UMGENI WATER

STANDARD SPECIFICATIONS

FOR MECHANICAL WORKS

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I N D E X

MECHANICAL WORKS

1 STANDARD SPECIFICATION FOR MECHANICAL WORKS

1.1 STANDARD SPECIFICATIONS

This part of the document contains the standard specification sections. The standard specifications define the standards of equipment and materials and the quality of services required for the various elements of an installation.

The standard specification forms an integral part of the contract document, and shall be read and interpreted in conjunction with the project specification.

In the unlikely event of a conflict between the project specification and the standard specification, which has not been clarified before the submission of a tender, then the project specification shall have preference over the standard specification.

1.2 EQUIVALENT MANUFACTURE

Various standard and project specifications refer to equipment being equivalent to a certain brand article.

This should be read as equipment that would normally meet the requirements of the Engineer, but as brand articles are always subject to changes by the manufacturers, it remains the Tenderer's responsibility to ensure that such brand article will also meet the performance and other technical requirements of the project specification.

Such requirements shall be read as being in addition to that which the brand article can provide. If the brand article cannot be offered by the Supplier, to meet such requirements, then the Tenderer must allow for the adjustment of the brand article to comply with such requirements.

1.3 EQUIPMENT INSTALLATION

In preparing a design, the Engineer will have contact with Suppliers of equipment, to allow for such normal requirements with regard to equipment size, access for installation, access for maintenance, mass, electrical supply, safety precautions, etc., that Suppliers might have, in order to ensure proper installation and future safety and optimum operation of such equipment.

As the final selection of equipment is, however, in the hands of the successful Tenderer, and the contract for the supply of the equipment, is between the Contractor and the Supplier, it shall be the Contractor's responsibility to ensure that the equipment ordered will be suitable for the spaces in which it will be installed and that other influences shall not interfere with the safe, and optimum future operation of such equipment. Particular attention must be given to the aspects of easy accessibility for maintenance and adjustment and specific safety requirements of particular Suppliers.

1.4 LOCAL PRESENTATION

Preference will be given to equipment and materials of local manufacture where such equipment and materials meet with the requirements of the standard and project specifications.

Tenderers shall only offer equipment and materials of a well-known recognised make, unless prior approval has been obtained from the Engineer.

The continuous successful operation of the system is dependent on good maintenance and the availability of spares. It is therefore important that Tenderers only include for equipment with good local representation, who are able to provide an after-sales service.

1.5 INSTALLATION FIT

Installation fit is an engineering function and not a system design function

Tenderers shall price in their contract for the required engineering undertaken during the preparation of shop drawings in co-ordinating services to suit service spaces provided.

Such engineering to include co-ordination with other Contractors and shall take into account the Civil Contractor's preferred services installation sequence program.

1.6 SYMBOLS

Symbols prescribed by the Systeme Internationale (SI) which are used in this Specification, are given below :-

Symbol	**Meaning**
mm	millimeter
m	metre
m^2	square metre
l	litre
Ml	megalitre
m^3	cubic metre
g	gram
kg	kilogram
t	tonne (1000kg)
kN	kilonewton
bar	bar
kPa	kilopascal
MPa	megapascal
s	second
h	hour
d	day
kW	kilowatt
Hz	hertz (cycles/second)
dB	decibel

1.7 ABBREVIATIONS

The following abbreviations are referred to in the text :-

ASTM	:	American Society for Testing Materials
BS	:	British Standard
BSCP	:	British Standard Code of Practice
SABS	:	South African Bureau of Standards
SIS	:	Standards Institute Sweden
CI	:	Cast Iron
Sa	:	Followed by a number refers to the relevant part of Swedish Standard SIS 055900
CID	:	Constant Internal Diameter
COD	:	Constant Outside Diameter
PTFE	:	Polytetrafluoro Ethylene
PVC	:	Polyvinyl Chloride
UPVC	:	Unplasticised Polyvinyle Chloride
V	:	Velocity
g	:	Gravitational acceleration
NPSH	:	Net positive suction head
Vrms	:	Root mean square value of velocity
NB	:	Nominal bore

2 PUMPS

2.1 SCOPE

This Specification covers the requirements for pumps used in pumping applications on Umgeni Water installations.

2.2 DEFINITIONS

For the purpose of this Specification, the following definitions shall apply :-

2.2.1 Static Head

The difference between the free fluid surface on the suction side and the free fluid surface on the delivery side of an open system.

2.2.2 Friction Head

The head required to overcome the friction in the pipeline, external to the works provided under this contract, as well as all losses in pipework specials and valves inclusive of fittings within the scope of this contract, entrance and exit losses.

