

Section C Detailed Mechanical Specifications

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PM 001 – Scope

The Mechanical Works consists of the design, manufacture, supply, delivery, installation, testing and commissioning and upholding during the Defects Notification Period of mechanical equipment for the following Upgrade Works at the Leeuwkuil Wastewater Treatment Works (WWTW):

1. Archimedean Screw Pump Station (Upgraded Pump Station 34); and
2. Wash Water Pump Station.

This Detailed Mechanical Performance Specification is supplemented by the requirements of the Standard Specification for Mechanical works in Section J. Where these specifications may conflict with other specifications, conditions and requirements that are of a general nature, this specification shall have precedence. Should the Contractor note an inconsistency between the specifications and the drawings, he is required to immediately notify the Engineer and obtain clarification or instructions prior to tendering and prior to ordering or installing equipment.

The Scope of Works, includes, but is not limited to, the following complying with the Specifications:

Archimedean Screw Pump Station (Pump Station 34)

Three (3) screw pumps for Pump Station 34, the installation is to include the following components:

- Archimedean screw, including top and bottom bearings, bearing housings and mountings.
- Motor and belt-drive.
- Gearbox.
- Flexible shaft coupling.
- Motorised bottom bearing lubrication system.
- Corrosion protection of screw.
- Fabricated deflector.
- Sunscreens.
- Supply and installation of fibre-glass protection covers for expansion and contraction of the screw pumps to assist with safety and odour control
- Hoisting equipment
- Sluice gates

Wash Water Pump Station

One (1) Wash Water Pump Station with the following:

- 1 x set of three (3) Multi-stage pumps complete with all pipework, valves and other fittings to make the pump sets complete and operational
- Self-cleaning filters
- One (1) submersible or alternative seepage sump pump
- Lifting equipment

This description of the Works is not necessarily complete and shall not limit the work to be carried out by the Contractor under this Contract.

PM_002 – Archimedean Screw Pump Station

PM_002.1 Existing Facilities

The existing pump station was constructed as a temporary solution in 2010 and has since not been upgraded. The existing PS 34 consists of two (2) submersible pumps installed in two (2) separate open manholes constructed from ROCLA rings. The incoming flow is screened with a manually operated basket screen. Thereafter the screened flow is split between these two manholes. The capacity is limited to estimated Average Dry Weather Flow (ADWF) 72 l/s should the second pump be considered for standby only.

PM_002.2 Minimum Standards

All the equipment and systems supplied under this Contract shall comply with the minimum standards as contained in this Specification, the standard Specifications; the latest amendment of the OSH Act, Department of Water and Sanitation regulations; any standards or requirements by Rand Water; the latest amendment of the National Environmental Act; as well as local and Municipal by-laws.

In addition, special attention shall be applied to the following items:

- A minimum of 3 complete provisional maintenance manuals shall be handed over to the Engineer for review and comment.
- Where self-priming pumps are to be used these must be equipped with a casing heat sensor port to allow the control and instrumentation Contractor to install a heat sensor to measure heat in case of the pump cavitation.

PM_002.3 Description

The Contractor shall design, supply, deliver to site and install, test and commission and uphold during the Defects Notification Period of three (3) screw pumps.

The installation is to include the following components:

- a) Archimedean screw, including top and bottom bearings, bearing housings and mountings.
- b) Motor and belt-drive.
- c) Gearbox.
- d) Flexible shaft coupling.
- e) Motorised bottom bearing lubrication system.
- f) Corrosion protection of screw.
- g) Fabricated deflector.
- h) Sunscreens.
- i) Supply and installation of fibre-glass protection covers for expansion and contraction of the screw pumps to assist with safety and odour control.

PM_002.4 Performance and Operational Requirements

The Contractor is to design, supply, install test and commission and uphold during the Defects Notification Period three (3) screw pumps with the following characteristics for each screw pump:

- Flow rate : 500 l/s per screw
- Construction Head (CP-TP): 11.45 m

Construction Head to be confirmed as per civil design and construction drawings.

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- Angle of inclination to the vertical: 38 deg
 - Pump Speed : Contractor to propose
 - Motor Power : 132 kW (Final size to be confirmed)
 - Motor Speed : 4 pole
 - Gearbox make : Contractor to propose
 - Gearbox service factor : 2

The screw pumps are to operate on a two (2) duty plus one (1) standby regime. The Chute Point (CP) defined as the level at which the upper end of the screw flights will start to discharge liquid during rotation and is also the level at which the screw trough ends and the Touch Point defined as the level at which the lower end of the screw flights will touch the liquid during rotation is defined on the drawings.

