass screws.

All relays, contractors etc, shall be identified by similar labels as specified above.

All control circuit wiring shall be numbered at all terminal points with engraved interlocking ferrules and these numbers shall appear on all schematic and wiring diagrams.

Unless otherwise approved, all secondary wiring shall be carried out in 660 V grade 2,5 mm^2 PVC insulated multi-stranded copper conductor with a minimum of 7 strands per conductor bearing the mark of approval of the South African Bureau of Standards.

PTP 15.10 Earthing

The crane rails shall be electrically bonded together with 35 mm^2 minimum stranded copper conductor and an additional conductor shall be supplied as part of the down shop conductor system exclusively for earth continuity.

The crane earthing system shall be continuous and shall terminate at a point adjacent to the isolator specified.

On no account shall cable armouring be used for earth continuity.

PTP 15.11 Insulation

All wiring shall be insulated to a level suitable for operation at 600 V. All wiring will be pressure-tested by means of a 1 000 V megger before the equipment is put into service.

PTP 15.12 Schematic and Wiring Diagrams

Complete single line and schematic diagrams of all main and control circuits for the crane and separate hoist shall be submitted to the Engineer for approval within four weeks after the contract is placed. The schematic diagrams shall each include a detailed list of components showing type, make, rating, etc.

Manufacture of any equipment shall not be commenced until such time as approval has been obtained for the schematic diagrams. The single line diagram shall show the motor ratings.

Symbols used in electrical drawings and schematics shall be drawn to NRS Specification 002-1990 requirements.

Final approved schematic diagrams of all main and control circuits of the crane and hoist shall be supplied. The Taking-Over Certificate will not be issued until all such diagrams have been received.

A photographic sepia copy of the approved schematic diagram shall be fixed to the inside of the doors of the cabinet housing the control equipment of the crane. The photograph shall be of adequate size to permit all details to be easily read, shall be non-fading and shall be covered by a clear perspex sheet.

PTP 15.13 Detail Electrical Equipment

The Engineer shall approve the make and type of motors, contractors, pushbuttons and collector systems, type of wiring, construction and arrangement of the control panels, etc, before any items are ordered from sub-contractors or their manufacture commenced.

PTP 15.14 Electrical Tests on Site

All apparatus shall pass such tests on site as are required by the Engineer to prove compliance with the specification independently of any tests which may have been carried out at the manufacturer's works. In particular all electrical pressure tests made at the manufacturer's works shall be repeated on site.

The tests shall include, but shall not be limited to the following :-

(a) Megger testing of all cables and wiring using a 1 000 V Megger.

(b) All motors and brakes shall be meggered using a 1 000 V Megger.

(c) All safety devices shall be set and tested for functionality.

(d) Down shop conductors shall be checked for alignment and contact.

(e) Access to all control panels shall be checked for ease of access and safety.

END OF SECTION

PTQ: PRIMARY SEWAGE TREATMENT EQUIPMENT

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Item **Description** **Page No**

PTQ PRIMARY SEWAGE TREATMENT EQUIPMENT

PTQ 1 HANDRAKED SCREEN

Typical details of the channels are shown on the drawings in which an inclined hand-raked screen is required in accordance with the Project Specification.

The screen bars shall be fabricated from mild steel and shall be 12 mm wide section by 60 mm deep as shown on the drawing. The clear openings between the screen bars at the narrowest point and the angle of inclination are specified in the Project Specification or relevant drawing. The screen bars shall be adequately supported with mild steel angles as shown on the drawings.

The entire assembly shall be hot-dip galvanised fabricated in accordance with SANS 763 - 1977.

Stainless steel bolts shall be used to fix the screen in position.

PTQ 2 COARSE MECHANICALLY RAKED SCREEN

PTQ 2.1 General Description

Typical details of the channels are shown on the drawings in which the screen of a vertical or near vertical screen rack with a rake mechanism cleaning the rack is required in accordance with the Project Specification. The rack shall consist of 50 mm x 12 mm steel bars spaced so that it has 20 mm clear openings, and the teeth of the mechanical rake shall remove screenings from the bottom of the screen to the top of the rack. A suitable cleaning mechanism shall dislodge the screenings near the top of the rack and channel the dislodged screenings onto a conveyor.

The Tenderer shall submit full details with his tender regarding the plant offered and shall outline any special requirements re anchor bolts etc.

The screen shall be enclosed in stainless steel Grade 304 sheeting, supported by a galvanised steel framework. Inspection doors shall be provided to inspect moving parts.

PTQ 2.2 Electrical Requirements

The screen shall be equipped with its own weatherproof switch and operating panel, mounted in close proximity to the equipment.

The control equipment should make it possible to change cycle time, control water level differential, protect against overload, under voltage, single phasing etc and also have a manual override with start/stop pushbuttons and automatic selector switches.

The electrical supply and cable to the panel will form the subject of another tender and all electrical supply and cabling from the panel to the screen shall form part of this tender.

PTQ 3 ELEVATED FINE MECHANICAL RAKED SCREEN

PTQ 3.1 General Description

Typical details of the sump in which the screen of a vertical or near vertical screen rack with a rake mechanism cleaning the rack is shown on the drawings. The rack shall consist of 20 mm x 3 mm steel bars spaced so that it has 10 mm clear openings, and the teeth of the mechanical rake shall move screenings from the bottom of the screen to the top of the rack. A suitable cleaning mechanism shall dislodge the screenings near the top of the rack and channel the dislodged screenings onto a conveyor.

The Contractor shall submit full details with his tender regarding the plant offered and shall outline any special requirements re anchor bolts etc.

The screen shall be enclosed in stainless steel Grade 304 sheeting, supported by a galvanised steel framework. Inspection doors shall be provided to inspect moving parts.

PTQ 3.2 Automatic Operation

Each screen shall be equipped with its own weatherproof switch panel as specified mounted in close proximity to the equipment and comprising time switches (adjustable anywhere between zero and 60 minutes for selection of frequency of cycles and adjustable between zero and 30 minutes for selection of duration of operation per cycle), water differential control equipment, starter with overload and single phasing protection (if applicable), stop/start pushbuttons for manual operation as an alternative to automatic operation.

PTQ 3.3 Electrical Installation

The supply and installation of a power cable (up to the local distribution/control panel) will form the subject of another contract and where applicable, will be carried out in accordance with the requirements of the Contractor under this section of the Contract.

PTQ 4 CONVEYOR BELT

PTQ 4.1 General Description

The screenings from the coarse mechanical, the coarse handraked and the elevated fine screen will be deposited on the conveyor if required in terms of the Contract. The conveyor must run continuously next to the above and transport the solids into a hopper. The conveyor shall have a belt ± 450 mm wide which shall be shaped by rollers to "hold" the screenings on the belt and discharge it at the one end.

The belts shall operate at a speed of ± 5,0 m/minute and shall be provided with a scraper at the delivery side to scrape the solids into a hopper.

Provision must be made to tension or slacken the belt if it should stretch or it becomes necessary to remove the belt.

The framework supporting the conveyor shall be manufactured from mild steel and then be galvanised. Concrete plinths shall support the conveyor framework at both ends. Holding down bolts shall be supplied with the framework, and the mechanical tenderer shall be responsible to set the conveyor to exact lines and levels, whereafter the final grouting will be done by the civil engineering contractor.

PTQ 4.2 Automatic Operation

The conveyor shall be interlocked with the screens; shall start up together with the screens and shall stop approximately 1 minute after the screens have stopped.

PTQ 4.3 Electrical Requirements

The conveyor shall be equipped with its own weather proof switch and operating panel, mounted in close proximity to the equipment.

The control equipment should make possible to stop/start the conveyor and protect it against overload, under voltage, single phasing etc.

The electrical supply and cable up to the local distribution/control panels will form the subject of another tender, and where applicable will be carried out in accordance with the requirements of the Contractor under this Contract.

Trip pull wires complete with supports and switches shall be provided and installed along the entire length of the conveyor belts, all in accordance with the requirements of the Machinery and Occupational Safety Act, 1983. Connecting up of the pull wire switches shall be carried out by others.

PTQ 5 SCREENINGS COMPACTOR

PTQ 5.1 General

The screenings from the coarse and fine screens, both mechanically and/or manually raked, will be discharged onto a conveyor (either belt of centreless spriral conveyor) and the specified conveyor will transport the screenings into a hopper, immediately above the screw compactor. The hopper shall form part of the screenings compactor and shall be bolted to the press body of the compactor.

The body of the receiving hopper and screw compactor will be manufactured of grade 304L stainless steel.

The press must be capable of pressing the solids from the screens with a moisture content of 85 to 90% to at least 80% dryness.

The press must be of the screw type. Holes or slots must be provided for the drainage of the liquid squeezed from the press. Water sprays shall also be provided above the screw to ensure that organic matter in the screenings is washed out and returned to the channel upstream of the screens. The return water pipework forms part of this contract. It is anticipated that the screenings compactor will be installed on a concrete plinth at the level shown on the drawings.

The hopper will feed the screenings directly into the press chamber and it should not be necessary for an operator to feed or handle screenings.

PTQ 5.2 Construction

The press shall be of robust construction. The chute shall have a funnel like top extending to at least 800 mm above the screw compartment to ensure clean operation. The exit chute shall be manufactured in stainless steel grade 304 of sturdy construction to allow for some rough handling. A water discharge trough shall be provided along the bottom of the press to collect any liquid oozing from the press and shall be manufactured in grade 304L stainless steel. The operation shall be clean and hygienic. Access to parts that need maintenance and cleaning must be provided, the covers being corrosion free and sturdy to prevent damage during maintenance or cleaning operations. The screw tube, frame, discharge pipe, chute housing and trough shall be manufactured in grade 304L stainless steel. The screw shall be of heavy duty type mild steel (hard-faced) and coated with an appropriate epoxy. The screw must be easily removable for maintenance purposes.

The press unit shall be mounted on a concrete platform which will be constructed by others in accordance with the requirements of the Tenderer. The entire unit must be designed for easy cleaning and spraying down to reduce fly nuisance.

PTQ 5.3 Drive Unit

The drive unit shall match the requirements of the press without overloading and shall be situated to allow unimpeded access to the press. The screens and spiral conveyor will operate intermittently and the press and drive mechanism shall be activated by an electrical impulse from the spiral conveyor. They will be electrically interlocked.

The drive unit shall be isolated from the press area so as to prevent any water leakage into the drive unit.

In the case of overloading, the press must be automatically reversed for a few seconds before commencing a forward motion again. This sequence of reverse and forward operation shall only be allowed to occur three times, after which the press shall trip and sound an alarm.

PTQ 5.4 Electrical Requirements

The screenings press shall be equipped with its own weatherproof switch and operating panel, mounted in close proximity to the equipment.

The control equipment should make it possible to stop/start the press and protect it against overload, under voltage, single phasing etc.

The electrical supply and cable up to the local distribution/control panels will form the subject of another tender, and where applicable will be carried out in accordance with the requirements of the Contractor under this section of the Contract.

PTQ 6 GRIT REMOVAL EQUIPMENT

PTQ 6.1 Submersible Grit Pumps

PTQ 6.1.1 The settled grit will be pumped from each tank into a cyclone, and the overflow from the cyclone will run back into the inlet channel.

PTQ 6.1.2 The grit removal pumps shall be of an approved submersible design, rubber lined and shall be suitable for heavy duty. It shall be capable of passing solids up to 50 mm dia, and be capable of handling rags and plastic material.

PTQ 6.1.3 The pump suction shall be ± 100 mm above the bottom of the concrete tank, and shall pump at a rate of 5 l/s against a head of 5 m. The pumps shall deliver the grit through a 75 mm dia rubber reinforced hose into the cyclone or grit classifier.

PTQ 6.1.4 A hand-operated winch (galvanised to SABS 121:2000) with 6 mm grade 304L Stainless Steel cable shall be supplied for each pump.

PTQ 6.1.5 Full automatic control of the grit removal mechanism for intermittent operation of the unit by means of an adjustable timer will be provided by others.

PTQ 6.1.6 All pipework from the grit pumps to the grit classifiers shall be grade 304L stainless steel, 4,5 mm wall thickness.

PTQ 6.1.7 The suction inlet of each pump shall be 100 mm above the floor of the grit tanks.

PTQ 6.1.8 Electrical Requirements

The supply of weatherproof distribution/control panels, starters and cables will be provided by others.

Power cables from the motors (3 off) up to the 3-phase outlet by others for grit removal equipment shall be provided and installed under this section of the Contract with 4-pin waterproof plug to suite the type of 3-phase outlet supplied by others.

Tenderers shall give full details of any special requirements (if any) for storing, etc to suit the particular equipment offered.

Automatic control of the grit removal mechanism for intermittent operation of this unit by means of an adjustable timer shall be provided.

PTQ 6.2 Cyclone Grit Separator

PTQ 6.2.1 The discharge from the cyclone shall be double acting clam gates, hand operated, and will discharge the sand/grit into a dumper truck. The discharge shall be at least 2 000 mm above the road surface.

PTQ 6.2.2 The overflow from the cyclone shall be a 150 mm dia m.s. galvanised pipe.

PTQ 6.2.3 The cyclone shall be made of grade 304L stainless steel. Full working dwgs shall be approved by the Engineer before manufacturing can commence.

PTQ 6.2.4 Each vortex grit separator will be required to remove all grit, sand and inorganic particles of above 0,1 mm in diameter and specific gravity greater than 2,0 from the inflow.

PTQ 6.3 Air Lift Pump Station

PTQ 6.3.1 *Blowers*

Blowers shall be of the 'Wade', 'Robushi' or equal approved Roots air cooled positive displacement type. The blower housing and rotor shall be of high-quality spheroidal graphite or cast iron. The rotor shall be mounted on a high tensile steel shaft and the complete assembly shall be supported on ball and roller bearings located in housings in the end plates.

The rotors shall be linked by accurately machined and hardened timing gears mounted on the shaft. The end covers shall cover the gears and form the reservoir for lubricating oil. An oil sight glass shall be provided on the reservoir. Each end cover shall be effectively sealed from the compression chamber to prevent ingress of air, oil or water. A drainpipe with stainless steel lever operated ball valve and cap shall be provided to extend beyond the base plate to facilitate oil drainage.

Each blower and its respective motor shall be mounted on a rigid mild steel bed or baseplate manufactured from channel section and be supported from the concrete foundation with foundation bolts. Pockets for these bolts will be provided by the Civil Contractor.

The blowers shall be driven directly or through an adequately rated V-belt or wedge belt drive selected in accordance with the requirements of BS 3790 with a service factor of not less than 1,4 at a speed not exceeding 2000 rpm.

Each blower shall be provided with a lockable adjustable pressure relief valve which shall be capable of passing the full compressor capacity and which shall connect to a common manifold for discharge outside the blower building.

An inlet filter/silencer with renewable cartridge element shall be capable of passing the full compressor capacity and which shall connect to a common manifold for discharge outside the blower building.

An inlet filter/silencer with renewable cartridge element shall be provided on the suction side of each blower. The filter shall be provided with manometric or equal approved system giving positive indication of pressure drop across the filter and cleaning/renewal level. A discharge silencer shall be provided on the outlet from and situated beneath each blower.

PTQ 6.3.2 ***Low Pressure Air Pipework Valves and Supports***

Isolating wafer pattern butterfly valves and wafer pattern reflux valves shall be provided on the discharge side of each compressor.

The butterfly valve body, blade and trim shall be manufactured from grade 304L stainless steel.

The reflux valve body, gate and hinge pin shall be manufactured from grade 304L stainless steel and be provided with a spring assisted closure.

Isolating wafer pattern butterfly valves shall be provided for interconnection and duty isolation.

Pressure relief valves shall be manufactured from spheroidal graphite or close-grained cast iron or gunmetal body and cap and be fitted with gunmetal trim. An actuating lever with lock which shall prevent access to the valve components shall be provided. Adjustment of the operating pressure shall be provided.

Flexible couplings of the ‘Vibraflex’ or equal type with flanged connections shall be provided on the discharge side of each compressor rated from the maximum air discharge temperature.

The air supply valve to each degritter shall be of the ‘Burkett’ solenoid type with flanged connections designed to fail in the closed position. A manually operated bypass and isolating ball valve system shall be provided.

All air pipework within the blower building and to the air supply valve including the bypass system at each degritter shall be manufactured from carbon steel and shall be flanged in accordance with the requirements of the Specification. Pipework from the air bypass system to the connection to the slurry discharge pipe shall be manufactured from grade 304L stainless steel. A nozzle shall be provided on the discharge line from each compressor to accommodate a pressure switch.

All pipework shall be adequately supported using robust common 3CR12 steel bridge mounted brackets which will accommodate high- and low-pressure air pipework, wash water and slurry pipework and make provision for the mounting of power and instrumentation cabling and racking.

All pipework equal or less than 80 mm NB shall be hot dip galvanised and flanged in accordance with the specification.

PTQ 6.3.3 ***High Pressure Air Pipework Valves and Supports***

High pressure air supply pipework shall be manufactured from grade 304L stainless steel. Isolating and bypass valves shall be provided using stainless steel lever actuated ball valves with open/close indicator and stop.
The air supply and control valve to each pneumatically actuated valve shall be of the 'Burkett' solenoid type manufactured from non-corrodible materials type designed to fail in the closed position.

A combined condensate trap and air filter/water separator shall be provided on the supply to each actuated valve together with bypass and isolating valve system.

A pressure regulating valve shall be provided on the supply line to each valve actuator to regulate the system pressure to that required by valves. The valve body and internal components shall be manufactured from brass or similar non corrodible material.

All pneumatic pipework shall be neatly formed and run-in neat bundles with piping supports provided at a adequate intervals and changes in direction.

Pipework shall be supported on the common supports provided under Section PTQ 6.3.3. and shall be flanged.

PTQ 6.3.4 ***Washwater Pipework Valves and Supports***

Washwater pipework shall be manufactured from carbon steel. Washwater control valves shall be of the pneumatically actuated 'air to open', 'spring to close' 'Sanders' or equal approved 'straight-through' diaphragm type. the body shall be manufactured from spheroidal graphite iron. The diaphragm shall be manufactured from reinforced natural synthetic rubber material. The valve bore shall be of the same diameter as the washwater pipe. Actuators shall be of the direct acting type complying to the requirements of Specification PTW directly mounted to the valve body.

Pipework shall be supported on the common supports provided under Section PTQ 6.3.3.

All pipework equal or less than 80 mm NB shall be hot dip galvanised and flanged in accordance with the Specification.

PTQ 6.3.5 ***Grit Slurry Pipework Valves and Supports***

The vertical slurry discharge pipe from the bottom of the vortex separator and manifolds discharging to the classifier shall be manufactured from stainless steel grade 304L with a wall thickness of not less than 10 mm. Pipe lengths shall not exceed 3,0 m and be provided with flanged connections to permit rapid dismantling of sections. All bends shall be of the long radius type fitted with a flanged rodding tee. A fixed high pressure air connection of 25 mm diameter with isolating ball valve shall be provided between each slurry discharge valve and the vertical slurry discharge pipe for clearance of blockages.

Slurry discharge valves shall be of the pneumatically actuated 'air to open, spring to close' 'Saunders' or equal approved 'straight-through' diaphragm type. The body shall be manufactured from spheroidal graphite iron with a soft natural or synthetic rubber lining specifically selected for extended abrasion resistant duties on the material specified. The diaphragm shall be manufactured from similar reinforced material. The valve bore shall be the same diameter as the slurry pipe. Actuators shall be of the direct acting type, complying with the requirements of Specification PTW directly mounted to the valve body.

Pipework shall be supported on the common supports provided under Section PTQ 6.3.3.

PTQ 6.3.6 *Electrical Installation and Instrumentation*

The motor control centers and equipment together with the cabling and electrical installation will be provided under a separate contract.

Wall mounted pressure gauges shall be provided on the discharge side of each compressor. Gauges shall be manufactured from stainless steel, be glycerine filled and a minimum of 100 mm in diameter. Each gauge shall be provided with a brass isolating cock and shall be connected with suitably rated flexible hosing to prevent vibration of instruments.

A pressure gauge of the same type as that provided to the compressors with brass isolating cock shall be provided to the common high pressure air line feeding the pneumatic actuators.

The pneumatic actuators for the slurry and washwater valves shall be provided with proximity switches with IP68 enclosure for remote indication of valve status. Consideration will be given to limit switches incorporated in the actuator providing they are of a robust type suitable for operation under the conditions specified and shall be to the Engineer's approval. Limit switches shall be provided on the torque limiting coupling to the classifier drive.

The contractor will be required to provide all information including overload requirements and control philosophies necessary to permit design and construction of the motor control centres.

PTQ 6.4 Grit Classifiers

PTQ 6.4.1 *General Description*

Water, grit and air in the case of an airlift grit pump will be discharged into the grit-receiving reservoir.

The classifier shall be provided with an inclined grit washing-dewatering screw. The grit must be conveyed from the bottom of the hopper by a centreless spiral conveyor, washing the grit below the water level in the basin and dewatering the grit efficiently along the remainder of the inclined conveyor. The conveyor must deposit the dewatered grit into a container. The discharge level must be at least 2,0 m above the ground level. It is essential that the grit and organic matter is separated effectively to ensure minimal contamination of the classified grit.