2.2.3 Velocity Head

The velocity head in the delivery line given by V^2 / 2g at the point of measurement.

2.2.4 Pressure Head

This value represents the energy per unit weight stored in the fluid by virtue of the pressure under which the fluid exists.

2.2.5 Total Head

Total head is the sum of the static head, friction head, velocity head and pressure head.

2.2.6 Pumping Head

The head based on the total head, ie the head against which the pump must deliver.

2.2.7 NPSH (Net Positive Suction Head) of Pump

This value defines the total fluid pressure at the pump suction nozzle necessary for the pump to operate under the defined cavitation conditions. (Refer to the project specification or detail inquiry for details).

2.3 GENERAL

All work carried out shall comply fully with the requirements of the Machinery and Occupational Safety Act Nº 6 of 1983.

All pumps shall be provided with adequate protection over inlet and outlet flanges before being delivered to site. Protection covers shall be able to withstand normal handling during construction work. Protection covers shall preferably be of the bolt-on type.

The total pumping head shall be finally checked by the Contractor, when all the information regarding the selected system elements is available. These calculations shall be submitted to the Engineer for approval prior to ordering the pumps.

All pumps shall be provided with appropriate flexible drive couplings between the pump shaft and motor shaft to allow for angular and axial deviations. No pumps shall be permitted to operate before the shaft alignment has been checked by the Engineer or his Representative. In the case of parallel shaft pump arrangements, the alignment of the motor with respect to the pump centre line shall be checked.

Pumps shall be provided with extended lubrication points where lubrication points on the pump are not easily accessible.

All pump drives shall be suitably protected by a securely mounted sheet metal guard.

Air-cocks shall be provided on the pumps and at any high points on the delivery mains within the limits of this contract. Drain-cocks shall be provided on the pumps as well as drains from the pump seals. All water and drain-cocks shall visibly discharge into tundishes, discharging to waste.

A corrosion-resistant data plate shall be permanently attached to the pump and contain the following information :-

Manufacturer's Name
Serial Number of Pump
Size and Type of Pump
Rated Capacity in m^3/hr
Pumping Head in metres at this pumping capacity
Pump Speed
Maximum Allowable Casing Working Pressure in kPa

Before any pump is accepted, the following information shall be submitted for approval to the Engineer:

- Mass and dimensions of motor and pump assembly
- Country of manufacture
- The complete pump performance curve of head/capacity/power absorbed/NPSH required for each pump type offered, together with the relevant system head curves on which the duty points shall be clearly marked.

Before any installation takes place on site, detailed drawings showing the suction and discharge details, as well as the pump-base details required, must be submitted for approval to the Engineer.

2.4 MATERIALS

In all cases, careful consideration must be given to the selection of materials for pump construction. The components which are in direct contact with the pumped fluid, or any other component which may under any conditions come into contact with the pumped fluid, shall be manufactured from a material which is compatible with the fluid being pumped.

Material selection should take into account the corrosion, as well as abrasion properties of the fluid.

2.5 SELECTION, DUTY AND OPERATING REQUIREMENTS

All pumps shall be selected to operate at a maximum speed of that corresponding to a four or six-pole, electric motor. No belt drives shall be permitted to arrive at the required pump speed. The above does not apply to cases where adjustable speed drives between pump and motors are required.

The efficiency of each pump selected (except in the case of dosing pumps), shall not be less than 70% and not more than 3% below the peak efficiency curve for that particular pump range.

The operating speed of rotating elements shall be below and as far removed as possible from the critical resonant speed thereof.

The following maximum permissible vibration limits shall apply to pumps :-

Where anti-friction bearings are fitted

(measured on bearing housing), maximum vibration velocity value (Vrms), 2,8mm/s.

Where sleeve-bearings are fitted

(measured on the shaft), maximum vibration velocity value (Vrms), 4,5mm/s.

Vibration testing shall be done by an approved Agency, when requested by the Engineer. In the event of the pump and associated pipework failing to meet the acceptable vibration values given, the Contractor shall be held responsible for the cost of the tests, rectification and subsequent re-testing until the acceptable values are met.

Equipment or a combination of equipment shall not exceed the maximum noise limit in decibels, in each octave band of the 85dBA sound pressure level, as given below :-

FREQUENCY Hz	63	125	250	500	1k	2k	4k	8k
dBA	104	94	87	82	79	79	78	80

Measurement of equipment sound pressure levels shall be taken at a horizontal distance of 5m from all major sources and at a height of 2m above the equipment.