The following definitions are also applicable in order to define the pumping head at maximum flow (i.e. the difference between the Maximum Pumping Point and the Fill Point):

- The Fill Point is defined as the level at which the lower end of the screw flights will pump the maximum amount of liquid during rotation. At any level higher than this, no additional liquid will be pumped.
- The Maximum Pumping Point is defined as the maximum level at the upper end of the screw flights at which the liquid rises to at maximum flow.

The Contractor will be required to submit their design calculations and detail technical specification during the design and drawing stage for approval, before commencement of the manufacturing of the screw pump sets.

PM_002.5 Operation and control

The three (3) screw pumps shall operate on a two (2) duty plus one (1) standby regime, with duty rotation. The pumps will be run on a fixed speed.

The system will be controlled by a water level measuring device in the channels.

The capacity of each screw pump is 500 l/s per pump at 100% rotational speed.

A unit shall not start unless the bottom bearing grease pump is in operation. The grease pump shall be operate-able without running the main screw pump motor in order to prime the system and during maintenance procedures.

The screw pump is designed with a specific fill point. If the water level at the bottom-end of the screw pump should be higher than the fill point level, the VSD control must incorporate a slow start until the fill point is reached, then the VSD can ramp-up to the maximum operating rotation speed.

The level measuring device will monitor the bottom-end water level to control the VSD drive speed.

The current load should also be monitored via the VSD to ensure that the VSD drive does not exceed the maximum operation current of the electrical motor.

Activation of any one of the safety devices shall halt the operation of all of the screw pumps.

Manual start and stop of each item of equipment shall be provided.

PM_002.6 Rotating Screw Assembly

i. Centre Tube

Tube construction will be of longitudinally/spirally seam welded sections with circumferential butt welds if necessary. Circumferential welds will be as far away as

possible from the highest stressed centre portion of the tube. The tube size must be selected so that the design stress during operation is very low.

ii. Flights

Flights are cold formed using a specially designed bending machine and then filled welded to the centre tube into a series of smooth continuous helices with close attention paid to flight pitch accuracy.

After final welding of the flights to the tube the screw assembly is rotated between centres and the outer flight edges are accurately trimmed by flame cutting to give the screw a truly concentric and cylindrical shape.

iii. End Plates

The end plates, which are machined and drilled to securely fix the top and bottom of the centre tube, are accurately positioned and aligned prior to being welded to the centre concentric rotation of the end shaft.

PM_002.7 Top and Bottom Bearings

i. Top bearing assembly

The rotating screw assembly is supported at the end by a self-aligning double spherical roller bearing that is mounted in a specially selected housing incorporating a removable cap and grease seals.

The bearing, which takes both axial and radial loading, is of the heavy-duty type and is rated well in excess of a B10 – 100 000 hours life.

Lubrication is by automatic, self-driven greasing intermittently from within the motor room.

ii. Bottom Bearing Assembly

The bottom bearing assembly consist of a phosphor bronze bushed housing that is fixed to, and rotates with, the screw. The bush runs on a stationary stub shaft that is supported on a stainless steel (grade 316) housing fixed rigidly to the concrete sump floor, wear is therefore evenly distributed. The Bearing is continuously grease lubricated through piping from a pump situated in the motor room.

A grease seal is incorporated at the lower end of the shaft some distance away from the bush of the bearing and quite a long annulus exists between the bearing bush and the seal. This annulus becomes packed with grease that has passed through the bearing on its way to exit at the lip of the seal. Should a grease pump failure occur, the grease packed annulus protects against the ingress of water and lack of lubrication for longer periods of time.

The bottom bearing is subject to radial loading only and takes no axial loading whatsoever. The rotating parts of the assembly are covered with a cowling to prevent any rags or stringy material from becoming entangled.

PM_002.8 Screw Trough

i. Trough

The screw rotating within a specially formed concrete, or manufactured stainless steel (grade 316) trough, with a uniform and carefully selected clearance between the screw

flights and the trough surface. The clearance is designed with consideration being given to both hydraulic and any operational eccentricity of the rotating screw. Operational eccentricity will normally only occur upon start up and is caused by the temperature on the upper surface of the screw being higher than the lower surface.

The concrete portion of the trough will extend around the lower 180° of the screw and is to be constructed such that no “wedges” are present which might cause jamming with solid materials.

ii. Side Profiles

To maintain high pump efficiency and prevent backflow of water, fabricated stainless steel (grade 316) side profiles will be installed. These profiles will be positioned and fixed, after installation of the screw and after final setup of design clearance, to be maintained around at least 230° of the screw circumference.

Additional UV-resistant fibre-glass protection covers to enclose the entire unit, to contain odours, assist with expansion and contraction of the screws and exposure to the sun are also included, as specified.