PTQ 6.4.2 *Construction*

The constituent elements of the centreless grit classifier shall comprise those detailed in Section PTQ 9.

The classifier shall be of robust construction. The screw trough, the steel pipe with the steel flight and the access chute shall be constructed of 4,5 mm thick, stainless steel grade 304L.

The Tenderer shall submit full details regarding the plant offered by him and shall submit full details of the requirements for fitting the units into the civil structure. He must demonstrate the operation of the screw and the way in which water will be drained to facilitate drying of the grit.

Discharge chutes shall be fitted at the drive end of the classifier trough.

PTQ 6.4.3 *Control of Grit Classifier*

Each grit classifier shall be controlled either manually or by means of an adjustable timer supplied under this Contract.

PTQ 6.4.4 *Electrical Installation*

The electrical scope of supply for the grit classifier shall be the electric motor. The motor shall comply with the Specifications.

The supply and installation of motor control switchgear, local stop/start station and cables shall form part of a separate electrical installation Contract. Any special requirements of the Contractor completing this contract shall be specifically identified e.g. type of motor starting required etc.

Both Contractors shall be in attendance during the testing and commissioning phase.
The material from which the centreless grit classifier is to be fabricated shall be grade 304L stainless steel unless otherwise detailed or specified.

PTQ 6.5 Corrosion Protection

Corrosion protection of all plant and equipment shall be carried out in accordance with the Specifications and the drawings.

Colour coding shall be undertaken on all compressors, motors, bearing housings, piping and classifier steel work as advised by the Engineer prior to commencement of corrosion protection.

The final finishing coat of re-coatable polyurethane on equipment shall be applied after completion of installation.

Before galvanised pipework is to be painted it shall be thoroughly degreased and primed with a proprietary etching primer to the engineer's approval to provide adequate bond to the paint system specified.

PTQ 6.6 Installation

All pipework installed on the common supports to the degritters shall be restrained with stainless steel U-bolts. Drilling and installation of the bolts shall be undertaken after completion of final alignment and levelling. Provision shall be made in the design of the support to accommodate the separate racking for the electrical and instrumentation cabling to be provided under a separate contract.

PTQ 6.7 Tests on Completion

Performance testing will be carried out on the equipment after commissioning, adjustment and training of the Council's employees.

The tests will be performed on the equipment over a single 8 hours shift.

The tests shall consist of the following:

PTQ 6.7.1 *Vortex Degritter*

a) Efficient and effective operation of valves, actuators, pressure relief valves and ancillary equipment under automatic and manual control.
b) Measurement of rate of discharge of slurry from each degritter.

PTQ 6.7.2 *Grit Classifier*

a) Smooth and efficient operation of the blowers.
b) Measurement of absorbed power using a calibrated kW/hour meter and calculation of efficiency of each blower.
c) Measurement of the inlet and outlet volume and pressure of each blower.

d) Measurement of noise level (dbA) one meter from each blower unit as well as the total noise level inside the compressor building with all the blowers operational.
e) Vibration analysis on the blowers using calibrated portable equipment complying with BS 4675: Part 11.

The equipment will be considered acceptable when:

1) The equipment meets the duty requirements as defined in this section of the Specification.
2) The tests defined above prove the acceptable operation of the equipment.
3) Where a power test is required, the power absorbed by each motor at duty point does not exceed the values stated in the Technical Data Sheets.
4) Where a vibration test is required, the vibration measured at each point does not exceed the level prescribed in BS 4675 Part 1 – 1976 for the appropriate class of machine.
5) Where a noise test is required, the noise generated by the equipment does not exceed the values stated in the Technical Data Sheet.

PTQ 7 MECHANICALLY FRONT-RAKED SCREEN

Typical details of the channels are shown on the drawings in which a near vertical screen rack with a rake mechanism cleaning the rack is required in accordance with the Project Specification.

PTQ 7.1 General Requirements

PTQ 7.1.1 *Material*

All components of the screen, including screen bars and rake, shall be manufactured from grade 304L stainless steel unless otherwise specified in the Project Specification.

PTQ 7.1.2 *Frame*

The rectangular frame shall be formed entirely from plate of a minimum of 4.5 mm thickness and shall be recessed to accommodate the chain guides and idler sprockets.

The screen shall be set in the channel at approximately 75° to the horizontal. The frame shall be grouted into position in recesses in the channel walls and invert or, for screens of the removable variety, either braced at coping level on a spindle bar permitting the unit to be swivelled, or rested against brace-plates affixed to the channel walls, permitting the unit to be hoisted from above.
The frame shall be fully welded to the sole plate, the debris plate and the discharge chute. At the upstream face of the unit, box-section cross-members shall be securely welded to the side members of the frame at regular intervals between a point above the maximum water level and the head of the screen. These cross-members shall form the supports for removable stainless steel grade 304L cover panels.

PTQ 7.1.3 *Screen bars*

The screenfield bars shall be accurately set at the required spacing and solidly secured to the brace-plates for bolting onto the screen frame, for easy removal of the screenfield. The bars shall be approximately 40 mm deep of a tapered profile with the thickness of the bars at the upstream edge approximately 6 mm and the downstream edge approximately 3 mm. The bars shall extend from the sole plate, to which they shall be individually held in position by a removable fixing plate, and at the top of the screen field held in position by a lazer-cut slotted retention plate for simple removal when damaged.
Intermediate stiffening supports perpendicular to the bars shall be used to brace the screen bars at the downstream of the screenfield. The supports shall be welded to the screen bars for

strengthening as necessary and each screen bar shall be individually welded to the stiffening support.

PTQ 7.1.4 ***Sole plate***

The sole plate shall be profiled to induce screenings and debris in the lower level of the flow to be directed onto the lower portion of the screen bars and not to accumulate at the foot of the screen. The leading edge of the sole plate shall be level with the channel invert.

PTQ 7.1.5 ***Raking mechanism***

The rakes and tines shall be formed from single continuous bars of sufficient depth to ensure complete stiffness across the full width of the bar. The rake shall have a minimum thickness of 10 mm and shall have tines of appropriate profile to suit the screen bar spacing, laser or plasma-cut on the leading edge. The tines shall have an angle of 5° to the plane of the screenfield when engaged, with the ends of the tines trailing the remainder of the raking mechanism.

The raking bars shall be attached to the drive chains within the side members of the screen frame utilising suitably fabricated links. The raking bars shall be accurately aligned to ensure that, for the full width of each bar, the tines penetrate the screen bars to the necessary amount for the full extent of travel of the tines whilst engaged within the screen bars.

The raking mechanism shall consist multiple raking bars which shall restrict the headloss to a maximum of 150 mm at peak flow.

PTQ 7.1.6 ***Chains, guides and sprockets***

The chains shall be of the roller-ball type with links of a minimum length of 100 mm. The side-plates shall be of stainless steel grade 304L, with pins, bushes and rollers made of stainless steel grade 314 heat-treated. The chain guides shall be securely fixed to the side members of the screen frame for the full length of travel of the chains.

Idler sprockets shall be located at the lower end of each side member of the screen frame and shall have a minimum thickness of 20 mm. A bush housing shall be continuously welded on both faces to the sprocket. The sprocket shall be mounted on stub axles utilising self-lubricating bush-bearings. The sprockets shall be retained on their stub axles by a suitable, easily removable, mechanism to ensure ease of replacement of the bearing should this be necessary.

The drive shaft at the head of the screen frame shall have two chain sprockets mounted thereon and shall be securely keyed to the shaft. The bearing for the shaft within the screen frame shall be self-lubricating.

PTQ 7.1.7 ***Drive unit***

The drive unit shall be suitably rated for continuous operation and shall be selected to match the duty of the particular screen. The drive unit shall be directly coupled to the screen drive shaft through the gearbox.

A facility shall be incorporated within the drive mechanism mounting arrangement to enable the scraping mechanism drive chains to be correctly tensioned and the raking bars to be accurately positioned across the screen face. Such adjustments shall be possible without the dismantling of any part of the screen frame and without the necessity for any special tools.

The following electrical control equipment shall be supplied and installed with the screens.

A current sensing overload device with a built-in intelligent control facility shall be incorporated within the screen starter compartment in the motor control centre. The device shall have the facility to be able to reverse the direction of travel of the scraping mechanism, should a blockage occur on the screen and cause the overload device to trip the normal operation of the screen.

The device shall have the additional facility to enable this reversing action to be affected twice for any one occurrence, before tripping the alarm. Further, the device shall either re-set automatically if the blockage causing the initial overload conditions is cleared, or should the blockage remain upon the completion of the second attempt at automatic clearance, an alarm shall be generated.

PTQ 7.1.8 ***Cleaning mechanism***

The cleaning mechanism shall comprise a single bar, which shall engage each raking bar as it raises above the upper edge of the screening retention plate.

The scraper bar shall be fabricated and mounted so that it efficiently cleans the full width of each raking bar. The bearing for the scraper bar shall be self-lubricating.

PTQ 7.1.9 ***Discharge chute***

The discharge chute shall be set to guide all the screenings removed by the screen as efficiently as possible onto the screenings handling system. The chute shall form an integral part of the screen. The discharge point of the screenings outlet shall be at least 1,5 m above the top of the platform of the structure housing the screen to allow for a conveyor belt to be installed on the platform next to the screen.

PTQ 7.2 **General**

PTQ 7.2.1 ***Corrosion protection***

Corrosion protection must be carried out strictly in accordance with the requirements of the Corrosion Protection Specification.

PTQ 7.2.2 ***Spares, tools and lubricants***

Lubricants are to be supplied with the equipment included under this Contract.

Details of spares are to be listed in the Tender Document.

PTQ 7.2.3 ***Bolts***

Holding down bolts which are to be built into concrete work for securing the plant shall be grade 304L stainless steel and shall be supplied and installed under this section of the Contract. Grouting up of these bolts will be done by a Civil Contractor appointed by the Mechanical Contractor, after completion of setting up of the plant by the Mechanical Contractor under this Contract.

PTQ 7.2.4 ***Bearings***

The upper bearing assembly must be adequate to support the thrust loads and any radial loads that might develop in addition to its share of the mass of the equipment. All bearings shall be of robust construction and designed for a life of 100 000 hours at a B10 rating.

PTQ 7.2.5 ***Speed reducers***

Speed reducers shall be selected for continuous operation 24 hours per day. Mechanical power ratings (according to AGMA) shall be not less than twice the installed power. Thermal power ratings shall be based on an ambient temperature of 40°C.

All gears and pinions must be hardened and ground after cutting.

Casings shall be of close-grained cast iron.

Tenderers shall provide a catalogue of the make of speed reducer offered and indicate how the selection of the unit was made.

Each speed reducer shall be fitted with a nameplate showing at least the following information:

i) Speed reducer type or model number;
ii) Serial number;
iii) AGMA rating;
iv) Nominal reduction rates and
v) Approximate oil quantity required.

PTQ 7.3 Electrical Installation

The electrical scope of supply for the equipment shall be the electric motors. The motors shall comply with the Specifications.

Any special requirements of the Contractor completing this contract shall be specifically identified e.g. Type of motor, starting required, function description, etc.

PTQ 8 SPIRAL CHANNEL SCREEN

Typical details of the channels/pipes are shown on the drawings in which a centreless spiral screen is required in accordance with the Project Specification.

PTQ 8.1 General Requirements

PTQ 8.1.1 The screen tube and dewatering zone shall be manufactured from stainless steel grade 304L.

The spiral channel screen will be required to remove waste, convey and compact as one unit, from a wastewater channel or pipeline. The screen field shall be manufactured from wedge wire or perforated plate. Screenfield aperture shall be 3,0 mm.

PTQ 8.1.2 ***Drive Unit***

The drive unit is suitably sized with a output speed selected to facilitate the load transported and with a minimum service factor of 2,0 on installed power. The drive unit is a flange mounted Inline helical bevelled geared hollow shaft type to accommodate the drive shaft. The drive unit is bolted to a drive end flange, machined with spigots and tapped holes for accurate alignment. The protection rating to be IP 55, 380 V. TEFC.

PTQ 8.1.3 ***Spiral Tube***

The tube must be manufactured to suit the spiral diameter and must be fitted with removable grade 304L stainless steel support wear bars to keep the spiral in line when working on full capacity. Support legs shall be totally adjustable vertically and horizontally. The complete unit shall be positioned at 35 degrees.

PTQ 8.1.4 ***Centreless Spiral***

The centreless spiral shall be manufactured of continuous high tensile steel flat bar, cold formed into a strong, flexible spiral. The centreless spirals shall be cold formed to extremely accurate diameter and spiral pitch.

The centreless spiral shall be flanged at the drive end and bolted to the flanged drive shaft to facilitate ease of maintenance. The spiral shall be fitted with a heavy duty brush system to keep the screenfield clean.

PTQ 8.1.5 ***Compaction/Dilution Zone***

The dilution zone shall consist of a cylindrical perforated tube attached to the spiral tube. The cylindrical perforated tube shall be fitted within a housing with an outlet drain and high pressure washing showers. These shower bars must be extended to approximately 200 mm within the centreless spiral conveyor to brake-up and dilute the faecal matter. A reducer and flop gate shall be fitted to the outlet to create pressure in the cylindrical perforated tube. Once the screenings are transported into the dilution zone, a plug will be formed, causing a pressure increase in the dilution zone that causes the fluids to drain through the cylindrical perforated tube, and back into the system through a flexible hose. Tenderers must specify what pressure is required for this system.

PTQ 8.2 **General**

PTQ 8.2.1 ***Corrosion protection***

Corrosion protection must be carried out strictly in accordance with the requirements of the Corrosion Protection Specification.

PTQ 8.2.2 ***Spares, tools and lubricants***

Lubricants are to be supplied with the equipment included under this Contract.

Details of spares are to be listed in the Tender Document.

PTQ 8.2.3 ***Bolts***

Holding down bolts which are to be built into concrete work for securing the plant shall be grade 304L stainless steel and shall be supplied and installed under this section of the Contract. Grouting up of these bolts will be done by a Civil Contractor appointed by the Mechanical Contractor, after completion of setting up of the plant by the Mechanical Contractor under this Contract.

PTQ 8.2.4 ***Bearings***

The upper bearing assembly must be adequate to support the thrust loads and any radial loads that might develop in addition to its share of the mass of the equipment. All bearings shall be of robust construction and designed for a life of 100 000 hours at a B10 rating.

PTQ 8.2.5 ***Speed reducers***

Speed reducers shall be selected for continuous operation 24 hours per day. Mechanical power ratings (according to AGMA) shall be not less than twice the installed power. Thermal power ratings shall be based on an ambient temperature of 40°C.

All gears and pinions must be hardened and ground after cutting.
Casings shall be of close-grained cast iron.

Tenderers shall provide a catalogue of the make of speed reducer offered and indicate how the selection of the unit was made.
Each speed reducer shall be fitted with a nameplate showing at least the following information:

i) Speed reducer type or model number;
ii) Serial number;
iii) AGMA rating;
iv) Nominal reduction rates and
v) Approximate oil quantity required.

PTQ 9 CENTRELESS SPIRAL CONVEYOR

PTQ 9.1 General requirements

The general requirements and position of installation shall be stated in the Project Specification.

PTQ 9.2 Spiral trough

The spiral trough shall be manufactured in a “U” shape from stainless steel grade 304L with a lip on either side to accommodate the centreless spiral. The trough shall be bent and not rolled for optimum lateral strength to specific diameters and clearances. The trough sections shall be joined and fully welded to the specified trough length. Support legs will support the spiral trough, to suit the application. These support legs shall be manufactured from stainless steel grade 304L in a “H” shape from channel and be welded to the side of the spiral trough and bolted to the concrete floor with stainless steel anchor bolts.

The trough shall be covered by grade 304L cover plates bolted to the trough lip where no screenings will be discharged into the trough. There shall also be a discharge chute on the opposite end to the drive unit for emergency conditions.

The spiral trough shall be flanged at the drive end to facilitate the mounting of the drive unit and discharge chute.

The spiral trough shall be fitted with replaceable liners or wear bar strips.

The replaceable liner shall be manufactured from material with a low friction co-efficiency combined with high resistance to abrasion. The standard liner supplied will be a two-coloured liner (6 mm green & 4 mm red) ultra high molecular polyethylene (UHMPE), with the red as an indicator to wear. The liner is restrained in position by holding down lugs, welded to the spiral trough. The liner will simply be clipped in or out from behind these lugs.

The replaceable liners are supplied pre-bent to the correct trough diameter in 1 meter sections.

The replaceable wear bars shall be spot welded to the spiral trough. The material of the wear bars shall be softer in nature than the material of the centreless spiral to prevent excessive spiral wear. The wear bars are placed in the spiral trough to guide the centreless spiral and to protect the spiral trough.

PTQ 9.3 Centreless Spiral

The centreless spiral shall be manufactured of continuous high tensile steel flat bar (or suitable alloy), cold formed into a strong, flexible spiral. The centreless spirals shall be cold formed to extremely accurate diameter and spiral pitch. The outside diameter of the spiral shall be specified in the Project Specification. The spiral flights shall have a width of at least 70 mm and a thickness of not less than 10 mm.

The centreless spiral is flanged at the drive end and bolted to the flanged drive shaft to facilitate ease of maintenance.

The spiral conveyor shall be designed such that all silt and fine material shall be positively removed.

PTQ 9.4 Drive Unit

The drive unit shall be suitably sized with an output speed selected to facilitate the load transported and with a minimum service factor of 2,0 on installed power. The drive unit shall be a flanged mounted inline helical bevelled geared hollow shaft type to accommodate the drive shaft. The drive unit shall be bolted to a drive end flange, machined with spigots and tapped holes for accurate alignment. The protection rating to be IP 55 or higher, 380 V or higher.

The following electrical control equipment shall be supplied and installed with the conveyor.

A current sensing overload device with a built-in intelligent control facility shall be incorporated within the drive unit starter compartment in the motor control centre. The device shall have the facility to be able to reverse the direction of rotation of the spiral, should a blockage occur in the spiral tube and cause the overload device to trip the normal operation of the conveyor.

The device shall have the additional facility to enable this reversing action to be affected twice for any one occurrence, before tripping the alarm. Further, the device shall either re-set automatically if the blockage causing the initial overload conditions is cleared, or should the blockage remain upon the completion of the second attempt at automatic clearance, an alarm shall be generated.

PTQ 9.5 General

PTQ 9.5.1 *Spares, tools and lubricants*

Lubricants are to be supplied with the equipment included under this Contract.
Details of spares are to be listed in the Tender Document.

PTQ 9.5.2 *Bolts*

Holding down bolts which are to be built into concrete work for securing the plant shall be grade 304L stainless steel and shall be supplied and installed under this section of the Contract. Grouting up of these bolts will be done by a Civil Contractor appointed by the Mechanical Contractor, after completion of setting up of the plant by the Mechanical Contractor under this Contract.

PTQ 9.5.3 *Bearings*

All bearing assemblies must be adequate to support the thrust loads and any radial loads that might develop in addition to its share of the mass of the equipment. All bearings shall be of robust construction and designed for a life of 100 000 hours at a B10 rating.

PTQ 9.5.4 *Speed reducers*

Speed reducers shall be selected for continuous operation 24 hours per day. Mechanical power ratings (according to AGMA) shall be not less than twice the installed power. Thermal power ratings shall be based on an ambient temperature of 40°C.

All gears and pinions must be hardened and ground after cutting.

Casings shall be of close-grained cast iron.

Tenderers shall provide a catalogue of the make of speed reducer offered and indicate how the selection of the unit was made.

Each speed reducer shall be fitted with a nameplate showing at least the following information:

i) Speed reducer type or model number;
ii) Serial number;
iii) AGMA rating;
iv) Nominal reduction rates and
v) Approximate oil quantity required.

PTQ 10 MEASUREMENT AND PAYMENT

END OF SECTION

PTR: SEDIMENTATION TANKS (Clarifiers)

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PTR SEDIMENTATION TANKS (Clarifiers)

PTR 1 SCOPE

This Section of the Contract covers the supply, delivery, transport, handling, storage, erection, installation, commissioning, testing, adjustments, handling over in complete working order and upholding during the Defects Notification Period of plant for the sedimentation tanks as described in the Project Specification. The purpose of the sedimentation tank, i.e. primary sedimentation and/or secondary clarification shall be stated in the Project Specification.

PTR 2 TANK SHAPE

The clarifiers will be built in concrete and will have an internal diameter and water depth as specified under the Project Specification. The floor of the tank will either be nearly horizontal (v shaped scrapers) or will have a slope towards the centre of the tank. In the latter case the sludge will be scraped towards a central sludge collection hopper from where it will be withdrawn through a sludge draw-off pipe. On flat floors V shaped scrapers will be specified, sludge will then be lifted hydraulically to a central sludge outlet box.

The effluent launder will be built in concrete on the outer tank wall.

The flow into the tank will be by an inlet pipe passing under the tank floor turning upwards at the centre to discharge and disperse the sewage water within a deflector drum inducing even radial flow into the body of the tank.