Sound pressure measurement procedures shall be guided by the stipulations of SABS Code of Practice 0197 - 1984.

Unless otherwise required by the Project Specification, each pump and electric motor shall be capable of operating satisfactorily at an assumed maximum shade temperature of 40ºC.

The available NPSH of the system shall be carefully checked by the Contractor for each pump application before final selection takes place. This will be compared with the NPSH required by the pump for that particular duty, and no duty point shall be selected where the head loss due to NPSH conditions is greater than 0%.

2.6 SHAFT SEALS

Shaft seals for pumps shall be of either the radial face, mechanical seal type or the non-contact type shaft seal or compression packing seals. Preferences, if any, will be specified in the Project Specification.

2.6.1 Radial-Face Mechanical Seals

Mechanical seals shall be of the single-acting, balanced type with multiple springs able to withstand rotation in either direction.

Wherever possible, and especially where space limitation exists, all mechanical seals shall be made as cartridge units. These units shall simply slide over the shaft and be a bolt-on unit.

All seals shall have capsulated springs, or springs that are situated outside the medium. Mechanical seals which utilise formed metal bellows instead of springs, will also be acceptable in instances where clogging may present problems.

The following material combinations shall be used :-

For Potable Water or Non-Abrasive Fluids:

All metal parts to be stainless steel

Carbon-rotating face-on-chrome-oxide stationery seat, or silicone-carbide face against carbon-seat, or solid tungsten carbide against carbon-seat.

For Raw Water or Abrasive Fluids

The metal parts shall be manufactured from 316 stainless steel, solid tungsten carbide face against silicone carbide seat or solid tungsten carbide against solid tungsten carbide seat or silicone carbide face against silicone carbide seat.

2.6.2 Compression Packing Seals

All pumps using compression packing seals shall be provided with drip trays. A 25mm drain pipe shall be installed between each drip tray and the nearest floor drain or tundish.

Stuffing boxes shall be deep enough for not less than four rings of packing and shall have bronze glands. Glands for horizontally split casing pumps shall be split.

Non-asbestos type packing, suitable for the duty of the pump, shall be used as a packing material.

2.7 BEARINGS

The bearings shall be either grease or oil-bath lubricated or water lubricated. Where grease is used, high quality bearing grease of Lithium soap base, free of resins and acids, with an anti-corrosive effect shall be used. The grease shall have a penetration figure of between 2 and 3, and a drip-point of not below 175ºC. A thrust bearing shall be provided to accommodate the end thrust on any rotating component. Bearing numbers shall be quoted in the Operating and Maintenance Manuals to facilitate replacement in future.

Thrust bearings for vertical pumps may be located in the drivers, except when flexible couplings are fitted.

Bearing housing closures, of the labyrinth type slinger are required on horizontal pumps at each point where the shaft projects through a bearing housing, except that a mechanical oil-seal is acceptable at the coupling end of the bearing housing. A non-labyrinth type slinger is acceptable on the stuffing box end of a bearing housing when it is combined with a mechanical oil seal. All bearings shall be suitable for shaft rotation in both directions.

Where end thrust arises, adequate long wearing thrust bearings shall be provided.

2.8 PLINTHS AND BASE-PLATES

All pump unit pump/motor units shall be installed on concrete plinths, raised at least 120mm from the general floor level of the building housing the pump.

Pump units of 100kW and less shall be mounted together with the electrical motors on a common base-plate of rigid design, manufactured in galvanised mild steel. Stainless steel anchor bolts shall be provided for mounting the base-plate onto the concrete plinth.

Each pump and motor set shall be mounted on a separate base-plate which shall be completely separated from any other adjacent equipment base-plates.

On larger pumps, detailed drawings of the pumping equipment shall be provided in good time to enable the Civil Contractor to construct the grouting holes required for the pump, as well as the motors.

The mass moment of inertia for each of the pumps, as well as the motors shall be provided during tendering stage. Base-plates and pump supports shall be so constructed and the pumps so mounted, as to minimise misalignment caused by deflections arising from normal piping strains, hydraulic piping thrusts and similar causes.

Anchor bolts shall be as per the manufacturer's requirements. An approved pre-packed 2-part epoxy compound or cement grout shall be used for grouting in of anchor bolts.

2.9 SHAFT COUPLINGS

All pumps and motors shall be direct-coupled with a suitable type of flexible coupling which will satisfactorily take up minor misalignment or offsetting of the motor and pump shaft.

The coupling shall be designed in such a manner that no axial or radial loads will be imposed on the motor and pump bearings which are in excess of the loads approved by the motor and pump manufacturers respectively, for the installation offered.