PM_002.8 Screw Drive

i. Base Plate

A common base plate will be supplied for mounting of the top bearing, gearbox, motor and other ancillary equipment. After final alignment, mass concrete is to be cast around the base plate and framework to form a rigid structure with the motor room floor.

Starter reinforcing bars will be required to project from the motor room floor beneath the base plate concrete. All starter bars and concrete work etc. are excluded from our offer.

PM_002.9 Lubricator Piping

Grease lubrication of the bottom bearing is supplied by an automatic lubricator. A high quality, reliable lubricator has been selected because of the critical nature of the lubrication duty and the life of the bottom bearing depends entirely upon the reliability of this unit.

An independent, directly coupled, motor drives the lubricator. Should the lubricator motor fail the screw motor will be automatically cut out to protect the bottom bearing. The rate of grease supply is adjustable and the grease reservoir incorporated an external level indicator.

Grease is conveyed to the bottom bearing through stainless steel (grade 316) or heavy-duty copper piping with a flexible nylon pipe connection to the lubricator within the control room. The piping passes through a conduit that runs parallel to the screw and is cast into the concrete by the civil Contractor.

PM_002.10 Covers

Cover plates will be installed on the inside of the motor room over each opening through which the screw drive shaft passes to protect the drive coupling and top bearing against splashing.

PM_002.11 Gearbox

The gearbox offered has been selected for reliability and efficiency over operational range and incorporates helical reduction gear trains mounted within a robust cast iron gear case. The gears are oil bath lubricated and the box is modified to operate efficiently at the angle of the

screw. Gear ratings are to AGMA or DIN standards and incorporate a service factor of indicated in the technical data sheet.

Bearings are rated for a B10 life of at least 100 000 hours and inspection covers, an oil breather, oil level indicator and oil drain are provided for ease of routine maintenance and inspection.

PM_002.12 Motor

The foot-mounted motor is a standardized metric motor of the totally enclosed fan cooled type rated for the maximum power absorbed plus a service of at least 20%.

PM_002.13 V-Belt Drive

The gearbox is driven from the motor by a substantially rated V-Belt drive that has the following advantages over direct driven units.

- V-Belt drive allows flexibility between motor and gearbox thus limiting stress on the gears and bearings if the screw meets some sudden resistance.
- Direct coupled drives do not possess this flexibility and the alternative use of overload devices is complicated and expensive.
- Gearbox noise and wear is reduced as the input speed to the gearbox can be reduced by a third and a lower gear reduction used.

PM_002.14 Holdback Device

A holdback device is fitted to prevent rotation of the screw and subsequent damage.

The device will free wheel smoothly and silently whilst the pump is running in the normal direction of rotation. No ratchets are involved and wear is almost non-existent.

PM_002.15 Guards

Guards will be supplied to cover all moving parts such as the V-Belt drives, rotating shafts and couplings.

Guards will be supplied to prevent and protect the screw from direct sun light and from contraction and expansion due to direct sun light.

PM_002.16 Screw Rotation

Due to the configuration of the flight-bending machine the screw rotation will be clockwise when viewed from the non-drive end.

PM_002.17 Hoisting Equipment

The Contractor shall design, supply and install, test and commission and uphold during the Defects Notification Period, giving a 12 month guarantee on all hoisting equipment and infrastructure associated with the hoisting equipment.

A Gantry with a crawl beam and support structure to be designed and installed to assist with operation and installation of equipment. This structure and hoisting equipment to have a minimum lifting capacity of five (5) tons and manufactured from hot dipped galvanised mild steel.

The set of manually operated crawls and chain hoists to be installed on single-lifting I-beams to facilitate the handling of equipment at various locations (where required), and shall have the following specifications:

- 1) hoist mechanism and lifting I-beam capable of lifting the tonnage of mechanical equipment such as the intended pumps with motors
- 2) able to provide sufficient lift using chain and hook
- 3) able to run on overhead single rail
- 4) complete with operating and lifting chains and hooks
- 5) auxiliary chain or lifting slings to be used to mount the equipment to be provided and able to handle the loading tonnage

Each hoist must be supplied with:

- a) Test Certificate for each hoist
- b) Chain Number for each hoist
- c) Material Certificate for each chain
- d) Material Certificates for the other components
- e) Hook certified to lift loading tonnage

The capacity of each hoist must be confirmed once the pumps and motors are selected and their weights known.

1. The Contractor will test and certify each hoist installation.
2. The hoisting equipment must comply with the Standard Specification on Hoisting Equipment.

Details of the proposed hoisting systems for the pump station and location shall be submitted to the Engineer for approval prior to placing of orders. The tendered rates shall be for the suitably sized hoisting equipment proposed for Pump Station 34.