PTR 3 INLET/OUTLET AND DISPERSION ARRANGEMENTS

The inlet pipe under the floor and inside the inlet structure of the clarifier will be supplied and installed by the civil engineering contractor and does not form part of the mechanical Contract. Similarly the sludge draw-off pipe under the floor of the tank will be supplied and installed by the civil engineering contractor.

A 100 mm inside diameter continuous conduit pipe (reinforced PVC) with no sharp bends, complete with cable draw wire and fixed at each end of the conduit and orientated to suite the site electrical layout will be supplied and installed by the civil engineering contractor.

The concrete centre column encases the inlet pipe at its lower end. The incoming flow leaves the concrete centre column through a series of vertical slots arranged below water level and is deflected by an annular deflection drum to be provided by the Mechanical Contractor, and which shall be fabricated from glass fibre reinforced material. The Mechanical Contractor shall detail in his tender the dimensions and location of the deflector-drum, and the Engineer must approve the final arrangements.

PTR 4 ACCESS BRIDGE AND WALKWAY

The rotating half bridge shall be supported by a pivot bearing assembly to mount the bridge on the central support and by drive and support wheels supported at the other end. It shall incorporate an access walkway not less than 750 mm in width between internal faces and designed to support a uniformity distributed live load of 2,5 kN/m^2. Galvanised handrailing, adequately supported, and a 100 mm x 3 mm thick kicker plate made of galvanised steel shall be provided on both sides of the walkway. The walkway flooring shall be open-grid galvanised steel, and shall be capable of supporting the above loading with a maximum deflection of 2,5 mm. The bridge shall be designed with a camber sufficient to completely cancel the deflection which will be produced by the dead load of the complete bridge with scraper mechanism attached, the latter un-submerged.

The underside of the bridge and the underside of the backing plates for the squeegees shall have sufficient clearance to prevent any touching between metal and concrete when the tyres are worn down.

A loading notice shall be fixed to the bridge in accordance with applicable safety regulations.

A ladder with the necessary handrails shall be rigidly fixed to the outer end of the bridge to provide access thereto.

The walkways, handrails and ladder shall be manufactured of hot-dipped galvanised mild steel to SANS 763. The rotating bridge shall be manufactured of mild steel and coated in accordance with the relevant specification.

The access bridge and scraper mechanism (sludge and surface scum) shall be single unit and shall include the electric drive unit, speed reducer, wheels, scraper arm and blades and surface scum skimmer.

PTR 5 END CARRIAGE AND DRIVE UNIT

The outer end of the bridge shall be carried by two polyurethane tired wheels, one drive wheel and one trailing wheel running on the peripheral wall. The driving and supporting wheels shall have wearing surfaces consisting of tyres of an approved synthetic material with good wearing properties. The wheels must be accurately aligned so that the plane of rotation is normal to a line drawn through the pivot of the wheel and the centre point about which the bridge rotates, so as to minimise wear of the tyres.

No special track will be provided and the Mechanical Contractor must give tolerances of the finished concrete wall.

The drive wheel shall be driven by a flanged mounted weather proof electric motor directly coupled to an oil filled reduction gear-box. Full details of the wheel axle support and its fixing must be given in the Tender documents.

A deflector must be incorporated in front of the leading and trailing wheels to deflect any foreign objects and prevent accidents. A thermal overload device or shear pins shall be incorporated in the drive unit to stop the bridge immediately should it becomes jammed.

The rotating bridge brush gear shall be supplied and installed under this portion of the Contract. The brush gear to be installed on the kingpost of the bridge at the centre of the tank to facilitate connections between the incoming supply cable and the cable from the kingpost to the motor starter installed on the rotating arm, shall consist of the following:

(a) A set of **four** (4No) 20mm wide and **three** (3No) 8mm wide **brass** slip rings on an ebonite or equivalent insulating sleeve (i.e. three slip rings or phase connections, one for the earth connection, three slip rings for the control circuit, namely, start, common and stop connections). Connections to these slip rings shall be effected *via* an approved heavy duty terminal block with stud type brass terminals onto which the lugs on the cable tails shall be bolted. This terminal arrangement shall be completely independent of fixing screws for the slip rings.

(b) A set of four main circuits and three control circuit “Morganite” carbon brushes, or equivalent. Each of these brushes shall be spring-loaded to ensure high contact pressure and the springs shall be rust-proofed.

The above-mentioned brush gear shall be installed in a weatherproof IP55 grade UV protected and impact proof synthetic housing with removable cover situated on the kingpost of the bridge. This brush gear housing shall be suitably sized to accommodate the relevant equipment without cramping, and shall be insect proofed.

The brush gear housing shall be designed and constructed to prevent the accumulation of gas and the condensation of moisture inside the housing and the pressure of the brushes on the slip rings shall be high enough to obtain a self-cleaning effect during operation.

The driving motor (drive unit) shall be provided under this contract and shall comply with the requirements of Particular Specification PEE: *Low voltage electrical motors.* The motor will be provided with a weatherproof emergency stop push button station by the electrical contractor, mounted on the bridge in close proximity to the bridge access ladder. The supply and installation of the cabling between the motor, emergency push button station, brush gear and kingpost, however, shall form part of this contract. The cable shall be installed in a grade 304 stainless steel conduit mounted on the underside of the bridge and secured to the bridge by means of stainless steel conduit saddles.

PTR 6 CENTRE PIVOT

The bridge shall be supported at the centre of the tank by means of a totally enclosed weather proof pivot bearing assembly, designed to carry the bridge with super imposed loading. An arrangement must be incorporated in the pivot assembly to allow small vertical movements of the bridge at the outer end without imposing undue twisting of the bearing assembly. The assembly must be provided with grease nipples to allow easy lubrication. A weather proof 7 ring slipring assembly must be provided, generously rated for the electrical power required to drive the bridge. All electrical connections and covers at the centre pivot shall be protected from the ingress of moisture.

PTR 7 SCRAPER AND SLUDGE REMOVAL EQUIPMENT

The scraper mechanism shall scrape the entire floor area, and shall be arranged in either an echelon formation or a series of Vee-shaped scrapers as specified in the Project Specification.

The scrapers shall be fitted to an underwater support system suspended from the overhead rotating bridge. The scraper mechanism and bridge shall form one rigid unit but there shall be at least 30 mm adjustment in the level of the floor scrapers. Supporting arms from the bridge shall be of grade 304L Stainless Steel angle iron sections. All bolts and nuts shall be in grade 304L Stainless Steel.

The scraper blades shall be manufactured of 4,5 mm thick grade 304L Stainless Steel, of 150 mm minimum overall depth and fitted with abrasion resistant rubber or other approved material wearing edges.

In the case of Vee-shaped scrapers, each scraper must be secured to a vertical uptake pipe suspended from the bridge structure with a horizontal branch leading to a common sight box mounted below the walkway. As the bridge rotates the scrapers sweep the floor of the tank and the accumulated sludge is discharged under hydrostatic head through the vertical tubes, passing along the horizontal branches to the sight box. Precise control of the flow from each of the tubes is provided by a trimming valve in each vertical leg which is accessible from the bridge.

The level of the sludge in the sight box must be maintained below the discharge points for the horizontal branches by means of a syphon connected with the annular sludge outlet drum. Initial priming of the syphon must be accomplished by means of a hand pump. A sludge draw off pipe must be provided, connecting the annular sludge drum to the sludge removal pipe cast in below the tank floor.

In the case where scrapers are specified in an echelon formation, the structural members suspending the scrapers from the bridge shall be sufficiently sturdy to keep the scrapers in their relative positions without the metal back plates coming into contact

with the floor. The maximum sludge concentration will be specified in the Project Specifications.

Sludge is conveyed by the scrapers along a sloping floor to a central well. A sludge draw-off pipe (by others) extends from the central well under the tank to an external chamber, the flow, which is under hydrostatic head being controlled by either a sluice valve, or an adjustable bell mouth (telescopic) draw-off system.

PTR 8 SCUM REMOVAL

The scum baffle is to be supplied and fixed by the Mechanical Contractor, under this contract. The position shall be shown on the drawings.

Scum removal is required in each tank and consists of a scum skimmer as detailed on the drawings, to skim the entire water surface area within the scum baffle and a scum receiving hopper. The apparatus shall be of a design suitable for continuous operation activated by the movement of the bridge past it and shall withdraw from the tank sufficient liquid to ensure an efficient flushing of the scum through the scum pipe. During the remainder of the bridges cycle the outlet shall shut tight so as to prevent leakage.

The scum baffle shall be 400 mm wide with 300 mm immersion and be fixed along the full length of the overflow weir with grade 304L Stainless Steel brackets adjustable in a horizontal direction.

The scum skimmer shall be 300 mm wide.

The scum removal system complete including the baffle, skimmer and hopper shall all be manufactured of (at least) 4,5 mm thick grade 304L Stainless Steel.

The scum removal mechanism must be complete with scum baffle, scum receiving hopper, scum discharge pipe, control valve, all necessary stays etc. The termination point of the mechanical Contract with regards to scum discharge pipework shall be shown of the drawings.

PTR 9 OVERFLOW WEIR

A serrated overflow weir manufactured of 3 mm thick grade 304L Stainless Steel plate must be provided and installed by the Mechanical contractor as shown on the drawings. The weir plate shall be 250 mm wide with 50 mm deep slots as shown on the drawings, fixed 150 mm above the concrete sill of the overflow launder with Stainless Steel bolts and nuts. The weir shall be adjustable to ensure an even effluent discharge around the whole circumference of the tank, without leakage through joints. No leakage either between concrete and or weir sections shall be allowed. Tenderers shall allow in their prices for sealing and levelling of the plates.

PTR 10 SCREED TO TANK FLOOR

The Main Contract for the Civil Engineering Work contains a clause stating that granolithic concrete screed should be laid to the required levels by use of the scraper mechanism, used in strict accordance with the instructions and under the supervision of the Mechanical Contractor.

The Civil Engineering Contractor will be required to supply and fix mild steel templates for screeding purposes to the scrapers.

PTR 11 CORROSION PROTECTION

Corrosion protection must be carried out strictly in accordance with the Specification.

PTR 12 ANCILLARY EQUIPMENT

Details of spares and special tools are to be listed in the Data Sheets.

The Mechanical Contractor will be responsible for the supply, delivery to site and erection of all ancillary equipment, in the form of holding down bolts, rawlbolts, pipe clips, small pipes, grease piping etc. to complete the Mechanical Contract.

The Mechanical Contractor will also be responsible to compile a manual in which all the relevant mechanical equipment is described together with the routine maintenance, lubrication schedules etc for proper running of the plant.

PTR 13 STARTING AND STOPPING THE BRIDGE

There is to be no automatic control of the rotating bridges.

PTR 14 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the methods stated below:

PTR 14.1 <u>Design, Drawings and General</u>

	Pay Item	***Unit***
PTR 14.1.1	Provide design drawings and design information as specified.	Sum

PTR 14.2 <u>Supply and Delivery to Site</u>

	Pay Item	***Unit***
PTR 14.2.1	Annular deflector drum	No

PTR 14.2.2	Access bridge and walkway complete with sludge scaper, surface scum skimmer, motor, brush gear, handrailing and associated cabling between kingpost and drive unit/emergency stop	No
PTR 14.2.3	Serrated weir	m
PTR 14.2.4	Scum removal system including scum baffle, scum hopper and discharge pipework, valves, flanges and open/close mechanism	No

PTR 14.3 **Installation Work**

	Pay Item	***Unit***
	The following items shall include taking delivery of materials on site, handling safeguarding, installing, painting, fixing, grouting and aligning	
PTR 14.3.1	Annular deflector drum	No
PTR 14.3.2	Access bridge and walkway complete with sludge scaper, surface scum skimmer, motor, brush gear, handrailing and associated cabling between kingpost and drive unit/emergency stop	No
PTR 14.3.3	Serrated weir	Sum
PTR 14.3.4	Scum removal system including scum baffle, scum hopper and discharge pipework, valves, flanges and open/close mechanism	No

PTR 14.4 **Commissioning**

	Pay Item	***Unit***
PTR 14.4.1	Commissioning of sedimentation tank	Sum

PTU: CHLORINE DOSING EQUIPMENT

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PTU CHLORINE DOSING EQUIPMENT

PTU 1 SCOPE

This section of the Specification includes the supply, delivery, installation, commissioning and upholding during the Defects Notification Period of chlorination equipment.

PTU 2 MATERIALS

The chlorinator equipment, all associated chlorine dosing pipework and accessories that may come in contact with chlorine gas or solution shall be constructed of materials resistant to corrosion from the effects of chlorine.

PTU 3 EQUIPMENT REQUIRED

A vacuum operated chlorinator system containing two vacuum regulators suitable for fitting onto 1 ton containers are required. The chlorinator system shall operate in the change-over configuration.

Each vacuum regulator shall have an integral electrical heating system. The vacuum shall be created by an ejector in the chlorine dosing system. The ejector will be driven by a clear or process water supply as specified in the Project Specification. The pressure required in the water supply system to the ejector shall be stated in the tender. Each chlorinator shall be provided with the necessary drainage and ventilation pipes.

Chlorinators shall be adjusted manually by the plant Operator to achieve a prescribed dosage. Flow/residual pacing or automatic rate-controlled chlorination shall not be required, unless stated in the Project Specification.

Each system to be supplied and installed under this portion of the Contract must include the following:

- regulators, heaters, rate valves, rotameters, ejectors, in-line strainers, etc.

- for automatic rate control system (if specified): regulators, heaters, actuated gas controller with automatic proportional to flow/residual control facility, appropriate Signal Conditioning Unit (SCU), rotameters, ejectors, in-line strainers etc. The facility to operate the system manually shall be provided.
- the complete gas piping including valves and fittings to the ejectors and the uPVC piping to the diffuser.

- the diffuser shall be designed to match the equipment accepted and shall be readily removable.

- complete piping from the clear/process water supply pipework including valves, fittings and an appropriate pressure gauge to the chlorine room.

The following ancillary equipment will be required:

- The complete electrical installation, cables, etc.

- Electrically driven extractor fan(s) with a capacity of 1 000 l/min.

- A sturdy weatherproof cupboard, 750 x 750 x 300 deep with a 50 mm minimum roof overhang and with two glass doors in front must be mounted on the wall just outside the chlorine room. A hardwood-framed fibre glass covered construction is required. The Tenderer to submit details of his offer with his tender. This cupboard will be used to house a resuscitator and two gas masks, completely self contained with oxygen cylinders, etc. "Siebe Gorman" ref. 01457708 or equal. Design of the cupboard must be approved by the Engineer before manufacturing.

- One chlorine detector with alarm unit.

- One lifting beam with hooks suitable to lift the containers with a 2 ton chain block and trolley.

- Emergency repair kit for the containers.

- The change-over device between the containers shall be provided with a potential-free contact for monitoring purposes.

- Emergency shut-off system for containers (refer to PTU 5)

PTU 4 LOAD CELLS

To determine the chlorine available in a container, load cells with a capacity from 0 to 2 000 kg with associated LCD display unit shall be provided. The LCD display unit shall be mounted in the chlorine dosing room. The accuracy of the load cells shall be within 0,25% of scale deflection.

The tare weight of the container must be back balanced to give a net reading of the weight of liquid chlorine available in the container. The platform of the scale must have four trunnions mounted thereon for easy positioning of the chlorine containers. The scale must be sturdy and dependable and of high quality, suitable to operate under extreme condition of dust, moisture, corrosion and impact. The gross weight of a chlorine container is approximately 1 600 kg.

PTU 5 EMERGENCY SHUT-OFF SYSTEM

An emergency shut-off mechanism of the outlet valve of the active containers shall be provided under this portion of the Contract. The system shall operate either electrically or pneumatically. In the case of pneumatic operation, compressor(s) and air storage vessel shall be provided.

The shut-off system shall be activated by a high chlorine level (typically 5 ppm) detected in the chlorine storage area. Once the detection level remains for say 30 seconds, a signal shall be generated initiating the closure of the outlet valves. If the mechanism is operated electrically, the valves shall be closed in the event of a power failure.

PTU 6 MEASUREMENT AND PAYMENT

The tendered prices shall include for the supply, delivery, installation, testing and commissioning of the equipment required as specified:

	Pay item	***Unit***
PTU 6.1	**<u>Chlorine dosing equipment</u>**	
	Chlorinators as specified shall be supplied complete with ejectors, multiple flow meter assembly, rate control valves, isolating and solenoid valves, rotameters, in-line strainers, pressure gauges, by-pass connection, heaters, vacuum regulators and automatic change-over devices (automatic rate control devices if specified)	Sum
PTU 6.2	**<u>Load cells</u>**	
	Load cells for weighing 1 600 kg chlorine containers complete with trunnions and LCD displays in dosing room	No.
PTU 6.3	**<u>Pipework</u>**	
PTU 6.3.1	Cadmium plated copper flexible connectors and seamless steel header piping to BS 1485 from the containers to the regulators including brass plug valves and suitably sized catch pots Sum	
PTU 6.3.2	The complete uPVC piping with the necessary isolating valves, bends, flanges, etc. from the ejectors to the diffuser	Sum
PTU 6.3.3	The complete uPVC piping with the necessary isolating valves, bends, flanges, pressure gauge etc. from the site water installation to the ejectors	Sum
PTU 6.4	**<u>Chlorine diffuser</u>**	

PTU 6.4.1	Chlorine diffuser complete with the necessary fixing brackets, bends flanges, etc. to complete the installation Sum		
PTU 6.5	**Low level fans**		
PTU 6.5.1	Low level extractor fans with vent pipes for controlled release		No
PTU 6.6	**Ancillary items**		
PTU 6.6.1	Wall mounted cupboard with glass front complete with resuscitator and two gas masks	Sum	
PTU 6.6.2	Chlorine detector	Sum	
PTU 6.6.3	Lifting beam with hooks and 2 ton chain hoist & trolley Sum		
PTU 6.6.4	Emergency repair kit for the containers Sum		
PTU 6.6.5	Emergency shut-off system	Sum	

PTV : CORROSION PROTECTION

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PTV CORROSION PROTECTION

PTV 1 SCOPE

This section includes the corrosion protection and materials required for this Contract.

PTV 2 GENERAL

PTV 2.1 The Contractor shall ensure that he has available the latest editions of all the relevant National Specifications and Codes of Practice and the manufacturer's data sheets for materials to be used.

PTV 2.2 All paints in a paint system shall be purchased from the same manufacturer.

PTV 2.3 The Contractor shall submit in the Appendices to the document, details of the paints he intends using and shall only proceed with purchase of the paints upon receipt of written approval from the Engineer. Manufacturer's data sheets or legible copies thereof for each product shall be attached to the Appendices.

PTV 2.4 Materials and procedures shall comply with the appropriate SABS Specifications and Codes of Practice when relevant.

PTV 2.5 Strict attention shall be paid to fettling of surfaces by the Fabricator (see Clause PTV 4) prior to coating. Surface preparation requirements, the need for strict cleanliness and adherence to specification requirements especially with regard to overcoating times are emphasised.

PTV 2.6 Areas which are inaccessible after assembly shall be prepared and fully coated with the specified system and to the specified requirements before assembly. The coating shall be fully hard dry before assembly.

PTV 2.7 Mating surfaces shall be coated with primer or first coat only. The coating shall be uniform in thickness and shall not interfere with the mechanical tolerances. After assembly the outside surface of the joint shall be fully coated.

PTV 2.8 The painting sub-contractor shall provide evidence of his competence to apply the specified materials in the specified manner and to apply the necessary Quality Control procedures. The Engineer, at his discretion, may demand a Quality Audit of the Contractor's facilities by a technically competent and independent organisation (See Clause PTV 10).

PTV 2.9 The Contractor shall provide a Quality Plan to show the stages at which Quality Control will be carried out. Further details are given in Clause PTV 10. The Quality Plan is subject to approval by the Engineer, who may require it to be revised if considered inadequate.

PTV 2.10 The Engineer will require a Program of Work so that Quality Surveillance inspection can be planned and executed at the appropriate time according to the Contractor's program (see Clause PTV 10).

PTV 2.11 The Contractor shall provide to material suppliers the specified descriptions of materials to be used and shall receive from them a written assurance that the materials to be supplied comply with the requirements specified.

PTV 3 DESIGN

PTV 3.1 General

All items shall be designed to minimise corrosion in exposed environments, under immersion conditions and in interior corrosive situations such as in chlorination rooms. The following notes may be used as guidelines.

PTV 3.2 Water Retention Areas

Avoid water retention areas wherever possible. For example, angle or U section steel should be used with the toes pointing downwards. The concrete base of steel columns should be sloped away from the steel and the sloping edge should be painted to avoid water ingress at the steel/concrete interface.

PTV 3.3 Crevices

Crevices give rise to accelerated corrosion by forming an oxygen concentration cell. Crevices may be avoided by using

(i) continuous welding, not space welding
(ii) mastics or sealants to seal unavoidable crevices such as bolted connections

(iii) insertion rubber or suitable plastic between mating surfaces (See also Clause PTV 2.7).