Spacer couplings shall be provided on all centrifugal pumps of the back pullout type to allow for the removal of the pump impeller, without disturbing the motor position. The couplings shall be robust, shall be such that they can be readily dismantled and re-assembled and shall have a service factor of at least 1,5.

2.10 PUMP CONSTRUCTION AND ASSEMBLY

Close coupled motors will only be permitted on pumps of 2,5kW or less. Pump designs for other pumps where motors form an integral part of the pump housing, will not be acceptable.

All positive displacement pumps shall be equipped with a pressure relief valve on the discharge of the pump or a pressure diaphragm rated for 1,5 times the normal duty point of the pump.

End suction, centrifugal pumps, shall be constructed in such a way that the impeller can be removed from the rear of the pump without disconnecting the discharge and suction flanges. A removable shaft section shall be provided to facilitate the removal of the impeller.

2.11 ANCILLARY ITEMS

Glycerine filled pressure gauges with a full scale reading of 1,5 times the maximum discharge pressure shall be provided on each pump discharge.

An in-line stopcock/bleeder valve, shall be provided before each pressure gauge, to isolate it from the mains.

2.12 AUXILIARY PIPE SYSTEMS AND PIPING

If required, a re-circulating piping systems for gland oil lubrication inclusive of accessories, such as gauges and valves, shall be furnished by the Contractor, fully assembled. These systems shall facilitate easy maintenance.

Materials used for all auxiliary piping and valves shall be suitable for the designed duty of the pumps and all items shall be properly cleaned before assembly. They shall be installed in a manner which prevents transmission of vibration of the pump.

18Cr-8Ni stainless steel piping or tubing shall be used for flushing fluids to mechanical seals. Minimum tubing wall thickness for sizes up to 20mm OD sizes, shall be 1,65mm.

Tubing connections shall be Crawford Swagelock, or approved similar. Tubing fittings and ferrules shall be 18Cr-8Ni stainless steel. Copper tubing and brass fittings are unacceptable.

Auxiliary piping connections shall be plugged with solid plugs. Carbon steel plugs shall be used with cast-iron casings, otherwise the plugs shall be of the same metals as the casing material. Plugs shall have a shank to permit the use of a spanner.

2.13 CENTRIFUGAL PUMPS

2.13.1 Casings

For raw water and potable water applications, the casings shall be of close-grained cast iron. For pumps with impeller diameters of 200mm or larger, in order to achieve high efficiency, the inside of the pump casing shall be grit blasted at least to Grade Sa 2,5 and two coats of self etching primer

shall be applied within 4 hours of blast cleaning. Thereafter the casings shall be given four coats of an approved, non-toxic, epoxy resin, of which the thickness shall be at least 150 microns.

Where abrasive slurry or sludge is pumped, provision shall be made to line the casing internally with a suitable synthetic material to prevent abrasive erosion of the pump casing.

Pump casings shall be manufactured from 316 stainless steel or approved alternative material, in cases where corrosive fluids are pumped.

2.13.2 Impellers

Information regarding the chemical, abrasive and corrosive properties of the fluids to be pumped will be provided by Umgeni Water and the impeller material will be selected accordingly. Impellers for sludge or slurry transfer pumps shall be coated with a hard wearing synthetic material surface to prevent erosion.

2.13.3 Shafts

Shafts shall be of chrome-steel or other approved material.

They shall be located by deep-grooved ball bearings and the axial movement must be accommodated by roller bearings.

The impeller shall be keyed to the shaft.

2.13.4 General Construction

To eliminate noise and vibration when running, pumps shall be accurately and efficiently balanced statically, dynamically and hydraulically, so that there is no unbalanced end-thrust.

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.

All parts shall be of ample dimensions and strength, and of the best, and most suitable material, corrosion-resistant, free from flaws, accurately machined, properly assembled and fitted so as to avoid initial stresses and to ensure free running.

Each pump shall be provided with a cast-in or permanently attached direction-of-rotation arrow.

2.14 METERING PUMPS

All pumps used as metering pumps shall be positive displacement pumps.

Preference shall be given to locally manufactured equipment of which spares and accessories are readily available.

The delivery of metering pumps shall be adjustable over the range 0 - 125% of the required dosing rate, as specified in the Project Specification or as required in the treatment process.

Restricting the flow rate by any means, to achieve the specified dosing rate of the fluid, will not be acceptable. Variable speed pumps are acceptable.
Variable discharge can be achieved by either varying the speed of the pump mechanically, via a variable speed drive, by means of power electronics (frequency or voltage adjustment), or by means of adjustment of the stroke length.