PM_002.18 Sluice Gates

The following mechanical equipment shall be designed, supplied, installed, tested and commissioned and upheld during the Defects Notification Period and give a 12 month guarantee.

Four (4) 1 000 x 2 000 mm wide sluice gates, to be installed at the inlet of the screw pump station. Material type of sluice and all associated components will be stainless steel grade 316.

Three (3) 1 000 x 1 000 mm wide sluice gates, to be installed at the outlet of the screw pump station. Material type of sluice and all associated components will be stainless steel grade 316.

PM_002.19 Drawings

Reference to Drawings in the Specification and tender documentation will include the minimum of the following;

- Equipment Drawings: detail technical drawings of each mechanical component, with all dimensional detail, assembly and material description.
- General Arrangement (GA) Drawings: detail showing the interaction of all mechanical assemblies with each other, and interaction with the other infrastructure (civil), with all dimensional detail, layouts and sections.
- Pipe and Instrumentation Diagram (P&ID): a P&ID must be prepared and submitted of all the electro-mechanical equipment, with all mechanical equipment, pipe and/or process flow and all instrumentation part of the equipment's control philosophy.

PM_002.20 Operation and Control

The operational control (control philosophy) specified, must be incorporated under the electrical design. The Contractor must ensure that it is included under his design, supply, manufacture, installation and commissioning/testing for the specified control philosophy, for each of the electro-mechanical equipment.

As required for the mechanical designs and drawings, the electrical drawings must be submitted and approved before the Contractor may commence with the manufacturing and supply of the electrical equipment.

PM_003 – Wash Water Pumps

PM_003.1 General

This Specification shall apply the Wash Water Pumps at the Leeuwkuil WWTW.

The Contractor shall provide pump sets complete with all ancillaries required to make the pump sets complete and operational.

The following Standard Specifications are to be read in conjunction with this section:

- SS1: Contract Administration and General Requirements
- SS5: Corrosion Protection
- SS19: Pipework, Valves and Fittings
- SS9: Dry Well Pumping Equipment

PM_003.2 Performance Requirements

Pumps are required to circulate the wash water from the Wash Water Pump Station, to the wash water points across the site. Wash Water Pump Station is shown in Drawing No. J39080-1115/01-001-01. The system will be in a 3 pump set configuration.

The Contractor shall provide the pump sets complete with all pipework, valves and fittings as shown in the Drawings, and any other ancillaries to make the pump sets complete and operational.

The pump station is a dry/wet well configuration and the following pumps shall be provided:

Wash Water System – Network

Type of pump:	Multi-stage pumps
Configuration:	2 x duty + 1 x standby
Duty flow:	20-30 litres/second
Pressure required:	4 bar
NPSH required:	1.53 metres
Material pumped:	Clearwater, prior to disinfection

PM_003.3 Operation and Control

The Wash Water Pump Station is to be operated continuously to maintain the required residual pressure in the wash water reticulation network.

PM_003.4 Measurement and Payment

The pumps shall be measured as per the Standard Mechanical Specifications SS 9.12

The pipework, valves and fittings shall be measured as per the Standard Mechanical Specifications SS 9.15.

PM_004 – Lifting Equipment for Wash Water Pumps

PM_004.1 General

Specifications for the lifting equipment for the various structures (as detailed below) are provided in this section. For additional details, also refer to the Drawings as detailed.

The following Standard Specifications are to be read in conjunction with this section:

- MGD: General Mechanical
- MCP: Corrosion Protection
- MLE: Lifting Equipment

PM_004.2 Design Requirements

A gantry beam with an electrically operated crab and hoist is required at the Wash Water Pump Station. The purpose of the gantry is for the removal/repair of the wash water pump equipment such as motors. The following dimensions and duties are required:

— Length of travel	:	10.3 m
— Height (floor to bottom of beam)	:	6.1 m
— Minimum lift height	:	0,5 m
— Working load	:	min 1 000 kg (or the maximum weight of the complete motor to be lifted should it exceed 1 000 kg)
— Hoist speeds	:	Refer Spec SS 20: Lifting Equipment
— Longitudinal travel speeds	:	Refer Spec SS 20: Lifting Equipment
— Crawl beam	:	254 x 146 x 43kg I-Beam

PM_004.3 Inspection and Testing Requirements

The Contractor shall make all arrangements and carry all costs for the Engineer to inspect, or witness the testing (if applicable), the fully assembled equipment, including lifting equipment, in the manufacturer's workshop, prior to being delivered to site.

PM_004.4 Measurement and Payment

The measurement and payment of the lifting equipment shall be measured under the Standard Mechanical Specifications Section SS 20.14.