PTV 3.4 Bimetallic Couples

Electrical contact between dissimilar metals gives rise to a corrosion cell when an electrolyte such as water is present. Junctions between dissimilar metals shall be insulated.

PTV 3.5 Accessibility

Whenever possible, the surfaces of corrodible materials such as mild steel shall be accessible for maintenance. The use of back to back angles, partially open box sections or inaccessible stiffeners shall be avoided.

PTV 3.6 Differential Aeration

Posts buried in soil are subject to accelerated corrosion due to differential aeration. Additional protection shall be given to that part which is buried and up to at least 100 mm above ground.

PTV 3.7 Sharp Edges, Weld Spatter and Weld Slag

The designer shall specify that all sharp edges shall be ground to a radius not less than 2 mm and that all weld spatter and weld slag shall be removed by the Fabricator (see Clause PTV 5).

PTV 3.8 Hot Dip Galvanising

The design of articles to be galvanised shall be referred to the galvaniser (see Clause PTV 8).

PTV 4 COATING MATERIALS

PTV 4.1 No variation in materials tendered and approved by the Engineer shall be permitted without the approval of the Engineer in writing.

PTV 4.2 Correct material selection shall be confirmed by the material supplier (see Clause PTV 12.1).

PTV 4.3 All coating materials shall be delivered in the manufacturer's original sealed containers, clearly marked with the following:

(i) Manufacturer's name.

(ii) Product Brand and Reference Number.

(iii) Batch Number which may incorporate the date of manufacture.

(iv) Date of manufacture, unless already incorporated in the batch number.

(v) Abbreviated instructions for storage and use of the material, which shall include mixing ratios of components of multi-component materials, minimum temperature of application and method of application.

(vi) The SABS mark where applicable.

PTV 4.4 All coating materials shall be kept in an approved store, which shall be dry, enclosed and where the temperature is unlikely to exceed 40°C or drop below 0°C.

PTV 4.5 Usage of materials shall be on a first in, first out basis and no materials may be used which have exceeded the shelf life recommended by the manufacturer.

PTV 5 FETTLING OR DRESSING BY THE FABRICATOR

Before any surface preparation or painting is commenced, dressing shall be carried out to avoid projections, sharp edges, weld slag and spatter that will interfere with the corrosion protection. This included the following:

PTV 5.1 Remove all weld flux and weld spatter. Flux is best removed by washing with clean water whilst weld spatter is normally removed by grinding to a smooth surface.

PTV 5.2 Sharp edges shall be ground to a radius not less than 2 mm.

PTV 5.3 Welds shall be continuous and shall have a smooth contour. Rough welds shall be ground where necessary to achieve the required smooth profile. Discontinuous welds shall not be permitted except by written approval of the Engineer. Undercuts are not permitted and shall be rewelded and ground where necessary.

PTV 5.4 Articles for hot dip galvanising shall not contain overlap joints. Closed sections shall be suitably vented. See Clause PTV 8 (Hot Dip Galvanising).

PTV 6 SURFACE PREPARATION FOR PAINTING

PTV 6.1 Mild Steel

Oil and grease contamination, when present, shall be removed by degreasing before blast cleaning.

Mild steel shall be blast cleaned in accordance with Section 4.3 of SABS 064 Code of Practice for "The preparation of steel surfaces for coating".

An additional requirement is that water soluble salts present in the steel after blast cleaning shall not exceed the values given in Table 1. Should these values be exceeded, the steel shall be cleaned by washing with clean potable water or by water shrouded or water injected blast cleaning until the soluble salts are within the limits

specified in Table 1. The steel shall then be allowed to dry, after which it shall be flash blast cleaned to achieve the required degree of cleanliness.

PTV 6.2 Cast Iron and Cast Alloys

All cast surfaces shall be blast cleaned with new iron slag, copper slag, or platinum slag abrasives designed for blast cleaning. The abrasive shall not be recycled or re-used. Cast iron shall be blast cleaned until all sand particles, residual burst on sand and casting skin have been completely removed. This blast cleaning shall be carried out by the Foundry prior to despatch to the galvaniser or painting contractor, when relevant. Conventional cleaning of castings is inadequate for galvanising.

PTV 6.3 Galvanised Steel Surfaces

Galvanised steel surfaces shall be thoroughly degreased prior to painting, using either a water risible solvent degreaser used in accordance with the manufacturer's instructions, or a mild acid-detergent degreasing solution. In both cases care shall be taken to avoid entrapment of cleaning agent in recesses or other retention areas and in both cases the surfaces shall be thoroughly washed until a "water break fee" surface is achieved. If necessary, the process shall be repeated until a "water break free" surface is obtained.

A water break free surface is one which, when wetted all over with potable water, maintains a continuously wet surface and the water does not break up into islands of unwetted surface.

TABLE 1 - STANDARDS FOR BLAST CLEANING REQUIRED

Property	Above Water	Immersed Surface	Tape Wrapping
Cleanliness to SIS 06 5900 (min)	Sa2½	Sa3	Sa2
Residual dust and debris	0,5%	0,3%	1%
Oil grease and perspiration	Nil	Nil	Nil
Surface Profile min (micrometers)	25 50	50 10	50 100
Water soluble iron salts - maximum At any point	500 mg/m^2	100 mg/m^2	500 mg/m^2
Average of any 250 cm	100 mg/m^2	100 mg/m^2	100 mg/m^2

After degreasing, the surface shall be lightly abraded by one of the following methods:

(i) On small areas by the use of abrasive paper not coarser than 120 grade, or by using non-metallic abrasive pads.

(ii) On large areas by "sweep blast cleaning", using a nozzle pressure not greater than 300 kPa and a very fine abrasive. Cracking, flaking, or any form of delamination of the zinc coating due to excessive blast cleaning shall not be permitted. Removal of zinc by blast cleaning shall not exceed 10 micrometers.

Finally, all dust and debris shall be removed by vacuum cleaning, or by washing, and the surface shall be allowed to dry before coating.

PTV 6.4 Aluminium

Generally, aluminium surfaces will be anodised or powder coated and will require no further treatment. Where painting is required, the aluminium surface shall be thoroughly degreased, then rinsed with clean potable water. If the surface is not "water break free", repeat the degreasing process until a water break free surface is obtained. Allow to dry completely, then apply a thin coat (8 to 13 micrometers dry film thickness) of wash primer complying with SABS 723, mixed and applied in accordance with the manufacturer's instructions.

NOTE: Wash primer is an adhesion promoter and does not replace the primer specified in the paint system.

PTV 6.5 Stainless Steel

Components fabricated from stainless steel shall not be contaminated with iron or mild steel. Sheared edges, welds or surfaces subjected to any form of heat treatment shall be pickled and passivated. Stainless steel surfaces shall not be scratched or stressed.

When it is required to paint stainless steel, the surface shall be blast cleaned with non-metallic abrasive such as iron slag, copper slag or platinum slag. The use of steel shot, steel grit or cast iron grit is strictly prohibited. Any contamination with iron or mild steel is prohibited.

Where blasting is impractical, the surface shall be cleaned with detergent solution and roughened manually by using non metallic abrasive pads, followed by washing with clean potable water to a "water break free" surface. If a "water break free" surface is not obtained, detergent cleaning shall be repeated until the surface is "water break free". Allow the surface to dry before coating.

PTV 6.6 Painted Surfaces

(i) Fully painted surfaces to be repaired

Bare areas shall be cleaned with abrasive paper not coarser than 220 mesh to bright metal surface. The surrounding paint, which must be intact, shall be feathered for a distance of 20 mm beyond the damaged areas. Dust and debris shall be removed by the use of a clean rag dampened with water or clean solvent that will not attack the coating. The damaged area shall be allowed to dry, after which spot repair shall be carried out with all the coats previously applied and shall overlap the undamaged area by 20 mm.

The requirements of the spot repair shall be not less than that specified for the undamaged coating.

When additional coats are required over the whole surface, the whole surface shall be abraded to a uniform matt finish, dust and debris removed, and the surface allowed to dry. All further coats shall then be applied as specified to give a uniform finish. Note that abrasion of the coating is not required for vinyl systems.

(ii) Fully painted surfaces to be overcoated

Where additional coats are required over the whole surface, the surface shall be degreased and abraded to a uniform matt finish. The surface shall be washed to remove all contamination and then allowed to dry. Further coats shall then be applied as specified to give the required coating thickness and specified finish.

(iii) Primed surfaces

Shop applied primers shall be thoroughly sanded with fine abrasive paper to achieve a uniform matt surface, then scrubbed with a solution of suitable water based detergent-degreaser using a bristle brush, followed by clean water rinses to remove all grease and water soluble matter. The surface shall be allowed to dry completely before application of the specified coating system over the whole surface.

PTV 6.7 Plastic Surfaces such as uPVC and Polyester GRP

Sand the surface thoroughly with fine abrasive paper to achieve a uniform matt finish. Remove all debris, oil and grease by scrubbing with a solution of a suitable water based detergent such as Shell Teepol Lensex. Allow to react for 15 to 30 minutes, then rinse

off very thoroughly with clean potable water to remove all residues. Allow to dry completely before painting.

PTV 7 APPLICATION OF PAINTS

PTV 7.1 Environmental Conditions

Paint shall not be applied in dusty conditions, nor when the steel surface temperature is less than 3°C above dew point, or higher than that advised by the paint manufacturer, nor when humidity is greater than 85%, nor when the ambient temperature is less than the minimum or greater than the maximum specified by the manufacturer of the coating material.

PTV 7.2 Mixing

All coating materials shall be very thoroughly mixed until completely homogeneous. In the case of two-pack materials, each component containing pigments shall be thoroughly mixed. The two components shall then be mixed together in the proportions supplied by the manufacturer until the mixture is completely homogeneous. In the case of solvent based epoxy materials, it is recommended that the mixed material be allowed to stand for an induction period of 20 to 30 minutes before use.

For two pack materials, the use of part of the contents (split packs) is strictly forbidden.

PTV 7.3 Method of Application

Application shall be by brush, roller, spray, airless spray, or other suitable equipment as appropriate for the surface to be coated and in accordance with the recommendations of the manufacturer. Application equipment shall be maintained in clean condition and in good working order. The use of equipment not maintained in good condition may lead to rejection of the coating.

NOTE: Zinc silicate primers shall be applied by conventional spray, using a continuously agitated pressure pot, unless otherwise recommended in writing by the manufacturer.

PTV 7.4 Overcoating

Overcoating times shall be not less than the minimum nor greater than the maximum specified by the manufacturer relevant to the ambient temperature. Strict adherence to overcoating times is particularly important for coatings which are subsequently immersed.

The Contractor shall be held responsible for blistering of paint coatings on immersion, when shown to be caused by solvent retention.

All coats shall be clean and free from dust, oil, moisture, perspiration before overcoating. Operators handling blast cleaned or partially painted surfaces shall wear clean gloves to avoid contamination of the surface.

PTV 7.5 Manufacturer's Instructions

Recommendations supplied by the manufacturer in the form of the latest edition of printed data sheets, or given in writing on the manufacturer's letterhead, shall be followed. Verbal information by the manufacturer's representative will not be accepted unless confirmed in writing by the company.

PTV 7.6 Handling

Coated components shall not be handled earlier than the hard dry time recommended by the manufacturer, relevant to the ambient temperature. Coated components shall be handled with broad band slings and suitable packing to minimise damage to the coating. All damage caused in handling, transportation, and erection, shall be repaired to the satisfaction of the Engineer at no extra cost.

METAL COATINGS AND CORROSION RESISTANT METALS

PTV 8 HOT DIP GALVANIZING

PTV 8.1 Design and Fabrication

Components for hot dip galvanising shall be designed and fabricated in accordance with the recommendations of SABS Code of Practice Project No. 341/50490 (not published at the time of preparation of this specification), except that the use of lead plugs is not permitted.

It is recommended that the manufacturer consults the galvaniser before design and fabrication to ensure that the fabrication will be suitable for galvanising.

The main requirements are as follows:

(i) Overlap joints shall be avoided wherever possible. If essential, such overlap joints shall be thoroughly degreased before assembly and shall be vented by drilling holes through one or both overlapping materials.

(ii) Closed sections shall be suitably vented. If the inside of a closed section is not to be galvanised, a snorkel vent tube of suitable length and bore shall be attached.

(iii) Gussets and internal baffles in tanks shall be cropped to allow free flow of zinc and air.

(iv) Joints shall be continuously welded, using balanced welding techniques to avoid stresses. Welds shall be free from cavities, undercutting, weld slag and spatter.

(v) Symmetrical design shall be used whenever possible and the use of thin gauge steel adjacent to heavy sections shall be avoided.

(vi) Openings and flanges of manholes and bosses shall finish flush on the inside to ensure complete drainage.

(vii) Castings shall be designed to be of as uniform section as possible and shall be blast cleaned in accordance with Clause PTV 6.2 before despatch to the galvaniser.

PTV 8.2 The Hot Dip Galvanising Process

(i) Hot dip galvanising shall comply with SABS 763 for fabricated articles, SABS 934 for pregalvanised sheet, or SABS 935 for wire.

(ii) Mating surface on fabricated or cast iron components shall be wiped or centrifuged on removal from the galvanising bath to remove blobs, runs or excess metal that may impair the air/gas/water tightness of the joint.

(iii) Bolts, nuts and washers used for fixing shall be hot dip galvanised to SABS 763. Electroplated fasteners will not be accepted unless otherwise agreed by the Engineer in writing.

PTV 8.3 Repair Of Galvanised Articles

Welding, flame cutting, or other heat processes shall not be carried out on galvanised articles unless permission is granted by the Engineer in writing.

If such permission is given, or if mechanical damage has occurred, repairs shall be carried out as follows:

(i) All scale, spatter and flux shall be removed by grinding and washing with clean water. Edges shall be ground to a radius not less than 2 mm.

(ii) The preferred repair process is to blast clean the bare steel and apply zinc by the thermal spray process in accordance with SABS 1391 Part 1, Grade Zn 150. On completion of metal spraying, burnish the surface by means of a

mechanical wire brush to give a uniform appearance. Such burnishing shall remove not more than 10 micrometers of zinc.

(iii) Where small areas are to be repaired, clean the surface thoroughly with fine abrasive paper, remove all debris with a damp cloth and allow to dry. Apply an approved one pack epoxy ester based zinc rich primer containing not less than 90% by mass of zinc in the dry film. A sufficient number of coats (usually 3 or 4) shall be applied such that the repair coating thickness is not less than the average zinc thickness specified in SABS 763, 934 or 935, as appropriate. The repair shall extend not less than 5 mm beyond the damaged area.

On completion of the repair and when the zinc primer is completely dry, one coat of alkyd resin based aluminium paint may be applied to obtain a uniform appearance.

NOTE: Repair of galvanised surfaces by application of aluminium paint alone IS NOT PERMITTED.

PTV 8.4 Storage of Galvanised Components

Galvanised components shall be stored to avoid the formation of "white rust" or other forms of storage staining.

Components shall be separated and supported on wooden battens to ensure adequate ventilation of all surfaces and in such a manner to avoid "ponding" by rainwater.

If storage staining does occur, remove the stains by scrubbing with detergent solution and bristle brush or nylon pad. The use of steel wool or other metallic abrasive is not permitted. Rinse thoroughly and allow to dry. If the residual zinc thickness complies with the requirements of the appropriate grade in the relevant specification, no further action is required unless instructed by the Engineer.

If the zinc thickness is below specification, the article shall be regalvanised or repaired in accordance with Clause PTV 8.3 as instructed by the Engineer.

PTV 9 STAINLESS STEEL FABRICATIONS

PTV 9.1 Grade and Welding Techniques

The grade of stainless steel to be used shall be as specified in the appropriate section of the mechanical specification or drawings. Where welding is necessary, the appropriate "L" grade (low carbon content) shall be used. Plate shall be supplied as No 1 Finish in accordance with BS 1449 Part 4.

Welding procedures shall be only those recommended by the stainless steel manufacturer or by the South African Stainless Steel Development Association. Only welders coded to BS 4870 Part 1 or to ASME IX, 1983 shall be employed.

Welds shall be smooth and free from blowholes, undercuts, sharp projections and similar visual defects.

Fabrication of stainless steel components shall be carried out in clean work places where there is no contamination by mild steel. Grinding and polishing equipment shall be dedicated and shall not be contaminated with iron or mild steel.

Stainless steel shall be suitably handled to avoid scratching the surface.

PTV 9.2 Pickling and Passivation

Cut edges, welds and heat treated surfaces shall be pickled and passivated to remove all discolouration. Proprietary pickling and passivating pastes (as supplied by Duva Chemicals (Pty) Ltd., or other approved supplier) shall be used in accordance with the manufacturer's recommendations. Care shall be taken not to exceed the maximum contact time recommended.

The safety precautions given in PTV 10.2 shall be strictly observed.

After passivation, surfaces shall be very thoroughly washed with clean potable water to remove all traces of acid. The surface shall be allowed to dry, then polished where necessary, using polishing compounds recommended by the stainless steel manufacturer or the South African Stainless Steel Development Association.

SAFETY PRECAUTIONS as specified in Clause PTV 10.1(ii) shall be strictly observed.

PTV 10 CORROSION RESISTANT STEEL 3CR12

PTV 10.1 Welding Techniques

(i) Welds shall be full penetration welds, using 309 austenitic electrodes or filler wire, or as recommended by the manufacturers (Middelburg Steel & Alloys (Pty) Ltd).

(ii) Welders shall be suitably coded for welding similar thickness of austenitic stainless steel, in accordance with BS 4870 Part 1 or ASME IX, 1983.

(iii) Welding procedures shall comply with the recommendations of the manufacturers of 3CR12 (Middelburg Steel & Alloys (Pty) Ltd).

(iv) Welds shall be smooth and free from blow holes, undercuts, sharp projections and similar visual defects.

PTV 10.2 Pickling and Passivation

(i) After completion of welding, both weld and heat affected zones shall be cleaned, pickled and passivated. Any heat scale on the steel shall be pickled and passivated.

(ii) The procedure shall be as follows:

(a) Not to painted surfaces.

Grind or wire brush, using dedicated grinders or stainless steel wire brushes to achieve the required smooth profile or remove scale.

(b) Pickle with a thixotropic paste containing 15-20% nitric acid and 1-2% hydrofluoric acid, with a contact time of 15 to 10 minutes.

(c) Rinse thoroughly with clean water until the pH of the washings is the same as that of the wash water.

(d) Repeat the above process, if necessary to remove all discolouration.

(e) Passivate with 10% nitric acid solution, or a proprietary passivating paste, for a contact time of 10-15 minutes, keeping the surface wet during this period.

(f) Rinse thoroughly with clean potable water until washings are the same pH as the wash water.

(g) Operatives shall wear protective aprons, gloves and safety glasses during pickling and passivating operations.

(h) Splashes on the skin shall be thoroughly washed with clean water immediately after contract. A weak solution of sodium bicarbonate shall be kept available for neutralisation. Seek medical attention if in doubt.

(i) Disposal of effluent shall be in accordance with the requirements of the local authority in whose area the work is being carried out. Generally, the effluent is stored in drums containing an excess of lime (calcium carbonate).

PTV 11 ALUMINIUM

PTV 11.1 Anodising

Aluminium components where specified as anodised shall be natural anodised and sealed in accordance with SABS 999 Grade 25. The corrosion resistance of the coating shall be not less than 8 when tested in accordance with 3.6 of specification SABS 999. Anodising shall be carried out after completion of all welding.

PTV 11.2 Powder Coating

When specified by the Engineer, aluminium handrails may be coated with polyurethane powder. Such coating shall only be carried out by Contractors with the necessary plant, equipment and experience to pretreat and powder coat aluminium effectively. The coating shall comply with BS6496, 1984.

PTV 11.3 Fixing

Whenever aluminium components, such as stop log frames, come into contact with concrete or grout, the surface of the aluminium in contact with the concrete shall be coated with two coats of an approved epoxy tar composition.

PTV 12 QUALITY ASSURANCE REQUIREMENTS

PTV 12.1 Contractor Qualification

The Tenderer shall state in the Appendix to this document the name of the painting sub-contractor that he proposes to use to carry out the painting or coating. The Engineer may, at his discretion, require a Quality Audit of the painting sub-contractor to ensure that he has the management, facilities, skilled staff, and quality control facilities and staff to carry out quality control during application of coatings to ensure compliance with the specification.

The contractor shall accept full responsibility for the quality of his work and of materials used, irrespective of any quality surveillance that may be carried out by the Engineer or his representative.

The contractor shall obtain confirmation from the material supplier that materials to be used comply with the specification and are suitable for the intended purpose by having the appropriate Appendix completed by the material supplier.

PTV 12.2 Quality Control

The contractor shall have the necessary equipment and staff knowledgeable in test procedures to carry out all the quality control required to ensure compliance with the

specification. The contractor will be required to produce a quality plan and a program for carrying out the work. The contractor shall maintain quality control records of all stages of the work, batch numbers of materials used, environmental conditions, all as required by the specification. Quality control shall be inclusive in the contractor's tender price.

PTV 12.3 Quality Surveillance

Independent surveillance - The Engineer may employ an independent service provider to perform the quality surveillance on his behalf.