The discharge flow adjustment selector shall be clearly marked according to the pre-calibrated pump discharge corresponding to the marked set point.

All metering points shall be installed at a level of at least one metre above finished floor level on a suitable stand.

An in-line pipe strainer shall be installed upstream of each metering pump inlet, to prevent any solid particle from entering the pump.

2.15 SUBMERSIBLE PUMPS

The unit shall consist of the pump directly coupled to a three phase AC motor with absolutely waterproof insulation of the windings designed to work under the fluid level as required. A suitably rated submarine cable attached to the discharge pipe with cable clips shall be used to supply electric power to the motor.

The pumps shall be capable of handling the required fluid as specified. The pump intake shall be protected by an adequately sized bar screen capable of passing solids at least 6mm and not more than 25mm in diameter, depending on the impeller used and the pump size.

Free standing units are acceptable and the pump shall stand on a suitable suction pedestal with clear passageways, mounted on the lower casing.

The pump shall be capable of running dry without damage.

Discharge shall be by means of heavy duty flexible synthetic hose (HELIFLEX or equivalent) or an automatic quick coupling device connected to the rigid pipework.

The pump shall have either radial or mixed flow impellers. The radial pumps shall be fitted with renewable diffusers, whereas mixed flow pumps shall be fitted with guide vanes cast integral with the stage casings.

The impellers shall be of a suitable material for the application.

The discharge connection shall incorporate a check valve.

The shaft and shaft sleeves shall consist of stainless steel of an approved quality. Bearing bushes shall be of high quality zinc-free bronze.

A pressure gauge is required on the delivery side ONLY.

2.16 TESTING

Tests shall be carried out on the pumps at the Manufacturer's works before shipment, or shall have been carried out on identical pumps, or such pumps shall have been in service for extended periods and be giving satisfactory results, all under conditions identical with, or closely approaching those under which they will operate under this contract. If so specified in the Project Specification, the Engineer or his Representative will witness these tests in the Manufacturer's works. The Contractor shall provide all testing equipment necessary to test the pumping equipment.

Proof of recent calibration of all test instruments shall be furnished by the Contractor before testing commences.

Two copies of the Contractor's records of all tests shall be furnished to the Engineer.

Acceptance tests for all centrifugal, mixed flow and axial flow pumps will be performed in accordance with the procedures specified in BS 5316: Part 1: Class C tests.

The performance testing of all other pumps will be done as follows :-

- The performance values to be guaranteed by the pump supplier shall be:

    - outlet rate of flow of pump
    - total head of pump
    - power input of motor pump unit

- NPSH

(The physical properties of the fluid to be pumped will be provided by Umgeni Water).

- The testing shall be carried out on site and the test arrangements shall be in accordance with paragraph 5.7 of BS 5316 Part 1.

- The procedure for the measurement of rate of flow, head, speed of rotation and power input shall be done in accordance with paragraph 6 of BS 5316 Part 1.

3 VALVES

3.1 SCOPE

This Specification covers the material and constructional requirements for valves.

3.2 GENERAL

For valve sizes referred to in this specification are nominal bore sizes. Details or requirements on supporting drawings, the project specification or letter of invitation to quote etc., may conflict with certain aspects of this specification, and in such cases are to take precedence over this specification. The Tenderer should check the requirements of drawings and supporting documentation and specifically in those where with phrases such as “unless otherwise specified” are used in this specification.

“Knife” valves will not be acceptable as either shut-off or modulating valves.

Lifting lugs are to be fitted on all valves which have a mass in excess of 50kg.

Each valve shall have a plate securely fixed to the body on which the following information shall be stamped :-

The Manufacturer’s name
Size of valve
Class of valve
Arrow indicating the direction of flow
The contract number

3.3 GATE VALVES

Gate valves shall be constructed according to the stipulations of the following Specifications:

SABS 664

For valves operating under working pressures up to 1 MPa and of diameter up to 350mm. These valves shall be constructed of cast iron.

Gate valves subject to working pressures up to 1,6 MPa and of diameter over 350mm, but not exceeding 600mm, shall be of cast iron and shall comply with the relevant requirements of SABS 664.

SABS 191

Valves operating under working pressures over 1 MPa and of diameter exceeding 600mm, shall be of cast steel and shall comply with the material and construction requirements of this specification.

The definitions as contained in SABS 191 and 664 are applicable to this specification.

All valves shall have double flanged ends.

Unless otherwise stated the valves are to be the non-rising spindle type.

The valve shall be provided with a handwheel, unless otherwise specified. Handwheels for Classes 10 and 16 valves, shall be manufactured from cast iron and for Classes 24, 40 and 100, from cast steel.