Program - The Contractor shall advise the Engineer timeously, in writing, when and where the following processes will be carried out:

(i) Completion of fettling or dressing prior to leaving the fabricator's works.

(ii) Blast cleaning and application of the first or primer coat.

(iii) After completion of all coats to be applied at the contractor's works.

(iv) At the commencement of repairs to be carried out on site.

Failure of the Contractor to advise the Engineer of his program may result in rejection of the work.

PTV 12.4 Access for Surveillance

For the purpose of carrying out quality surveillance, the Engineer or his representative shall be granted access to any part of the Contractor's premises relevant to the work being carried out, at any reasonable time. The Contractor shall provide, at his own cost, any equipment or labour necessary to gain access to surfaces which are coated, to be coated or are in the process of being coated.

PTV 12.5 Samples

The Engineer or his representative may remove any reasonable samples of materials to be used in the coating application. Rejection of the sample will place a hold on the use of material of the same batch number and may lead to rejection of all that batch of material and the reworking of any components that have already been coated with rejected material.

PTV 12.6 Destructive Testing

The Engineer or his representative may carry out reasonable destructive tests to ascertain compliance with the specification. Areas thus damaged shall be repaired by the contractor to the satisfaction of the Engineer at no additional cost.

PTV 12.7 Cost of Quality Surveillance

Cost of Quality Surveillance shall be borne by the Employer, except when surveillance results in rejection of the lot or when notice by the Contractor results in a fruitless strip, in which cases the cost shall be debited against the contractor's account.

PTV 12.8 Quality Control Records

Proper and adequate quality control records shall be maintained by the Contractor for all stages of the work. These records shall be available for inspection by the Engineer or his representative at the time of Quality Surveillance. Incomplete, inaccurate or inadequate records shall be regarded as non-compliance with the specification, and the cost of surveillance will be back charged to the contractor.

PTV 12.9 Data Sheets, Specifications, and Codes of Practice

The Contractor shall have available the latest issues of manufacturer's data sheets materials to be used, National specifications and Codes of Practice relevant to the work to be carried out, as well as a copy of this specification, all of which shall be available to the Contractors Quality Control Manager.

PTZ: AERATION BLOWER EQUIPMENT

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PTZ AERATION BLOWER EQUIPMENT

PTZ 1 SCOPE

This Specification covers the design, manufacturing, assembly, factory testing, transport, delivery, storage, handling, erection, installation, on site commissioning and testing, adjustment, handing over in complete working order, upholding during and servicing after the Defects Notification Period of the following aeration and ancillary equipment:

(a) Blower units complete, including motors, gearboxes (if applicable), cooling and lubrication system, air filters, silencers and ancillary equipment;

(b) Pipework inside the blower building up to the connection point to the main air feeder, valves and instrumentation for connection to existing air pipework or installation of new pipework.

(c) Dust filters and suction pipework to the blower units;

(d) Dissolved oxygen monitoring and control equipment;

(e) Control and isolating valves and air flow meters;

(f) Electrical control as required between field instrumentation and equipment and the Local Control Panel (LCP), including all hardware and software.

(g) Provision of suitable aeration control system & Master Control Panel and connection to LCP's for control of aeration system, including integration with existing plant SCADA.

PTZ 2 OPERATING CONDITIONS ON SITE

Relevant and applicable site conditions shall be stated in the Project Specifications.

PTZ 3 BLOWER GENERAL DESCRIPTION

The number of blowers to be provided under this Contract shall be stated in the Project Specifications.

The blowers to be provided can generally be described as electrical motor driven, single stage, integrally geared, dual vane centrifugal units. The blower equipment shall adhere to the general specifications described in subsequent sections of this Specification. Preference shall be given to blowers that operate at or below 3000 rpm's and maintains efficiency over the full turn-down ratio.

The blower package shall be designed and manufactured to provide at least 25 years functional lifespan with maintained maximum efficiency and ease of on-site maintenance.

The blowers shall be sized in terms of the prevailing climatic conditions, the required range of air flows to cater for the oxygen demand of the BNR process as given in the Project Specifications.

PTZ 4 OXYGEN DEMAND & AIR FLOW RATES

The maximum and average oxygen demand and design air flow rates shall be as per the Project Specification.

In the event of a new system, the Contractor shall be responsible for the design of the complete aeration system, including blowers, air headers, diffusers, instrumentation, and controls.

In certain instances, the diffuser and air header system may be existing, and the provision of new blowers, controls and instrumentation may be required. In this instance, all the information pertaining to the existing equipment will be provided under the Project Specification and the Contractor will be expected to incorporate the existing equipment into the design of the aeration system and take responsibility for the correct operation and efficiency of such system.

PTZ 5 CONTROL OF AIR SUPPLY

Control of the air supply to the respective aerobic zones within the basin shall be by means of suitable actuated air flow control valves, suitable for remote manual operation, in the feeder pipes to each of the zones, based on the actual dissolved oxygen (DO) concentration compared to a pre-set target DO value.

Dissolved oxygen shall be monitored by means of suitable Luminescent Dissolved Oxygen (LDO) probes installed in the reactor basin.

A suitable insertion type mass flow meter transmitter will be installed on each air header.

A pressure transmitter shall be installed on the common air header for ultimate control of the blower speed.

PTZ 6 GUARANTEE OF PERFORMANCE

The Tenderer shall guarantee the performance of his blower equipment by completing the table below.

Failure to submit this information will lead to the rejection of the tender on grounds of being incomplete.

Blower aerodynamic polytropic efficiency should be quoted according to ASME PTC-10, overall blower efficiency shall take into consideration bearing, gear and thermal losses in addition to aerodynamic efficiency.

Drive motor efficiency and tolerances shall be quoted according to IEC34-1 EN 60034-1.

Table 1: To be submitted with tender submission

Inlet pressure p0	Outlet pressure p2	Inlet flow %	308.15 K & Normal RH			303.15 K & Normal RH			293.15 K & Normal RH			283.15 K & Normal RH			273.15 K & Normal RH		
			m3/hr	kW	η	m3/hr	kW	η	m3/hr	kW	η	m3/hr	kW	η	m3/hr	kW	η
		100															
		80															
		70															
		60															
		45															

Notes:

Normal RH	*Normal Relative Humidity as per clause PTZ 2*
η	*Overall efficiency (blower + gearbox + drive motor)*
kW	*Consumed power*
p0	*Inlet pressure at compressor flange (bar)*
p2	*Discharge pressure at cone flange (bar)*

The guaranteed tender figures shall be validated by means of a factory test whereby the guaranteed figures shall be achieved or bettered. Achieving test results below that offered and guaranteed at tender stage may lead to the rejection of the equipment.

PTZ 7 AIR BLOWERS

PTZ 7.1 General

The envisaged size of the blowers in terms of required air flow rate and range shall be as stated in the Project Specification and shall be used as a guide for tender purposes.

The Tenderer shall offer at multiple blower systems as specified in the Project Specifications, of which one shall be selected during the award of the tender. Failure to submit alternative tenders will disqualify a Tenderer.

The HIGHEST priced offering shall be used for determining the Tender Sum.

PTZ 7.2 Blower and integral gearbox casing

Blower casing and volute shall be made of grey cast to BS EN 1561-1997 having a maximum continuous duty design temperature of 200oC, and a minimum design pressure of 2.0 bar (g). The blower inlet shall be field connected by the Contractor, directly to the inlet filter/silencer by a flexible connection supplied by the Manufacturer. Air inlet shall be axial through an annular inlet. Less efficient air flow directly into the center of the impeller is not acceptable. The discharge flange shall be faced and drilled to ANSI B16.1. A threaded port shall be provided at the lowest point of the casing for drainage. The blower casing shall be provided with lifting lugs capable of supporting the blower/gearbox.

The gear drive housing shall be of close-grained cast iron horizontally split and sufficiently rigid to maintain the shaft positions under maximum loads. Two inspection ports, with bolt-on covers, MUST be provided in the upper portion of the gearbox housing. The ports shall allow access to the gearbox internals for the purpose of inspection. A circular, bolt-on plate located on the fast shaft centerline, opposite the impeller end, shall be removable. This removable plate shall facilitate inspection and replacement of the fast shaft opposite impeller end journal and thrust bearing without disassembly of the gearbox.

Gearbox configuration shall incorporate a single helical gear set in an over/under configuration. The overhung impeller and fast shaft shall operate between the first and second critical speeds.

The blower and gear housing assemblies shall be machined to close tolerances for bearing fit, gear alignment, air, and oil tightness.

The gearbox shall be of ample size and rated to transmit the maximum torque and kW input requirements to the blower under all operating conditions and continuous duty.

PTZ 7.3 Impeller

The impeller shall be of the open backward swept type, with backward leaning blades and milled from forged aluminum alloy. Impellers constructed of any other method or material shall not be acceptable, except as described below. The impeller must be attached to the pinion shaft by shrink fit and locknut arrangement. The impeller shall be dynamically balanced.

The axial gap between the impeller and compressor casing shall be adjustable by means of shims in order to assure the prescribed gap. Gap adjustments by means of machining the casings or shafts are not acceptable.

Cast or fabricated 17-4PH, 316L stainless steel or chrome nickel steel impellers shall be acceptable, provided the Manufacturer meets the following requirements:

- A 115 percent over-speed test shall be successfully completed, followed by a magnetic particle or liquid penetrant inspection and dimensional check.

- For fabricated impellers, a complete 100% X-ray of the welded areas shall be performed. Results of these tests shall be independently certified by an agency acceptable to the Engineer and submitted for approval prior to ASME PTC-10 testing.

- Provide a five-year, unconditional warranty of a cast or welded impeller against any failure due to defect in quality, workmanship, or welding failure. The Manufacturer shall replace the failed impeller with the new impeller of same type material, repair any equipment damage at no cost to the Employer, and extend the warranty for an additional five years.

PTZ 7.4 Shafts, gears, and seals

The blower gear shafts shall be machined from heat-treated, forged high tensile alloy steel and suitably ground. Any responsive lateral critical speed of the rotating assembly shall be at least fifteen (15) percent from the normal operating speed. Any torsional resonances of the package shall be at least ten (10) percent from the normal operating speed. All shafting shall conform to “Design and Selection of Components for Enclosed Gear Drives” (AGMA 6001-D97).

The speed-increasing, helical, parallel shaft type gears shall be made of case-hardened alloy steel forgings with the gear teeth precision ground. All gears shall be rated in accordance with “Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical

Gear Teeth" (AGMA 2101-C95). The gears shall be manufactured to a minimum AGMA quality number of twelve (12) per "Gear Classification and Inspection Handbook" AGMA 2000-A88.

The shaft seals shall be of a non-contact, multi-point, labyrinth type and operated dry. A vented space between air and oil seals shall be provided. Any leakage shall be minimized by having small clearances between female and male parts. The female part shall be made of aluminum or bronze to avoid damage to the shaft in the event of a seal rub. Numerous slinger rings (diameter changes) on the shaft shall be provided in the sealing area to ensure oil is centrifugally slung off the shaft. Uniform shaft diameter without multiple slinger rings in each sealing area will not be acceptable.

PTZ 7.5 Bearings

Oil lubricated angular contact hybrid roller bearings with steel race and Silicon Nitride (Si3N4) ceramic balls shall be used in the gearbox.
Hydrodynamic, oil pressure lubricated bearings shall be required with sufficient oil film thickness under all operating conditions. All bearings shall be of bronze construction.

Slow speed shaft radial bearings must be cylindrical, journal type (hydrodynamic bearing).

Fast shaft radial bearings shall be multi-segment and babbitted, designed to suppress hydrodynamic instabilities and provide sufficient dampening to limit rotor vibrations. Fast shaft thrust bearings shall be multiple segment, tapered land type and designed for thrust in both directions. Material bronze alloy.

Rolling element (i.e. ball bearings) are not allowed be used for any bearing in the gearbox when main motor nominal power is equal or higher than 355kW.

PTZ 7.6 Variable vanes

If required in terms of the Project Specifications, flow and pressure regulation shall be achieved by the use of inlet and diffuser guide vanes positioned by linear electronic actuators and controlled by a proven PLC-based algorithm in order to provide the highest possible efficiency over the widest possible range of operating flows and pressures in order to maximize plant operational flexibility.

The purpose of the inlet guide vane and variable discharge diffuser system shall be to facilitate turndown of each blower from 100% to 45% of capacity, while maximizing efficiency over the entire turndown range.

Guide vanes shall be manufactured from cast iron or AISI 316 stainless steel. The inlet and diffuser guide vanes and covers shall be removable and shall allow full and unobstructed access to all the guide vanes, impeller and pinion shaft for inspection, in situ balancing and removal without disturbing the discharge pipe and blower volute.

An adjustable inlet guide vane assembly shall be provided to pre-rotate incoming air and, thus, maximize efficiency. Inlet guide vanes shall be made in an aerodynamic, streamlined design in cross-section and located in a radial fashion around the annular inlet. The inlet vanes shall not be used for capacity control.

Variable discharge diffuser vanes shall be provided for capacity control and designed to obtain the highest efficiency over the entire regulating range. Vanes shall be aerodynamically shaped for maximizing efficiency.

The inlet guide vane and the variable diffuser assemblies shall be mounted integrally with each blower, multi-leaf and pivoted, and located in cast iron housings. All vanes shall be mounted in permanently lubricated sleeve bearings. Operating linkages for inlet guide vanes and variable diffusers shall be housed within the blower. Blowers with variable vane assemblies located external to the blower housing, and/or have ball-in-socket linkages or other moving parts requiring periodic lubrication shall not be acceptable. The variable diffuser shall be manufactured from bronze alloy.

Each variable vane assembly shall include a blower casing mounted electric actuator, limit switches, and open/closed indication on the LCP. Independent floor mounting of the actuator or its operating mechanisms shall not be allowed.

The inlet guide vanes shall modulate simultaneously with the diffuser vanes to continuously and automatically optimize efficiency based on the three variables of inlet temperature, differential pressure, and machine capacity. The Manufacturer shall demonstrate, in submittals and testing, the simultaneous efficiency optimization based on these three

variables. Step control of vanes for efficiency optimization or control using less than these three variables shall not be acceptable.

The position of each set of vanes, from fully open to fully closed, shall be transmitted to the LCP via an analog signal. Position of both sets of vanes shall be indicated by an adjustable manual lever arm and calibrated dial on the blower casing. The inlet guide vane and the diffuser vane position shall be indicated on the LCP.

PTZ 7.6 Oil lubrication system

A complete lube oil system shall be provided with each blower, installed integrally with the blower base and arranged to permit ease of accessibility for operation, maintenance, inspection, and cleaning.

One main motor or gearbox shaft-driven primary oil pump and one electric motor-driven oil pump (as pre-lube and post-lube) must be provided, each capable of full capacity and pressure to supply lubrication for the air blower/gearbox when operating and during start/stop. The electric motor-driven oil pump shall operate at start/stop of the blower and, at low oil pressure, be activated by the control system located in the LCP. The motor

shall be 3 phase, 50 Hz, TEFC, high efficiency and have adequate power to pump oil equal to the mechanical oil pump flow rate at relief valve pressure and oil temperature of 10°C.

The oil reservoir shall be integral to the blower base with the reservoir interior de-scaled and rust-proofed by the application of a permanent coating of the Manufacturer's standard. The tank coating shall be certified by the Manufacturer for use in lubricating oil service. Reservoirs shall be baffled to minimize air entrainment, to isolate foam, be equipped with a suitably sized vent and breather filter, an oil level dipstick is mandatory, and have a minimum working capacity of three (3) minute retention time based on normal flow.

The oil filter shall be of the full flow, replaceable cartridge, duplex type with integral transfer valve, and capable of removing particles over ten (10) microns with a clean oil filter element pressure drop not exceeding five (5) psi at design temperature and flow. A visual gauge shall indicate when a filter is dirty and requires changing.

An air-to-oil cooler shall be provided to maintain constant oil temperature. All piping between the air/oil cooler and the blower skid shall be furnished and installed by the Contractor. If the air/oil cooler is located outside the blower building, and the ambient temperature is expected to go below 4°C, insulation and heat tracing of the oil piping and

cooler manifolds shall be provided by the Contractor. Two separate circuits shall be provided, one for the oil piping going to the cooler manifold, and one for the oil piping and cooler manifold for cooled oil returning to the blower skid. Location of the outdoor oil cooler shall be approved by the Manufacturer.

The Manufacturer's standard provisions for oil heating shall be provided to heat the oil if the ambient temperature around the blower is expected to fall below 10°C. If an insertion type oil heater is used, it shall be designed to heat lightweight oil with no more than fifteen (15) watts per square inch. The heater and thermostat shall be mounted on the oil reservoir with the contactor located in the LCP. The blower shall not start unless the oil is above 10°. Low oil temperature warning indication shall be provided on each LCP.

In the event that a sound enclosure is specified, the air/oil cooler must be mounted outside the enclosure, independent of the skid and field piped by the Contractor.

PTZ 7.7 Coupling

A flexible, forged steel, double-disc, dry type spacer coupling shall be furnished to connect the blower and motor. Couplings requiring grease lubrication shall not be allowed. Coupling and spacer shall be balanced to AGMA, Class 8, or better, and sized with a

minimum service factor of 1.5. Coupling construction shall be such that either shaft of the unit may be removed without disturbing adjustment of the other.

PTZ 7.8 Equipment base and mountings

The manufacturer shall furnish a base of adequate size to support the blower, gearbox, motor, lubricating system, and accessories. The base shall be constructed of fabricated Carbon steel in an integral welded box configuration with a drip lip, lifting eyelets, and have sufficient rigidity to permit lifting (using a four-point lift) with all equipment mounted. The base shall contain the oil reservoir.

The base shall be fully self-supporting and mounted on vibration isolators provided by the manufacturer and be suitable to absorb the weight and vibration of the blower assembly without undue stress or distortion. The vibration isolators shall be designed for a transmissibility of less than two (2) percent.

The units shall be factory precision aligned on the base prior to shipment.

PTZ 7.9 Electric motors

PTZ 7.9.1 General

The requirements for electrical motors associated with the air blower below shall supersede Particular Specification PEE and shall be applicable for the aeration equipment only.

Each blower shall be provided with a horizontal, constant speed, directly coupled TEFC (IP 55 1C 0141), squirrel cage induction type motor designed in accordance with current NEMA, ANSI and IEEE standards for satisfactory operation on a 400 volt 50 Hz three phase four wire supply of electricity with solidly earthed neutral.

The motor nominal power kW shall be equal to, or in excess of, maximum normal load that will be imposed at any point in the operating range of the design conditions specified (worst case scenario with all blower tolerances included). Each motor shall have a 1.15 service factor with “B” temperature rise and Class “F” insulation. Each motor shall be premium balanced for reduced vibration and supplied with lifting lugs and space heaters.

Motors shall be high efficiency design. Efficiencies shall be determined in accordance with IEC Standards, Test Method B. Nominal and guaranteed efficiencies shall be included on motor nameplates in compliance with IEC standards.

Motor insulation class IP55 as minimum

The torque-speed characteristics of each of these motors shall be so matched with the requirements of the associated driven air blower set when operating at the maximum specified duty to ensure smooth acceleration up to maximum speed within reasonable time.
Each motor terminal box shall be oversized to provide adequate space for connections and shall be constructed of cast iron or fabricated steel, neoprene gasketed, and bolted. The motor leads shall be permanently marked in agreement with the connection diagram.

The motors shall be designed and constructed for being started by means of ‘Direct-on-line’ starters with vacuum contactor switching. Special attention shall be paid to the winding insulation in this respect.

Each motor shall be suitable for six starts per hour of which two shall be in quick succession at the maximum ambient temperature to be experienced on Site.
The maximum starting current of these motors under locked rotor conditions at 3 300 volt on the motor terminals shall not exceed six times normal full load current (i.e. under ‘direct-on-line’ starting conditions).

Motors shall have factory installed fail-safe winding protection in each phase consisting of two embedded 100 ohm platinum temperature sensors per phase (one operational, one spare) or equal devices. Winding temperature RTD's shall connect to the LCP for monitoring and alarm.

Motors shall be equipped with thermal relays to sense high winding temperature. Thermal relays shall be wired directly to the LCP to provide high winding temperature trip protection.

PTZ 7.9.2 The Stator

The design and construction of the stator shall be such as to facilitate ease of replacement of damaged coils.

The winding insulation shall be resin rich, dense and void free to ensure absence of corona discharge and shall further have good head transfer properties, thermal expansion properties matching those of copper and shall be non-hydroscopic and solvent free.

The windings shall fit tightly into the stator slots and winding overhang shall be securely braced to prevent coil movement under starting and surge conditions.

The line leads shall beterminated via fully insulated stud type terminals in a suitably sized terminal box with a pressure relief diaphragm which will be forced out towards the motor under fault conditions.

The terminals shall be clearly and indelibly marked and the terminal box shall be designed to exclude the entry of dust and moisture and shall be sealed from the internal air circuit of the motor. All joints shall be flanged with gaskets of neoprene or other approved materials.

A cable sealing chamber with a filling hole, drain plug, universal brass wiping gland and armour clamp to facilitate the making off and connection of PLSTS cable shall be fitted onto the bottom of this terminal box.

The terminal arrangement shall be such that:

(a) The terminal box need not be disturbed when the motor covers are removed.

(b) The motor may be disconnected from its supply cable without disturbing the sealing compound or damaging the cable tails.

(c) The motor windings and supply cable can be tested separately.

PTZ 7.9.3 The Rotor

The rotor shall be statically and dynamically balanced.

The rotor bars shall have positive locations and shall fit tightly into the rotor slots to prevent bar movement and/or breakage under starting and surge conditions.

PTZ 7.9.4 The Bearings

The motor bearings shall be of the oil lubricated sleeve type with oil ring lubrication and air cooling.
The bearings shall be provided with at least two oil rings each running in an oil bath of ample capacity complete with filling hole, drain plug and an external oil level indicating device.

Where necessary, provision shall be made to prevent damage to bearings by shaft currents, by insulating both the drive and non-drive end bearings and their associated connections, the insulation at the drive end bearing being bridged by a removable copper strap.

The manufacturer shall ensure that the bearings are adequately cooled in service.

Bearing arrangements allowing complete removal of bearings for inspection or replacement without disturbing the coupling alignment are preferred.

The limits of permissible end float of the rotors on the motors with sleeve bearings shall be clearly marked and any special alignment procedures shall be supplied.

Each motor shall be installed complete with the first filling of bearing oil.

PTZ 7.10 Inlet filter and silencer

Each blower shall be provided with an inlet filter/silencer designed for maximum air flow at absolute minimum pressure drop and connected directly to the inlet of the blower via a flexible connector.

The filter shall be mounted on the silencer frame and fitted with rectangular, replaceable elements positioned on a flat, vertical track of aluminum construction. The filter shall be

removable through galvanized steel doors located on each side of the galvanized steel housing. A single-stage filter panel system shall be supplied. The filter shall be EU3 or EU4 type.

The integral inlet silencer shall consist of a set of lamellae, mounted internally in the filter/silencer between the filter elements and the blower inlet, suitably wrapped with sound deadening material. Lamella construction shall be such that there is no direct line of sight (direct flow) through the lamella, and the lamella so configured such that the line of air flow shall make at least four turns, for maximum attenuation. An airtight seal shall be provided between the filter frame and silencer.

Maximum clean filter pressure drop of the inlet filter/silencer with the elements installed shall be 0,003Bar. Maximum pressure drop with dirty inlet filters shall be 0,006Bar.

The inlet filter/silencer shall be installed by the Contractor by press fitting a one-inch foam rubber gasket, provided by the Manufacturer between the wall (transition shroud) (inlet plenum) and the flange around the periphery of the inlet filter frame. The Contractor shall connect the filter/silencer to the blower inlet via the flexible connector provided.

PTZ 7.11 Discharge flexible compensator

Each blower shall be provided with a discharge expansion joint, for field installation by the Contractor, capable of withstanding the vacuum, pressure, and high discharge air temperature under all operating conditions. The expansion joint shall be suitable for mounting between flanges drilled. The expansion joint material shall be suitable stainless steel.

PTZ 7.12 Discharge cone/silencer

The blower unit shall be provided complete with a mild steel discharge cone/silencer, for field installation by the Contactor, to increase the blower outlet size to the larger diameter air discharge piping. Maximum sidewall angle increase shall be 7^{o} per side (14^{o} total). Instrument connections shall be provided for components mounted by the Contractor, on the cone/silencer.

The inside of the discharge cone/silencer shall be lined with deep layers of sound absorbing material, resistant to high temperatures, covered by fiberglass cloth and a perforated steel plate, so as to form sandwiched layers of the external cone/silencer surface, acoustical material, and internal perforated steel plate.

The design of the cone diffuser shall allow a max air discharge speed below 20 m/s.

The maximum allowable noise level according to ISO 3744 (1m from the pipe) to be below 85 dB(A).

PTZ 7.13 Blow-off (bypass) valve

Each blower shall be equipped with a steel or cast-iron body blow-off wafer type butterfly valve for field installation and wiring to the LCP by the Contractor to allow unloaded start-up and stop, and designed for low pressure air service. The valve operator shall be motorized, 400/50/3, IP55, open/close in fifteen (15) seconds or less, equipped with starter, open/close limit switches, and shall be suitable for air service up to 120^{o}C. Controls for the valve shall be mounted in each LCP. A blow-off silencer shall be provided, as described below.

PTZ 7.14 Discharge valve

Each blower with a standard wafer type discharge butterfly valve for field installation and wiring to the LCP by the Contractor, identical to the blow-off valve, except for size and actuation speed, which shall open/close no faster than thirty (30) seconds.

PTZ 7.15 Check valve

Each blower shall be equipped with a wafer type discharge check valve of the dual, plate type with center hinge, spring closure, cast iron body, Viton-B seal and aluminum-bronze plates, Inkonel springs, and rated for temperatures up to 200°F. The check valve shall be mounted and installed by the Contractor, in a horizontal or vertical run of piping. Check valve diameter shall be as discharge cone diffuser size.

PTZ 7.16 Blow-off valve silencer

An Alu-zinc blow-off silencer shall be provided for each blow-off valve. Internal baffles, packed with sound absorbent material shall direct air flow around three (3) 90° turns in an annular flow configuration. The blow-off silencer shall be fitted with one (1) flange for direct bolting to the blow-off valve, with installation by the Contractor.

PTZ 7.17 Silencer hood

Each blower unit shall be supplied complete with silencer hood covering the complete unit, including the motor to ensure that the average sound level is less than 85 dB(A) a 1-meter distance from the aggregate according to ISO 3744. The hood shall be equipped with a sight window and thermostatic controlled ventilation fan.

PTZ 8 DUTY OF AIR BLOWERS

The filter system shall be suitable to ensure that the blowers receive air with a solids content of less than 2,5 micrograms/m^3 (refer section PTZ 13 for filtration requirements).

The total air demand will depend on the efficiency of transfer of oxygen by the air diffusers and must be either be determined by the Tenderer (in the case of a new system) or will be stated in the Project Specifications (existing diffuser systems). However,

the capacity of the blowers shall not be less than that stated in the Project Specification. The blowers shall be selected to provide for the losses in the system as proposed and shown in the lay-out drawings, considering the losses through the filtration system at a maximum of 750 Pa, as well as the present and future losses through the diffusers and all other appurtenances.

The blowers shall be selected to operate at or near optimum efficiency when delivering 80% of the maximum air at the site conditions as given under clause PTZ 2. The Tenderer shall submit a system back pressure curve for the fully designed system that is proposed together with the characteristic curves for the blowers supplied.

PTZ 9 BLOWER OUTPUT AND LOCAL CONTROL

Suitable probes will measure the dissolved oxygen (DO) content of the various reactors and will by means of a suitable oxygen controller transmit a signal as to whether more or less oxygen (i.e. air) is required and hence open/close an actuated knife gate-type control valve on the inlet header. If additional air is required, the valve will open resulting in a pressure drop in the air header, which in turn must signal the blower to increase speed and *vice versa*.

Tenderers must allow for an automatic blower output control scheme whereby the output from the blowers is varied in accordance with this, or similar signal. The scheme must also be such that local manual control may be reverted to in the event of malfunctioning of the DO equipment. This manual control will also be extended to the control room SCADA under the electrical portion of the Contract.

The scheme should preferably include for flow measurement on the inlet side of each blower, flow summation and division with subsequent Inlet Guide Vane (IGV) actuation by electric means.

The schemes must be such that the output load is equally shared between the operational blowers (if applicable) e.g. should one blower reach 100% output a second should come on-line and the outputs should be equalized (at 50% or thereabouts). This also applies in the case of decreasing output requirements.

Facilities must be included in the control scheme to introduce a 'time lag' as a blower is either brought into or taken out of operation in order to prevent excessive wear on the switching mechanisms (i.e. to reduce the effects of hunting). In addition, the limit switches responsible for bringing in or taking out the blowers shall be so set that there is an 'overlap' of duties, i.e. with two blowers running at minimum duty they should only produce about 85 – 90% of one blower's total capacity.

Automatic surge protection must be incorporated in the overall flow control scheme and should be of such a form that should 'surge' be sensed, the blow-off valve shall

automatically open. Provision for manual operation of the blow-off valves must be included.

Tenderers must submit clearly marked line diagrams of the automatic flow and surge protection schemes proposed with their tenders. These drawings must be accompanied by detailed descriptions of the control schemes including items such as:

(i) The balancing of blower outputs;
(ii) How the number of operational blowers is increased or decreased;
(iii) The sequence selection of the blowers;
(iv) Safety measures that are incorporated.

In the event that a duty/standby arrangement is required, provision shall be made for automatic duty rotation without stopping the flow of air as required by the treatment system.

Failure to enclose the drawings and the control descriptions will classify a tender as incomplete and render it liable to rejection.

Tenderers must allow for all the necessary instrumentation and actuators, as well as the steel instrument panel into which the instruments will be mounted. The panel will be positioned in the blower control room and Tenderers must not only include for all the panel wiring but also the cabling from the panel to transmitters, actuators etc. plus the connecting up thereof. In summary, the control system must be complete and capable of efficient operation.

Instrumentation components forming part of the blower assembly shall be compatible with the operational system of the plant and shall be provided by the manufacturer and mounted on the blower skid, except as noted, with all electrical connections external to the skid, wired to the LCP, by the Contractor.

Instrumentation to be provided with **each** blower shall include as a minimum:

- 1 x Inlet air filter differential pressure switch to monitor inlet air filter clogging;
- 1 x Inlet air temperature transmitter 4-20 mA – inlet high temperature and recirculation surge indicator;
- 1 x Surge protection switch;
- 1 x Discharge air high temperature transmitter;
- 1 x Differential pressure (inlet/discharge) transmitter 4-20 mA;
- 2 x Lube oil temperature transmitters;
- 2 x Lube Oil pressure transmitter;
- 1 x Oil filter differential pressure switch – Filter change warning;
- 1 x Inlet guide vane position transmitter;
- 1 x Discharge diffuser vane position transmitter
- 1set of Diffuser & IGV limit switches
- 1 x Inlet air flow meter transmitter
- 5 x PT-100 bearing temperature probes

- Seismic probe mounted on the gearbox casing to monitor vibration.

The PLC in the Local Control Panel (LCP) shall receive, and the Operator Interface shall graphically display, the signals listed above.

The Operator Interface shall include an adjustable alarm feature for rising differential pressures, temperatures, and vibration levels that first alarms and is followed by unit shutdown. The alarm/shutdown shall be displayed until reset. The necessary hardware for direct communication between vibration probes, PLC, and Operator Interface shall be included.

All LCP's shall be connected to a Master Control Panel (MCP), as described below, from where control of the aeration system as a whole shall be possible.

PTZ 10 MASTER CONTROL PANEL

A Master Control Panel (MCP) shall be provided to ensure the efficient and reliable full automatic control, monitoring and co-ordination of the complete aeration system. Suitable hardware in the form of an 15-inch minimum colour touch HMI equipped with a suitable PLC and control software shall be provided. The MCP PLC shall receive signals from all relevant external sources (DO probes, valve actuator settings, flow meters, pressure transducers etc) and shall control the operation of the air blowers and external equipment using efficient cascade control philosophy. It shall be possible to integrate the MCP with the plant SCADA and hence fully compatible electronic equipment shall be used as far as possible.

PTZ 11 ELECTRONIC EQUIPMENT

The electronic blower output control equipment shall be suitable for operation from either single phase 220 to 250 volts or three phase 380-433 volts 50 Hertz AC mains supply. The equipment shall not suffer from any form of instability or change of calibration during supply voltage and frequency variations of +10%.

All electronic equipment shall be similar to that used at the plant and shall be fully compatible with existing equipment and control systems.

All units which are to be supplied from a socket outlet shall be fitted with a 3-core mains supply lead terminated in a 15A 3 pin plug to SABS 164.

All portions of the equipment shall be provided with means for effective earthing and all equipment shall be supplied with the following protection against faults:

- main voltage surge protection, varistor or equal
- overload protection
- output circuits short circuit protection
- circuits to be intrinsically safe, using zener barriers or equivalent.

Any regulated DC supplies shall have a load regulation better than 0,1% from non-load to full-load with input variation as defined above.

All equipment shall be suitable for operation under the following conditions:—

- maximum ambient temperature : 80°C
- minimum ambient temperature : -5°C
- humidity (absolute max) : 100%

The construction of the equipment offered shall be such that maintenance and overhaul may be easily performed and the housings shall be robust, vermin proof and dustproof to IP 54. All equipment offered shall be suitable for panel mounting. All panel fixing shall be of the captive type and all bolts and fixings shall be cadmium plated or otherwise protected against a severely corrosive environment.

Interconnecting leads shall be either of the flat cable or of the spiral harnessed type, strain relieved where necessary and numbered to correspond to the maintenance manual.

Discrete components and integrated circuits shall preferably be socket mounted. Plug-in components shall have both component surfaces gold plates.

Printed circuit boards shall be of the fibre glass reinforced type and shall be firmly supported in their respective units by means of suitable guides. Printed circuit boards shall not plug directly into edge connector sockets.

Where a plug-in facility is provided, edge connectors of the plug-in socket type shall be used and the plug shall be soldered onto the circuit board. Edge connectors shall be gold plated on all mating surfaces and the gold plating shall last for at least 1 000 replacements. Discrete test points shall be mounted on circuit boards at all points referred to in the maintenance manual.

All equipment offered shall be suitable for operation with standard 4 -20 mA ranges into 0 to 600 ohms loads.

PTZ 12 BLOWER STOP/START SEQUENCE

Although all motor starters and associated controls have been incorporated into the electrical portion of the Contract, Tenderers must include for initiating devices such as pressure or limit switches necessary for safe operation and sequence starting of the blowers. Electrical wiring diagrams for the stop/start sequence of a blower incorporating the abovementioned limit switches must be supplied by the successful Tenderer.

PTZ 13 AIR FILTRATION SYSTEM

Air filtration equipment is required for the filtering of air prior to being fed to the blowers for compressing and subsequent supply to the air diffusers in the activated sludge system. This section of the Contract includes for the supply and installation of the filters, all pipework, inlet and outlet connections, ducts, bellows (for insulating the equipment and the environment against noise), valves or other means of isolating individual units for repair or cleaning operations, inlet louvres or roof inlets equipped with rodent screens, shaking mechanism where applicable, access hatches, preliminary filters, automatic advancing mechanism where applicable such that the entire system will be complete for operation. Where use is made of pre - coating on

the filters, the Tenderer must allow for supplying and feeding the precoat material into the filters during the commissioning of the plant operation.

The Tenderer shall allow for modular units in the blower house such that any unit can be taken out of service and cleaned without interrupting the air flow to the blowers.

PTZ 13.1 Quality of Inlet Air

The quality of the inlet air will vary from fairly good during the summer to dust laden during winter months. Apart from the normal dusty conditions encountered on the Highveld during the winter, the plant is subjected to temperature inversions during winter which may fill the air with smoke-laden particles. Tenderers shall therefore take into account that heavy coal smoke will be contributing to the dust load. It is estimated that during winter mornings the dust load may exceed 400 micrograms/m3.

PTZ 13.2 Quantity and Quality of Air to be delivered

The air filters shall be capable of processing air at a rate varying between the minimum and maximum requirements for the diffusers for the oxygen transfer as stated in the Project Specification. The maximum rate will be experienced if for test purposes all the blowers are operated simultaneously. Although this high rate will be unlikely, especially during the initial stages, the possibility exists that such operating conditions may occur. This maximum flow may occur at any of the conditions that might be encountered at the site of the plant, situated to the north of Rustenburg at an altitude of 1 090m above sea level, having a temperature range of -0°C to 40°C and normal relative humidity of 70% increasing to 95% in summer.

The filters are to be operated continuously under conditions of varying output with normal daily variations unlikely to exceed a ratio of four to one. During the initial stages, it is assumed that the range will be on the lower side and it would be possible to take some of the units out of commission during this period.

The air produced shall contain less than 2,5 micrograms/m^3, of dust, shall have a dust spot efficiency of greater than 96% and shall have an efficiency of greater than 95% with the Dioctylphthalate smoke test (OOP test).

The dust spot test shall be the ASHRAE (Standard 52-78) atmospheric dust spot efficiency test in which volumes of atmospheric air and volumes of filtered air are drawn through two standard filter papers in such a way that 'dust spots' of the same intensity are formed.

The tests shall be performed under extreme conditions of particulate pollution of the air that is encountered at the site some winter mornings.

The DOP test is performed by the application of dioctylphthalate smoke of average particle size of 0,3 micron, produced by a special generator to the filter and testing the delivery and input air to the filter by particle counter.

PTZ 13.3 Staged Filtration Primary Filters

Due to the heavy dust load of the intake air and the requirement for a high quality outlet air, it is suggested that two-stage filtration be used. Depending on the efficiency of the units offered, the Tenderer may also decide to use a further stage of filtration.

The Tenderer shall offer a first stage unit that will remove at least 45% of the dust as determined by the Dust Spot Efficiency Test. The filtering material shall be disposable and may be of the viscous surface type but oil impregnated filtering units will not be acceptable.

The Tenderer shall offer automatic control of the advancement of the filtering unit as well as local indication of the need for the replacement of the material. In case of automatic advancement of a roll of filtering material, the automatic device must determine the pressure loss through the cloth and when this loss becomes unacceptably high, the roll must be advanced one full width, similar to advancing a film in a camera. In addition to describing fully the type of filter cloth to be used, the Tenderer shall give such details as the unit mass, the filtering characteristics, the filtering efficiency, availability, unit cost, filter life and ease of replacement. For automatic units, it shall be possible to operate the units by hand should the mechanism fail. In the case of cartridges that must be replaced, the Tenderer shall provide a pressure loss metering device coupled to some form of warning system for informing the operator that the elements need replacing. It shall preferably be possible to connect the warning system to an electrical pickup for display in the control room of the Blower House. The primary filter shall be robust and shall be capable of withstanding the pressure from the inlet side when reaching the point of maximum pressure loss.

The maximum head loss through the entire filtering system shall not exceed 750 Pa at maximum flow rates and the headloss through the primary filters shall be such that optimal conditions for filtering can be obtained. The pressure loss through the primary system shall therefore be combined with the additional loss through the secondary filters and not exceed the maximum loss of 750 kPa.

PTZ 13.4 Secondary Filters

The secondary filters, where they are the final units, shall be capable of delivering air under varying conditions as mentioned above, under all conditions of temperature and climate to an efficiency of 96% using the OOP smoke test. The dust content of the air to the blower shall be less than 2,5 micrograms/m3 .

The secondary filters, may consist of replaceable cartridges or may be constructed of filter cloth using a pre-coating for obtaining the high efficiencies required. In the case of vertical bag filters, the individual bags shall be supported in such a way that the varying flow through the units shall not cause the bags to deform and develop weak spots during operation. The choice of material must take into account the probable life of the filters and the cost of replacement and repairs. Care must be taken that replacement of cartridges will not result in possible leaks around the replacement units.

When offering pre-coated bags the Tenderer shall include for a mechanism for the removal of the coating and the dust collected, including a suitable vibrating mechanism. The pre-coating shall normally remain on the filters even when the machines are stopped for short periods. In case the suction of the blowers will not be sufficient to lift the pre-coating after a collapse, the Tenderer shall provide for means of lifting the pre-coat onto the bags. The bags shall have a perfect fit on the filter housing that will prevent any leakages of air past the connections. The operation of the shaking or vibrating mechanism shall not have the effect of damaging the bags in any way or weakening the connections to the filter housing. Access shall be provided to the bags for inspection and for testing for leaks and other defects.

The Tenderer shall describe in detail the type of filter offered, the type of cloth, means of replacement, cost of replacement, expected frequency of replacement, availability of cloth or pre-coat, storage requirements, handling precautions, downtime for replacement, possible precautions at time of replacement and efficiency of filtering immediately after replacement.

The total pressure loss through both the primary and the secondary filters shall not exceed 750 Pa and the choice of filters shall be such that optimal operation of the two units in series is obtained. The pressure loss through both units shall be registered and recorded to serve as a warning to the operator to change the cartridges or the pre-coating.

The housing of the secondary filters shall be such that filtered air will not be in contact with corrodible metal. Galvanized sheets shall be used for the construction of those parts of the filter housing in contact with filtered air.

PTZ 13.5 Alternative Offers

The Tenderer shall offer at least primary and secondary units as per this Specification but may offer three stage filtration in place of two. In the event that the Tenderer can prove that the system offered by him does not require two stages but that one single stage will be sufficient to comply with the requirements of this Specification, he may offer such a system as an alternative to the two-stage unit. In such an instance he must clearly state the advantages that could be achieved having only a one-stage unit as well as the disadvantages that this system might have. (Failure to meet the

required air standards will be considered serious and all steps to rectify the situation at a later stage will be at the cost of the Contractor under this Contract). The Tenderer must preferably offer at least two alternative systems and price them separately, leaving the final choice of system to the Engineer.