The direction of closing shall be clockwise.

Channel-guides and shoes shall be fitted to valves falling within the following pressure and size ranges:-

- Class 10 500mm and above
- Class 16 300mm and above
- Class 25 250mm and above
- Class 40 150mm and above
- Class 100 all sizes

The valves shall be capable of being easily operated by one man, against the maximum, unbalanced pressure, and in order to comply with the above requirements, it has been found that the following is normally necessary :-

CLASS	VALVE SIZE	DRIVE
10	250mm and above	Ball thrust
16	200mm and 250mm 300mm and above	Ball thrust or 2,5:1 spur-gear Both ball thrust and 2,5:1 (or greater) spur-gear
25	200mm 250mm and above	Ball thrust or 2,5:1 spur-gear Ball thrust and 3:1 (or greater) spur-gear
40 and 100	All sizes	Ball thrust and spur-gear

The Tenderer shall state the spur-gear ratio offered and whether the valves are fitted with ball thrust bearings, together with a maximum torque required to operate the valves against the working pressure.

Class 10 and Class 16 valves are to be fitted with back sealing rings in order to permit the re-packing of the gland while the valve is under pressure.

Valve-trim shall be either Type B or Type C. Gate seating rings may be deposited.

Unless otherwise specified, position indicators shall be fitted on all valves of size 100mm and larger and shall show clearly the full open, and closed positions and the quarter, half and three-quarter intermediate open positions.

Supporting feet are to be fitted on all valves of sizes 300mm and larger.

In addition to the marking requirements listed in SABS 191 and 664, one flange edge shall have the following number of 3mm wide by 3mm deep grooves cut across it at top, dead-centre :-

- Class 10 1 groove
- Class 16 2 grooves
- Class 25 3 grooves
- Class 40 4 grooves

- Class 100 5 grooves

The design of the valves shall be such that the cast iron/steel sections are not subject to excessive tension, by the tightening of connecting bolts, as can happen when the faces of the bonnet and the stuffing box flanges are not fully machined for a full-faced gasket.

Bolts must be used to fasten the stuffing box to the bonnet and the bonnet to the valve body. The use of studs and Allen-type screws is unacceptable.

Resilient seal gate valves are acceptable for the application where the water contains undissolved solids. These valves shall be covered in bonded nitrile rubber. The gates shall be able to be replaced without removing the valve body from the pipeline.

3.4 BUTTERFLY VALVES

Butterfly valves shall be used on water services for positive shut-off only. This type of valve shall not be used for controlling the flow in any way. The valves shall be manufactured in accordance with BS 5155 (cast iron and carbon steel butterfly valves for general purposes), as far as is applicable. Where conflict exists, the requirements in this specification shall take precedence.

The following criteria for construction shall be met :-

3.4.1 Body

These shall be of the wafer-lug type, with drilled/tapped bolt holes, to allow the valve to be used at maximum working pressures of respectively 20 and 16 bars in terminal positions.

This is to allow downstream pipework to be disassembled with the upstream pipework under pressure.

Bodies shall be one piece casting Ductile Iron, UTS 400 MPa, YP 250 MPa, (elongational 12%) GGG 42 or equivalent for sizes up to 1500mm. Sizes above shall be of cast steel. Bodies shall never be in contact with the fluid conveyed and shall be fully protected internally by the resilient seat.

3.4.2 Disc

Shall be cast or stamped, spherically machined and positively splined or keyed internally to the driving shaft. (Use of plinths or bolts is totally prohibited).

Selection of the disc material shall be made taking into account the aggressivity of the fluid. (Cupro-aluminium or stainless steel 316 or equivalent).

3.4.3 Shaft

Butterfly valve technology shall be such that the shaft will never be wetted. (Dry shaft) Stainless Steel, AISI 420 of high mechanical characteristics shall be used.

It shall be positively splined or keyed to the disc. The upper and lower shaft and tie-bolt, when assembled to the disc, shall give in effect a one-piece shaft/disc assembly. At least three bearing assemblies, consisting of steel outer shell, with sintered bronze inner lining, coated with Teflon, facing shall be used.

The upper shaft shall be carried in two bearings, the lower in one.

3.4.4 Liner

The resilient, synthetic rubber seat shall be easily replaceable (bonded liners are prohibited) and shall entirely cover the inside of the body overlapping over the sides to form the seal between the body and matching pipework.

Where necessary, it shall be keyed to the body with annular grooves in the bore of the valve. The design shall be such as to allow the disc to seal drop-tight to the liner so that there is no ingress of fluid to the shaft area.

3.4.5 General

Valves with "0" Ring Shaft Backup Seals shall not be considered. The Manufacturer shall be able to offer alternative grades to cope with various fluids.

Quarter-turn handles shall be supplied for valves up to and including 150mm nominal diameter. The handle shall be lockable in all intermediate positions and be adaptable to the valves.

For valves larger than 150mm a gear shall be used. The gear operator shall be designed with a worm and nut system. The gear operator shall be irreversible in any position. The gear shall have a handwheel and an indicator protected by plexiglass, showing the position of the disc. If specified, limit switches shall be fitted, mounted in a waterproof and dustproof housing.
U-section wafer-type valves, as described in BS 5155, shall be acceptable, provided that :-

- the valve is suitable for individual bolting of each flange

and

- the dimension between the inside faces of the flanges is not less than 3D, where D is the diameter of the flange bolts as specified in BS 4504: Part 1, or SABS 1123

The use of single flanged and flangeless valves shall be permitted only if provision is made for downstream pipework to be disassembled with upstream pipework under pressure.

The direction of opening of the butterfly blade shall be such that the bottom of the blade moves in a downstream direction.

All handwheels shall be fitted with a suitably sized shear-pin, that shall fail before damage can be done to the drive gearing of the valve.

3.5 REFLUX VALVES

Reflux valves shall be double-flanged for horizontal and vertical mounting of robust construction and suitable for the operating head and close drop tight.

The body, cover and door shall be of close-grained cast iron and the door shall be fitted with a zinc-free phosphor-bronze face, closing on a corresponding bronze face in the body.

The valves must be of the "non-slam" type, for horizontal or vertical installation. Valves with a stainless steel perforated cone, or resilient conical diaphragm, are also acceptable.

Wafer type reflux valves shall not be acceptable.

Swing check valves shall not be used in cases where the solids content of water exceeds 5%.

For fluids with a higher solids content, lined cast iron or cast steel reflux valves with a non-return disc, shall be provided. The disc and lining shall be of either rubber, polypropylene or PTFE, depending on the characteristics of the fluid.

3.6 STRAINERS

Strainers shall be provided and installed in all piping installations upstream of water pumps, control valves, etc., where a possibility exists that solid particles of appreciable size will damage the downstream equipment. Strainers shall be of the angle or Y-type. Strainers up to 50mm shall have bronze bodies with screwed ends and bronze screens.

Strainers of 65mm and over shall have cast iron or cast steel bodies, with flanged ends and screens of stainless steel or bronze. Screens shall be perforated as follows :-

STRAINER SIZE	PERFORMATION SIZE
Up to 50mm included	0,8mm
65 to 150mm	1,8mm
200mm and over	3,2mm

Strainers fitted in pipes larger than 150mm diameter shall be provided with a 15mm blow down globe valve fitted with a quick coupler.

3.7 VALVES FOR SPECIAL DUTIES

3.7.1 Pressure Regulating Valves

Pressure regulating valves shall be selected in accordance with the Manufacturer's recommendations for the inlet pressures and shall be designed to give a constant downstream pressure with varying upstream pressures.

The valves shall be hydraulically operated, pilot controlled, diaphragm-type single seat, Y-pattern globe or other approved valve.

The valve will be supplied with double flange end connections. The valve shall be so designed that it shuts down without inducing water hammer, and is capable of operating smoothly at low flows. It shall be fitted with single removable 316 stainless steel seats and discs of synthetic rubber of rectangular cross-section.

This type of valve can also be used in pressure reducing applications. Pressure reducing valves of 40mm and over shall have cast steel or malleable iron bodies, stainless steel working parts, flanged ends and built-in stainless steel strainers. These valves shall be direct-acting and shall be suitable for the system fluid characteristics, pressure and temperature.

3.7.2 Balancing Valves

Where required, calibrated balancing valves of the plug-cock type with bronze or cast iron valve bodies, with bronze plug seats. Internal seals shall be provided. Valves shall be screwed up to 80mm and shall have flanged ends for 100mm and over. Valves shall be provided with screwed take-off connections to which a pressure differential gauge can be coupled and provided with check valves in the take-offs. A valve position indicator shall be included. Valves shall be suitable for a working pressure of 2500kPa. A portable differential pressure gauge shall be supplied with the above valves, complete with all necessary tubing, shut-off and vent cocks and a carrying case.

A graph or chart shall also be supplied on which flow quantities against valve opening and pressure differential across the valve can be read off.

Calibrated balancing valves of the globe-type shall also be acceptable.