PTZ 14 DUCTING

The Contractor under this Contract must provide for all the ducting required to convey the air through both sets of filters and up to the inlet duct to the blowers.

The design of the ducts must take into account the pressure loss which must be minimized both with regard to cross-sectional area of the ducts and internal passages of the filters, and in adequate bends and the elimination of turbulence in the ducts.

The Tenderer shall provide for all means of supporting the ducts and where required must indicate how the ducts will be supported by the structure. Ducts shall be suspended from the ceiling of the pipework room by spring support. The Tenderer shall fix the supports to the concrete slab by means of corrosion resistant bolts.

Gate valves or other means of isolating the individual secondary filters shall be fitted into the ducts and the downstream gates shall have airtight closure such that no unfiltered air can be sucked into the blowers during the periods of maintenance or recharging of the elements. All ducting ahead of the secondary filters may consist of suitably protected mild steel but ducting conveying the final filtered air to the blower inlet manifold shall consist of stainless steel type 304 or equivalent. These ducts leading down to the manifold must be supported on the floor of the filter room and connected by bellows to the manifold. The bellows shall consist of approved pliable synthetic rubber that will be capable of absorbing vibrations and noise. The transmission of noise shall be minimized and, where unavoidable, the Tenderer shall allow for lagging of the ducts.

The ducts between the primary and secondary filters shall be adequate in size and shall be suspended from the roof of the filter house. The intake ducts of the primary filters, or when only one set of filters is supplied, the intake to this set, shall be situated on the roof of the filter house and shall be protected against accidental intake of birds and large flying insects. Depending on the size and shape of the intake and the amount of protection required against sound transmission these intakes will be protected by concrete surrounds to prevent the transmission of sound to the outside. One of the intakes to the filters shall be extended to the actual blower house to allow for the ventilation of the blower house. Air will be sucked in from the blower house which will be ventilated on an opposite wall in such a way that sound will not be transmitted to the outside. The provision of this duct also forms part of this Contract.

PTZ 15 PIPEWORK INSIDE THE BLOWER HOUSE

This section of the Contract includes the supply and installation of all pipework and valves inside the Blower House, generally as shown on the drawings or described in the Project Specifications. The pipework layout shown on the drawings is only tentative and the Tenderer shall submit his own design to suit the equipment offered.

Pipework shall be manufactured of grade 304 stainless steel and all valves and other equipment installed in the pipelines shall be of an inert material where in contact with the air passing through. All necessary pipe supports and pipe hangers must be included.

The Tenderer shall provide for sufficient expansion joints to compensate for creep due to changes in temperature under operating and non-operating conditions. Facilities must also be provided by means of which moisture which collect in the pipework can be conveniently discharged at definite points.

PTZ 16 FLANGES AND PIPEWORK IN GENERAL

The dimensions and drilling of all flanges in the air supply pipework shall comply with the requirements of BS 4504 for a working pressure of 2,5 bar (250 kPa).

All air pipework shall be grade 304 Stainless Steel. Wall thicknesses of stainless steel pipes shall be adequate to prevent deformation after installation as well as during handling, before installation but shall nevertheless not be less than 2 mm for pipes up to and including 300 mm and 3 mm for pipes up to and including 600 mm in diameter and 4,5 mm thick for pipes larger than 600 mm in diameter. Where pipes are to be laid on concrete floors or slabs the pipes shall be provided with welded on supports at distances which will prevent buckling or undue bending of the pipes.

All stainless steel pipes which will be installed in positions exposed to view shall be acid etched externally.

PTZ 17 ARRANGEMENTS IN BLOWER HOUSES

The Contractor shall be responsible for the design of the blower and pipework configuration inside the Blower House.

Allowance has been made for placing the secondary units in line in such a way that all outlet pipes will be feeding into the duct supplying the blowers with air. The duct for air to the secondary filters will be on the opposite side near the ceiling of the room to allow for access and for head room in the filter gallery. Depending on the size of the primary filters, they will be installed in a room on a floor higher than the secondary units, feeding into the duct supplying the secondary units. When offering the alternative of single units or when offering combined units, these units will be housed where the secondary filters are shown and provision must then be made for air intake through ducts in the roof of the filter gallery; these ducts to form part of this Contract and to be supplied and installed by the Contractor. Due to the urgency of the project,

the successful Tenderer shall be required to discuss his requirements for housing the filters at any early stage with the Engineer to assess the space requirements.
The Tenderer must give an indication of his requirements for installing the filter units in the blower house as proposed. Preference is expressed for modular units that could be assembled inside the building. Space requirements for moving the units into the blower house must be clearly indicated.

PTZ 18 MATERIALS OF CONSTRUCTION

The filtering units shall be supported on concrete floors. The housing of the filtering unit may consist of suitably protected mild steel or stainless steel. All parts of the housing or internal framework that will be in contact with the filtered air shall be of galvanized steel. In this instance the housing needs to be structurally self-supporting. In all events, the housing downstream of the filters must be able to withstand the pressure loss through the filters. Although it is specified that the loss should be less than 750 Pa, the housing shall be able to withstand differential pressures of more than 3 kPa without any permanent buckling. Stainless steel parts shall be acid etched on exterior faces.

The ducting leading away from the secondary filters shall comply with previous requirements. Leak tests shall be performed to ensure that no leakage of air can take place after the secondary filters.

PTZ 19 LEAKAGE TESTS

During commissioning and at the end of the Defects Notification Period, tests shall be performed, using DOP smoke generated by a smoke gun to determine if the system is leakproof. Any/all leaks discovered during the execution of these tests shall be repaired by the Contractor at his cost.

The test shall first be performed by generating smoke within each of the filter units to determine their efficiencies and also to determine if any leaks occurred in the bags themselves or in the connections between the bags and the manifolds or between cartridges and the housing. When it is clear that such leakages are occurring the Contractor under this Contract shall rectify any such defects at his cost. Torn cloth shall be replaced forthwith and the tests repeated until such time as the filters can deliver the quality of air as specified.

Leakage tests shall also be performed along the length of the ducts leading to the blowers by generating smoke around the ducts and measuring the smoke in the air by particle count.

A means of continuously testing the filtered air shall be provided. This may consist of a tube of about 25 mm dia. to be mounted near the blower outlet pipes and connected to delivery pipes, being fitted with a reducer to control the airflow, and a rotameter to meter the airflow, and having a millipore filter or other suitable filtering media mounted

in the tube in such a way that the air could be passed through the filtering unit as a predetermined rate of about 6 m3/m2 of area per minute. The filter paper or millipore filter could then be removed and stored as a record of the performance of the filters or compared for efficiency or weighed to determine the mass increase during the operation of the plant. Easy access to the filter paper would be required for regular testing and maintenance.

PTZ 20 DISSOLVED OXYGEN MONITORING AND CONTROL EQUIPMENT

The system required shall provide for continuous monitoring and recording of the dissolved oxygen levels in the aeration basins and shall also pace the aeration equipment such that the consumption of electric power will be minimized while at the same time maintaining the dissolved oxygen in the treatment process at predetermined and preset levels.

The Tenderer shall provide full details of D.O probes, calibration units, recorders and everything necessary to allow for the optimum oxygen input with the minimum power consumption.

PTZ 21 SPARE PARTS

The following spare parts shall be provided under this Contract:

- 2(No) complete set of all bearings for the blowers
- 2(No) complete set of o-rings, gaskets, and seals for the blowers
- 2(No) actuators for the inlet guide vanes (if applicable)
- 2(No) actuators for the variable diffuser vanes
- 2(No) main and auxiliary oil pumps complete with electric motor
- 2(No) sets of oil filter cartridge elements for each unit
- 2(No) set of inlet air filter elements for each unit

All spare parts shall be suitably packaged and clearly identified with indelible marking on the containers.

PTZ 22 TESTING OF BLOWERS

PTZ 22.1 Factory Acceptance Testing

Each blower shall be tested in accordance with ISO 5389-2:2005-12-15. Tests MUST be conducted using the JOB motor (factory test motor is NOT allowed). A calibrated torque meter shall measure the gearbox/compressor shaft input kW. The test shall include determination of the surge point and verification of the guarantee points. Shaft power consumption shall include one operating oil pump. Testing using less accurate heat balance or measuring the wire power draw shall not be allowed.

The blower net delivered flow rate and discharge pressure shall be measured, recorded, and guaranteed with no negative tolerance. There shall be no other tolerances or measuring uncertainties used in reporting test results (i.e., the tests shall be reported with ± zero percent tolerance).

Capacity shall be defined as, “the net rate of flow compressed and delivered, expressed in terms of Nm3/h at the prevailing inlet pressure and inlet temperature. It shall be measured in a suitable manner to exclude effectively all external leakage losses from sources such as shaft seals.” That is, air flow shall be measured on the discharge side of the blower at zero percent tolerance.

All test equipment shall be calibrated and certified by an independent test agency no more than twelve (12) months prior to the test date. Certificates shall show the stability of calibration over a period of at least one year per ISO 9001, Paragraph 4.11.

Velocity vibration versus frequency levels shall be recorded within 10-1,000 and 10-10,000 Hz frequency range. Vibration of the balanced blowers shall not exceed 25 micrometers double amplitude as measured on the shaft adjacent to the journal bearings.

The Witnessing Engineer shall sign each copy of the test data log sheet certifying that the required tests were performed in strict accordance with the requirements of ISO 5389-2: 2005-12-15.

Upon completion of assembly, each blower, motor, and oil lubrication skid shall be functionally tested. The oil lubrication system shall be run and tested for leaks. The LCP shall be tested using simulated sequences i.e all start/stop sequences and all safety and alarm systems, simulating start of the blower motor etc. Where applicable, the master control panel (MCP) shall be connected to all local panels. The entire system of all blowers, local panels (and MCP, if furnished,) shall be demonstrated to the Witnessing Engineers as an operating system before shipment. The Witnessing Engineers shall sign the test procedure and results, certifying that the assembled blowers were tested as per specification in the Manufacturer’s shop.

In the event that the Engineer and/or Employer wishes to attend the complete assembly functional tests of all the blowers at the Manufacturer’s testing facility, the requirement shall be stated in the Project Specifications and priced accordingly.

The blower test report shall present all computations and relevant performance curves showing capacity, pressure, and kW inputs, compared to those offered and guaranteed at tender stage.

Test results of the motors and blowers shall be included in the Operations & Maintenance Manual.

PTZ 22.2 After installation

Notwithstanding any other requirement for testing and commissioning stated elsewhere in the document, testing and commissioning of blower equipment after installation shall generally include the following:

(a) Ensure that the bearings are properly lubricated, oil reservoirs are filled to the correct level and bearing thermometers are correctly set.

(b) Ensure that all power and earth connections are properly made.

(c) Check all ventilation openings for obstructions.

(d) Measure the insulation resistance between phases mutually and between each phase and earth to ensure that the windings are dry.

After the motor has been started the following shall be observed:-

(e) Smoothness and period of acceleration up to maximum speed and motor currents at maximum speed.

(f) Noise, vibration and temperatures of motor and bearings.

PTZ 22.3 At the end of the Defects Notification Period

The Contractor shall allow in his rates for the complete servicing of the blower and ancillary equipment, including the replacement of any/all consumables (grease, oil etc) and reagents (if applicable) supplied under this Contract at the end of the defects notification period. The submission of all relevant service reports shall be a requisite for the issue of the Performance Certificate.

Once serviced, all equipment and items supplied under this Contract shall be re-tested to prove that continued compliance with the Specifications prior to the issue of the Performance Certificate, signifying final completion and acceptance of the Works.

PTZ 23 START-UP AND TRAINING

The Manufacturer shall furnish experienced start-up/commissioning personnel to inspect the final installation and supervise the field start-up tests of the equipment. The services shall be provided for a minimum of four (4), eight-hour (8-hr.) days for each unit, four (4) days for the MCP (if supplied), and four (4) days for the aeration system valves, controls, aeration system adjustment, and optimization. If there are difficulties in operation of the equipment due to the Manufacturer's fabrication or Contractor's installation, additional service shall be provided at no extra cost.

PTZ 23.1 Blowers and Appurtenances – Initial Start-Up

Provide, as a minimum, the following field commissioning:

- Verify proper connection of piping and installation of accessories
- Field precision alignment of the motor, blower, and coupling
- Check leveling of blower base
- Confirm proper wiring of all instruments and field wired items
- Run motor uncoupled for up to one-half (1/2) hour to verify motor operation and check magnetic center for proper marking/location

A minimum four (4) hour field run test shall demonstrate that, under all conditions of operation, each unit:

- has not been damaged by transportation or installation;
- has been properly installed;
- has no mechanical defects;
- has fully functional instrumentation, properly calibrated and set;
- will start, run, and stop in the prescribed manner;
- will run through the entire range of specified pressure and flow;
- has the proper shutdown sequence of standard stop, soft stop, and emergency stop;
- is free of overheating of any parts;
- is free of objectionable vibration and noise;
- is free of overloading of any parts;
- Demonstrate the simultaneous and continuous efficiency optimization by altering the inlet guide vane position based on inlet temperature, differential pressure, and capacity.

PTZ 23.2 Aeration System and Appurtenances

(a) Initial Start-Up

Conduct a minimum of four (4) hour field run test of the aeration system instrumentation, controls and valves. The test shall demonstrate the following:

- The air header pressure control loop will automatically control on-line blowers in a stable, cascade mode of operation.

- Demonstrate the proper operation of each air flow control valve, air flow meter, and DO probe, that each will transmit appropriate signals and react to MCP/manual adjustment.

- The aeration system shall be operated in air header pressure mode, only, with manual control of air flow control valves until such time as the entire plant comes on-line and the aeration system receives a consistent flow and BOD level into the aeration cells.

(b) System Optimization

After the wastewater flow and BOD have stabilized for at least three (3) weeks, but no longer than six (6) months after initial start-up, the Manufacturer shall return and

optimize aeration system performance based on most open valve control and automated DO control.

Tests shall demonstrate the following:

- Air flow control loop maintains the proper air flow to each aerated cell based on DO.

- The DO control loop maintains a pre-set DO level in each aerated cell.

- The air header pressure control loop will automatically control on-line blowers in a stable, cascade mode of operation.
- The entire aeration system of blowers, air flow control valves, and instrumentation operates in a stable fashion, maintains air flow control valves in their most open position, and maintains DO at operator set levels in the aeration cells.

- Field demonstration testing shall be conducted after the equipment has operated for a sufficient period to make all desirable corrections and adjustments. The Contractor shall schedule testing with the full knowledge and consent of the Employer and shall ensure no adverse effect on the operation of plant facilities.

- In the event the wastewater flow or BOD increases/decreases to a point that the aeration systems needs factory recalibration, after the initial optimization, the Manufacturer shall return on a per-diem basis, paid for by the Employer.

The entire system of aeration blowers, main air header pressure control, most open valve control, and overall aeration system automated operation shall be demonstrated to the satisfaction of the Engineer.

A factory representative, who has complete knowledge of proper operation and maintenance shall be provided for four (4) hours, if necessary, to instruct representatives of the Employer and Engineer on proper operation and maintenance, including start-up and shut-down procedures, proper lubrication practices, and troubleshooting of all equipment.

PTZ 24 INFORMATION TO BE SUBMITTED WITH TENDER

The following information shall be submitted with each tender in respect of the electric air blower drive motors offered:

- Outline drawings showing main overall dimensions
- Guaranteed continuous rating under site conditions (refer to PTZ 6)
- Guaranteed maximum starting current under locked rotor conditions.
- Guaranteed torque/speed curves at 45%, 60%, 80% and 100% of normal voltage.
- Guaranteed efficiency of motor at 45%, 60%, 80% and 100% normal full load.
- Guaranteed noise levels of motor at normal full load and 100% speed.
- Guaranteed vibration levels of motor at 100% normal full load and 100% speed.

- Guaranteed power factor of motor at full load and 45% load.
- Details of motor winding insulation with special reference to class of insulation and provision for vacuum contactor switching.
- Details of motor bearings.
- Details of over-temperature sensors.
- The mass of each complete blower assembly
- Details of anti-condensation heaters.
- Details of terminal arrangement on stator windings and cable end sealing box.
- Details of bearing thermometers offered.
- Details of output management system

PTZ 25 MEASUREMENT AND PAYMENT

Measurement and payment will be done in accordance with the general item descriptions stated below:

	Pay Item	***Unit***
PTZ 25.1	**Design, Drawings and General**	
PTZ 25.1.1	Provide design drawings and design information as specified.	Sum
PTZ 25.1.2	Attendance by Employer's Representative and Agent (2 people) of the FAT, including all travel and accommodation cost, cost of visa's (if applicable), travel insurance, subsistence while abroad etc.	Sum
PTZ 25.1.3	Provisional allowance for forward cover	Prov Sum
PTZ 25.2	**Manufacture, Factory Acceptance Test, Transport and Delivery to Site**	
	Rate tendered to include for all material, equipment, plant, testing apparatus, labour, manufacturing, corrosion protection, factory acceptance testing, transport, import/export duties, handling and possibly double handling, storage, delivery to and off-loading at Site	
PTZ 25.2.1	Air blower/compressor complete, including *inter alia* electric motor, gearbox, variable frequency drive, acoustic enclosure, integrated Local Control Panel (LCP), silencer block and machine mounts, oil lubrication and cooling system	No
PTZ 25.2.2.	Blower fittings and specials, including inlet silencer, inlet filtration system, flexible compensator, cone diffuser & silencer, blow-off valve & silencer, check valve, actuated discharge isolating valve; silencer block & machine mounts, oil lubrication and cooling system.	No
PTZ 25.2.3	Pipework inside blower house to connect blowers to main feeder pipe outside blower building	Sum

PTZ 25.2.4 One Master Control Panel (MCP) as specified connected to all the LCP's, DO probes, actuated control "V" port valves, air flow meters and pressure transmitters, including all control and power cabling, earthing, termination etc. (Refer PTZ 10) Sum

PTZ 25.2.5 Instrumentation as per clause PTZ 9 (Total per blower) No

PTZ 25.2.6 Insert type pressure transmitter and air flow meter on common feeder line inside blower
Building Sum

PTZ 25.2.7 Required reagents for instrumentation & first charge consumables (oil, grease etc) Sum

PTZ 25.3 <u>Installation</u>

Rate tendered to include for all plant, tools, labour, rigging, handling, placing into position, aligning, fixing, repair to damaged corrosion protection and getting ready for testing and commissioning

PTZ 25.3.1 Air blower/compressor complete including local control panel (LCP) No

PTZ 25.3.2 Master Control Panel (ABC / MCP) as specified connected to all the LCP's, DO probes, actuated control valves, air flow meters and pressure transmitters, including all control and power cabling, earthing, termination etc. Sum

PTZ 25.3.3 Air blower pipe fittings and specials (total per blower unit) No

PTZ 25.3.4 Pipework inside blower building Sum

PTZ 25.3.5 Instrumentation, pressure transmitter and air flow meter Sum

PTZ 25.4 <u>Testing and Commissioning</u>

Rate tendered to include for the drafting of the necessary testing and commissioning plans, attendance of required local and/or overseas specialists, testing apparatus, instruments and equipment, any/all temporary works, any/all sampling and analysis and compilation of final commissioning report.

PTZ 25.4.1 Air blower/compressor system complete Sum

PTZ 25.4.2 Electronic control system complete

Rate tendered to include for drafting of functional design specification or FDS, PLC, LCP and MCP programming, connection to external control equipment, optimization, troubleshooting, integration with existing plant SCADA Sum

PTZ 25.4.3 Testing, commissioning and optimization of remote instruments and equipment, including any/all DO probes, flow meters, pressure transmitters, actuators Sum

PTZ 25.5 Spare Parts and Servicing

PTZ 25.5.1 Provision of spare parts as defined (refer to PTZ 21)
Sum

PTZ 25.5.2 Servicing of equipment at the end of the defects notification period, including new charge of consumables and reagents as required:

.1 All blowers, including replacement of all air and oil filters Sum

.2 Electrical and electronic equipment
Sum

.3 Instrumentation, valves & actuators
Sum

.4 Leak test on all external pipework Sum

END OF SECTION

PXC : LOW VOLTAGE ELECTRICAL MOTORS

INDEX

Item No **Description** **Page**

PXC LOW VOLTAGE ELECTRICAL MOTORS

PXC 1 GENERAL

PXC 1.1 This specification covers low voltage (up to and including 1000 V) 3-phase, induction motors, slip ring and squirrel cage, of up to 450 kW and at a frequency of 50 Hertz. The voltage shall be 380 V and the motors shall have 4 poles unless otherwise specified***.

PXC 1.2 Motors are to be supplied complete with a suitable cable box for feeder cables, terminal boxes, nuts, locknuts, intermediate disconnecting leads, cable lugs, etc.

PXC 1.3 Mounting bolts and half-couplings must be included in the motor's price.

PXC 1.4 Motors of the same manufacture will be used throughout the contract where possible.

PXC 2 QUALITY OF MATERIALS

PXC 2.1 The motors shall be designed, manufactured, tested, delivered, erected and commissioned in accordance with:

SABS 948 : Three Phase Induction Motors.

IEC-34 (SABS IEC-34) : Rotating Electrical Machines, Part 1 to 18.

BS 4999 : Specifications for General Requirements for rotating electrical machines.

Where reference is made to a code specification or standard, the reference shall be taken to be the latest edition, including addenda, amendments and revisions thereto.

PXC 2.2 All deviations from these specifications must be clearly pointed out at tender stage as deviations not indicated, will not be accepted.

PXC 2.3 All materials shall be new and of the best quality and of the class most suitable for the purpose specified. All parts shall be capable of withstanding variations of temperature arising under working conditions without distortion, deterioration or setting up of undue strain in any part.

PXC 2.4 Quality control shall be in accordance with ISO 9000.

PXC 2.5 Mild steel plate for fabricated parts shall be of weldable quality in accordance with BS 4360. No welding, burning in, filling, plugging up or metal deposition to correct defects in any component will be permitted unless agreed to by the engineer in writing, following an inspection on the defect.

PXC 3 INTERCHANGEABILITY

PXC 3.1 Motors of the same rating shall be identical, fully interchangeable and from the same motor manufacturer.

PXC 3.2 All similar parts are to be made accurately to dimensions and must be inter-changeable with each other, so that a spare part or any part of another similar motor can be used satisfactorily in the relevant position on a motor without recourse to additional machining or filling.

PXC 4 MOTOR RATINGS

PXC 4.1 Motors shall have continuous maximum ratings not less than the following:

- 50 kW or under, not less than 25% in excess of the maximum likely to be drawn by the pumps within the operating range.
- Over 50 kW and up to 100 kW, not less than 15% in excess of the maximum likely to be drawn by the pumps within the operating range.
- Over 100 kW, not less than 10% in excess than the maximum likely to be drawn by the pumps within the operating range unless otherwise specified***.
- Where operating at other than continuous running duty is required, (i.e. short time or intermitted periods, as for valve actuators, hoists, etc.), motors shall have appropriate ratings in respect of output, duty and starting class.

PXC 4.2 All motors will be capable of continuous operation over the range of temperatures from –10°C to +40°C with a 24 hour continuous maximum ambient of 35°C at the specified altitude.

PXC 4.3 All motors will be suitable for operation at any voltage between □10% of the nominal value and □2% of nominal frequency at the altitude specified.

PXC 5 INSPECTION OF MANUFACTURED EQUIPMENT

PXC 5.1 The Engineer or his appointed representative, reserves the right to inspect the motors or associated parts at any stage of manufacture.

PXC 5.2 The Contractor shall ascertain whether inspection is required and the Contractor shall then give the Engineer not less than seven days notice of when the inspection may be undertaken.

PXC 6 GUARANTEE AND MAINTENANCE

PXC 6.1 The complete installation shall be fully guaranteed for a period of twelve months from the date of handing over to the Client. A complete full maintenance service shall be provided during this period. The Tenderer shall indicate with his tender what duties have been included and the time intervals between services. Should the Tenderer fail

to provide this information, the Engineer will lay down the duties as well as time intervals with which the Contractor shall comply.

PXC 6.2 Four copies of all test certificates, showing the results of all tests performed, will be supplied at a date not later than the delivery date of the motors.

PXC 7 TEMPERATURE RISES

PXC 7.1 All motors shall be designed for a class B temperature rise, that is 80°C rise above ambient.

PXC 7.2 The temperature rise of the bearings shall not exceed 50□ above ambient under continuous full load conditions.

PXC 8 BEARINGS

PXC 8.1 Type

Bearing shall be plain ball, or roller type, as appropriate unless otherwise specified***. Vertical shafts, shall have approved thrust and guide bearings. Grease-lubricated bearings, shall be sealed or regreasable.

Ball, or roller bearings shall be loaded conservatively, in order that the grease may be renewed at intervals of not less than 1 year, and they shall not be equipped with grease nipples or cups. If these are supplied, they shall be replaced with threaded plugs.

Care shall be taken that bearings are sealed properly, in order to prevent ingress of bearing lubricant into windings and cores. For purpose of maintenance, end-shield bearings are preferred. A minimum bearing life of 40 000 hours is required. Unless otherwise approved in writing, motor bearings shall be designed to allow the motor to run indefinitely, when uncoupled from the driven machine.

PXC 8.2 Insulation

Where necessary, to prevent damage by any shaft currents which may be produced, the bearings and their lubricating and cooling systems, shall be insulated from the bed-plate or frame.

PXC 8.3 Flow Indicator

A flow indicator and/or pressure switch shall be provided on forced-lubricating systems, to indicate failure of the system. Adjustable alarm and cut-out contacts, shall be provided.

PXC 8.4 Thermometers

Digital or dial-type bearing thermometers with adjustable alarm and cut-out contacts, shall be provided when specified in the project specification***. Where such thermometers are also provided on the pump, they shall be of the same type and manufacture.

PXC 9 TERMINAL BOXES

PXC 9.1 The terminal box for the supply cables shall be suitable for the cables specified*** and shall be oversized. It shall have a removable cover and gland plate. The degree of protection shall not be less than IP 55.

PXC 9.2 Cable outlets shall be capable of pointing to any of four directions at 90 degree intervals.

PXC 9.3 Heaters and embedded temperature detectors shall be wired up to separate secondary terminal boxes. These boxes must be suitable for an armoured multi core cable and must be oversized to house the 4-20 mA transmitters with die-cast caps when specified in the project specification***.

PXC 9.4 All terminals must be properly and permanently marked for easy identification.

PXC 9.5 Terminal boxes adjustable in 90□ steps to facilitate different cable entry positions.

PXC 10 NAME PLATES FOR MOTORS

PXC 10.1 In addition to the information required by SABS 948 the following shall also be marked on the name plates.

PXC 10.1.1 Year of manufacture.

PXC 10.1.2 The order number.

PXC 10.1.3 Total mass of motor in kg.

PXC 10.1.4 Diagram indicating the number, type and positions of heaters and temperature detectors if applicable.

PXC 10.1.5 Bearing types and sizes.

PXC 10.1.6 Bearing grease interval or bearing replacement interval where pre-packed bearings are used.

PXC 11 TEMPERATURE DETECTORS

PXC 11.1 All motors 55 kW and larger but smaller than 150 kW shall be provided with two PTC thermistors per winding suitable for class B temperature rise protection i.e. with reference temperature of 140□C. The three thermistors shall be connected in series

via terminal blocks in the terminal box. (1 per Winding connected to terminal blocks shall be spare).

PXC 11.2 All motors of 150 kW and larger shall be provided with two platinum resistance detectors (RTD's) of type PT 100 ohm per winding and one per bearing. The bearing detectors shall touch the outer bearing race and shall be spring loaded and of the screw type with weatherproof die cast alloy heads. (See also PXC 11.4). The RTD's shall be of the three wire type with a stainless steel sheath and mineral insulation. When specified in the Project Specification*** the RTD's shall be provided with 2 wire transmitters with a 4 - 20 mA output terminated in a die-cast cap.

PXC 11.3 The wires of all detectors must be wired to a terminal strip in a suitable terminal box on the motor.

PXC 11.4 When specified in the project specification*** the motor manufacturer shall provide a d inch "BSP" threaded hole in the motor casing to enable the installation of a bearing temperature probe by others.

PXC 12 MOUNTING

PXC 12.1 The motors shall be mounted as required by the driven equipment supplied.

PXC 12.2 Each motor shall be mounted on a common base-plate with the equipment driven. When uncoupled from the load, it shall be possible to lift the motor clear without withdrawing the rotor and with the minimum amount of dismantling.

PXC 13 DRAWINGS AND INFORMATION FOR APPROVAL

The following drawings and information shall be submitted for approval before manufacture commences:

PXC 13.1 Dimensioned outline and required foundation drawings of the motors. (Shaft diameter, shaft height and motor mass to be clearly shown).

PXC 13.2 Cross-sectional dimensioned drawings of the cable boxes.

PXC 13.3 Detailed drawings of the motor base plate showing full constructional details with dimensions.

PXC 14 ANTI CONDENSATION HEATERS IN MOTORS

PXC 14.1 Anti condensation heaters shall be built into the stators of motors of 7,5 kW and larger. Unless otherwise specified*** the power supply to the heaters shall be 231 V AC, 50 Hz and the heaters shall be continuously rated.

PXC 14.2 The terminals of the heaters shall be wired to a separate terminal box.

PXC 15 WINDINGS

PXC 15.1 The stator windings shall be delta-connected for all motors of 3 kW and larger. Each end of each phase winding shall be brought out to the stator terminal box. For single wound three phase motor, (for use in Star-Delta starters), six stator winding ends shall be brought out to the stator terminal box. A cable lug shall be supplied for each end of each phase winding.

PXC 15.2 All insulation material used shall be Class F.

PXC 16 ROTATION

PXC 16.1 All AC motors shall be capable of having their direction of rotation reversed, merely by interchanging the supply leads. AC motors fitted with unidirectional fans, and therefore not capable of being easily reversed, shall be supplied with a double-ended shaft and the holding-down bolt holes shall be symmetrical about both centre lines. This will permit the motor to be rotated through 180 degrees and coupled up to the load, giving an opposite drive. A suitable cover shall be provided for the unused bare shaft extension. The above arrangement also required that two motor terminal boxes are provided diametrically opposite each other. The correct direction of rotation of an unidirectional motor shall be indicated in a permanent manner on the frame.

PXC 16.2 The normal rotation of the motors shall be co-ordinated by the Contractor with the supplier of the driven equipment.

PXC 17 BALANCE AND CRITICAL SPEED

Motors and couplings shall be accurately and efficiently balanced statically, and dynamically, so that there will be no unbalanced end-thrust, when either new or worn, and to eliminate noise and vibration when running.
Where end-thrust arises, adequate long-wearing thrust bearings shall be provided. Dynamic balancing shall be done by the removal of parent metal, in a manner which does not affect the structural strength of the rotating element.

The use of solder, or similar deposits for balancing, will not be accepted. The operating speed of rotating elements shall be below and as far removed as possible from the critical resonant speeds thereof.

Operating vibration levels of all rotating equipment installed shall be to the satisfaction of the Engineer. Strict attention shall be paid to this aspect of the installation.

Notwithstanding the acceptance of the vibration limits during the works tests, the Engineer reserves the right to call for a vibration test on the installed equipment, if he considers it necessary and the Contractor shall be responsible for reducing the vibrations to within the specified peaks.

Noise levels shall not exceed the levels permitted in SABS 948.

The permitted levels of vibration generated within the motors shall not exceed the values as per SABS 948 Part 1.

The motors shall have a suitable margin of safety between critical and normal running speeds. The first critical speed shall be not less than 120 per cent of nominal speed.

PXC 18 TYPE OF MOTOR

Squirrel-Cage Induction Motors

Squirrel-cage induction motors shall be suitable for direct-on-line starting at full voltage unless Star-Delta, reactor or other starting method is specified in the project specification***. The breakaway starting kVA of motors shall be to Design letter D as specified in SABS 948 for two-speed motors.

All motors shall be capable of starting against the associated load, with a minimum of acceleration torque, of not less than 5% of full load torque, when the voltage at the motor terminal during starting, is reduced to 80% of the nominal value.

Slip-Ring Induction Motors

The slip-ring and brushgear shall be separately ventilated: Brush dust shall not be drawn into the machine windings. The brush gear shall be of substantial design, constructed with a view to minimising maintenance. Brush holders shall be designed so that adjustments of brush pressure are easily made and so that brushes can be easily removed and replaced. Removable covers shall be provided for safe and easy access to the brush gear.

Submersible Electric Motors

The motors shall be of the 3-phase, squirrel-cage wet type, suitable for a 380 V, 3-phase, 50 Hz AC supply. The motor casing shall be of steel, double surface protected. The bolts and nuts shall be 316 stainless steel. The stator-winding shall be completely surrounded by water. The insulation shall be very reliable, as thin as practicable, and manufactured in either polyamide or polyethylene. The resistance shall be at least 100 megohms. Unless otherwise specified***, the motor shall be wired for direct on-line starting.

The connections between the single windings shall be absolutely water-tight.

The stator and rotor, shall have special protection against corrosion.

The two leads of each thermistor element, shall be separately brought out to one terminal box on the outside of the motor, where the three thermistors shall be connected in series.

The bearings shall be of the journal type, made of bronze or rubber adequately sized for the motor to operate in a vertical position, to take the axial thrust, and shall be water-lubricated. The thrust bearing shall be made of special synthetic material, and shall have mechanical and electrical properties, of at least 316 stainless steel.

The motors shall be protected against sand and dirt, by means of a mechanical seal in the coupling casing. The shaft shall be of at least 316 stainless steel.

To compensate for change in volume with different temperature in the lower part of the motor, compensating devices shall be fitted.

The pump and motor shall be direct coupled.

The motor shall be completely sealed by an oil-bath lubricated, double, self-adjusting, mechanical seal on the shaft. The seal shall preferably be of tungsten carbide or other material possessing great resistance to abrasion. The motor in closure shall be at least IP68, and the cable entry shall be triple-sealed.

PXC 19 TEST IN THE FACTORY

PXC 19.1 Type Tests

One motor of every type, 50 kW and larger, shall be tested for temperature rise, efficiency and pull-out torque. Type test certificates on identical motors will be acceptable in lieu of these tests for motors smaller than 50 kW. Should type test certificates for motors smaller than 50 kW not be available then the first motor of each size manufactured shall be tested.

The measurement of the temperature rise of the stator windings of the motors shall be by the increase in resistance method.

PXC 19.1.1 In addition to the type tests specified in SABS 948 the following shall be done:

(1) Vibration Test: The amplitude of vibration (peak to peak) is to be measured in micrometer.
(2) Efficiency Test: The efficiency must be measured for full load and rated duty load.
(3) Temperature detector readings must be taken at intervals of test.

PXC 19.2 Routine Tests

PXC 19.2.1 The following tests shall be carried out in addition to the routine tests specified in SABS 948.

(1) All the resistances of temperature detectors and heaters shall be measured.

(2) The insulation resistance of all auxiliary circuits may be tested as follows:

Heaters

Space heaters shall be tested for circuit continuity.

Thermocouples

Resistance (AVO) to earth shall give open circuit resistance reading.
Resistance (AVO) between terminals shall give zero resistance reading.

Resistance Temperature Device (RTD)

Resistance (AVO) to earth shall give open circuit resistance reading.
Resistance (AVO) between terminals at room temperature shall give resistance reading of approximately 106 ohms per RTD.

Thermistors

Resistance (AVO) to earth shall give open circuit resistance reading.
Resistance (AVO) between terminals at room temperature shall give resistance reading of approximately 75 ohms per thermistor in series.

PXC 19.3 Test Certificates

Four copies of all test certificates, showing the results of all tests performed, shall be supplied at a date not later than the delivery date of the motors.

PXC 20 ERECTION AND COMMISSIONING

PXC 20.1 Erection

Where possible, motors shall be erected by the motor supplier. Care shall be taken to ensure that adequate tolerance margins are made available to ensure inter-changeability with replacement motors. In particular -

PXC 20.1.1 A minimum of 10 mm of packers shall be provided under the motor frame of motor bed-plate to allow for adjustments in height.

PXC 20.1.2 Before holding-down bolts are grouted in, the motor shall be lined up and the bolts shall be properly centred in the hole of the bed-plate.

Tenderers shall indicate with the tender who will erect the motors.

PXC 20.1.3 The Contractor shall satisfy himself that the motors are properly installed, aligned and sufficiently protected and shall check the settings of all motor protection gear before any motor is switched on. (Also refer to PA 8.3 + PXC 20.3).

PXC 20.1.4 The Engineer must be notified at least 7 days in advance of any commissioning or testing to enable him to be present.

PXC 20.2 Bearings

A complete set of spare anti-friction bearings shall be provided for each motor and delivered at the same time as the motor. should the bearings fail or exhibit symptoms or brinelling during the guarantee period, they shall be changed by the Contractor, free of charge, without delay.

PXC 20.3 Alignment

After erection, the alignment of the half-coupling between the motor and the driven machine shall be measured. In the case of a pedestal bearing motor, the air gap clearance between the rotor and the stator shall also be measured. A record shall be kept of these figures and they shall be submitted to the Engineer for approval.

The following order for checking alignment are recommended:

(a) Axial setting of shafts.
(b) Paralleling of shafts in the vertical plane.
(c) Centering the ends of the shaft (height and sideways setting).
(d) Paralleling of shafts in the horizontal plane.
(e) Re-adjustment of the "sideways" setting (c).
(f) Re-check of operations (a), (b) and (c).

Tolerance

A maximum tolerance or deviation for paralleling of shafts on the horizontal and vertical plane as well as centering of shaft ends of 0,05 mm can be permitted when using flexible couplings up to 400 mm in diameter. For larger couplings the permissible degree of tolerance can be based on a factor of 0,12 mm per meter of coupling diameter.

A horizontal sleeve bearing or limited end-float roller bearing motor shall be run uncoupled from its load to ensure that it rotates at the axial position indicated on the shaft and that the rotor is free to move to either side of this position. Particular attention

shall be paid to ensure that the free running position and the rotor end-float are in agreement with the axial movement of the flexible coupling.

PXC 20.4 Insulation Resistance

Before energising any of the motors, for the purpose of commissioning, the Contractor shall measure the insulation resistance of each motor between phases and to casings by means of a 500 Volt "Megger" instrument, and the values shall be recorded and forwarded to the Engineer for information. If any of the readings for a particular motor are lower than 1,5 megohms, that motor shall not be energised until it has been dried out by the Contractor by a method to the Engineer's prior approval. Unless the lowest of the insulation resistance measurements on that motor exceeds 1,5 megohms, the motor shall not be energised.

The method adopted for drying-out shall be by applying heat, preferably by circulating current through the windings or, alternatively, by means of space heaters located in and around the machine.

Insulation resistance measurements and temperature readings shall be taken regularly every half hour at the start of dry-out until the motor attains an even temperature and thereafter every hour. The characteristic dry-out curve of insulation resistance versus temperature shall be plotted and dry-out may be considered complete four hours after the resistance readings have started to rise from the steady minimum value, providing that the winding temperatures have remained steady during this period.

All equipment and the personnel required for the drying-out operation, shall be provided by the Contractor. The onus remains on the Contractor to satisfy himself that a motor is dry before it is connected to the supply. Any motor which fails as a result of being commissioned in a damp condition, shall be repaired free of charge by the Contractor.

PXC 20.5 Double Shaft Extensions

The unused shaft extensions of a double-ended shaft motor shall be covered with an approved rust preventative after the motor is commissioned.

PXC 21 STANDARD REQUIREMENTS

Supply	:	380 Volts : 3 Phase : 50 Hz
Output Rating	:	kW to suit pump requirements as per specification
Speed	:	1450 rpm
Type of Motor	:	Squirrel cage (6 starts per hour)
Enclosure	:	IP55 IC 0141 type to SABS 948

Mounting	:	Foot
Shaft Axis	:	Suitable for application
Insulation	:	Class F
Duty-Class	:	Continuous, S1
Bearings	:	Ball
Cable Entry (Location)	:	Terminal box adjustable in 90□ steps to facilitate different cable entry positions
Terminal box	:	Suitable for 2 X 120 mm5 4-core copper PVC/SWA/PVC cables and associated glands
Drive Details	:	Direct
Method of Starting	:	Direct-on-line

PXC 22 PARTICULAR SPECIFICATION

Temperature Detectors (Clause 11)

The following temperature detection shall be provided.

PXC 22.1 Windings

The motors shall be provided with two PTC thermistors per winding suitable for class B temperature rise protection i.e. with reference temperature of 140□C. The three thermistors shall be connected in series via terminal blocks in the terminal box. (1 per Winding connected to terminal blocks shall be spare).

PXC 22.2 Bearings

The motor manufacturer shall provide d inch "BSP" threaded holes in the motor casing to enable the installation of a bearing temperature probes for both bearings by others.

PXC 23 PAY ITEMS

Measurement and payment will be done in accordance with the methods stated below:

PXC 23.1 Supply and Delivery

Pump sets/motor will be measured per unit including the following:

PXC 23.1.1 Pumps, motors, couplings, coupling material, base-plates and monitoring items as individually itemised.

PXC 23.1.2 Design, manufacture, purchase, protection, supply, handling, transport and profit.

PXC 23.1.3 Fixing material required to secure monitoring equipment to pump/motor.

PXC 23.1.4 Fixing material required to secure the pump and motor to the base-plate.

PXC 23.1.5 Temporary storage and maintenance during storage, should it be required.

PXC 23.1.6 The required tests and inspections at the manufacturer's works.

PXC 23.1.7 Operating and Maintenance Manuals as well as drawings in accordance with the specification.

PXC 23.1.8 Commissioning of each pump set/motor as specified.

PXC 23.2 Individual Performance Checks

Pay-item	Unit
Performance testing of pumps/motors by independent institutions (Provisional item)	No

Should the Client require performance testing of the pumps or motors by independent institutions such as the South African Bureau of Standards, a separate pay-item will be provided in the Schedule of Quantities. The tendered rate shall include for the transporting to and from the institution, off loading, handling, etc., as well as all fees payable to the institution for each pump/motor unit tested.