3.7.3 Safety Relief Valves

Safety relief valve shall be provided on the discharge of all positive displacement fluid equipment, as well as in positions where indicated or required. Alternatively to relief valves, safety diaphragm outlets may be provided, rated for 1,5 times the normal pump working pressure.

The valves shall be of the spring-loaded type with side outlet and screwed connections. Valve bodies shall be of bronze or cast iron and working parts and trim of bronze.

The outlet shall be piped to a safe position, or to the inlet reservoir of the relevant fluid. Valves shall be constructed according to BS 1123 Specification.

3.7.4 Ball Valves

Ball valves shall only be used in pipe systems carrying potable water or other clean fluids.

3.8 DIAPHRAGM VALVES

Diaphragm valves shall be used as shut-off valves in pipe systems carrying abrasive fluids such as Bentonite or slurry. The diaphragm shall be made from a suitable material, to withstand any chemical attack by the fluid.

In case of a rupture in the diaphragm, the valve body and parts shall be constructed of materials which will withstand any corrosion caused by the fluid.

4 MATERIALS HANDLING EQUIPMENT

4.1 SCOPE

This standard specification covers the requirements for materials handling equipment normally used for the moving of raw materials, waste etc.

4.2 BELT CONVEYORS

4.2.1 General

All conveyors and their components, in the plant or area concerned, shall be thoroughly rationalised and standardised. The variety and different sizes of the drive components, motors, pulleys and shafts, bearings, belting, chutes, idlers and electrical power systems, shall be reduced to a minimum. For rationalisation purposes, equipment may be selected which is larger than necessary, in the interest of improved interchangeability, improved availability and longer life.

All major components, assemblies and major sub-assemblies shall be clearly numbered on drawings and in manuals and be clearly numbered before and after installation on site.

The conveyor duties shall be as specified in the project specification or shall be rated for particular application for which it is intended in that part of the process.

4.2.2 Conveyor Design

The general design and selection of conveyor layout and components shall be based on a minimum life of equipment of at least 10 years. Provision shall also be made in the general layouts and capacity of the belt for additions to the original plant which may take place in the future.

The calculated life shall include a full allowance for shock and service factors and be based on full load operation during the following numbers of hours per annum :-

HOURS PER ANNUM : W x D x H

W, D & H shall be as defined in the project specification or else as is required for the application and denote the number of working weeks per annum (W), average number of working days per week (D) and the average number of working hours per day (H).

The capacity of a belt is expressed in metric tons per hour and denotes the average tonnage per hour.

- The conveyor design capacity (CDC), shall be calculated as follows :

  CDC = SSC x K1 (t/h)

  Where:

  SSC = Maximum anticipated flow rate, in tons per hour
  K1 = Load design factor (normally 1,66 unless otherwise stated)

- The conveyor belt sizing capacity (BSC 1) shall be calculated as follows :-

  BSC 1 = SSC x K2 (t/h)

  Where:

  K2 = Belt sizing factor (normally 1,66 unless otherwise stated)

- The conveyor belt sizing capacity of all tripper belts shall be calculated as follows :

  BSC 2 = SCC x K2 x K3 (t/h)
  Where:

  K3 = Tripper belt sizing factor (normally 1,33 unless otherwise specified)

The final belt velocity quoted by the Contractor and used in the overall design of the conveyor shall allow for the predicted amount of coupling and motor slip and rated full load and shall allow for full thickness lagging on the drive pulleys. The minimum belt speed shall in all cases be one metre per second and the maximum 3,5 metres per second.

4.2.3 Commissioning of Conveyor Systems

The Contractor shall accurately record all commissioning test data which may serve later as a performance standard for the given conveyor.

Prior to any tests, the Contractor shall ensure that all lubrication has been completed and all safety features are in full working order.

Load tests may commence once the belt is running and the belt has run on no load for sufficient time to check on possible overheating of bearings, motors etc.

During the first part of any test, the skirt rubbers shall be lifted clear of the belt for the initial operation.

Additional test running shall be done with the skirt rubber properly adjusted.

Straining of the belt shall be the Contractor's responsibility. This straining shall be achieved via small adjustments of several idlers in the relevant area.

The measured full load belt speed shall be within 5% of the design value.

The measured motor gear box and/or fluid coupling temperatures, must be below the manufacturer's prescribed maximum levels.

The measured maximum tracking error of the belt, under full load conditions, must be within 40mm of the conveyor centre lines. All pulleys and idlers shall be correctly aligned and the full belt shall be in contact with every idler roller.

All pulleys and idlers shall be horizontal and at right angles to the conveyor centre line. The use of off-set and skew idlers for realignment shall be avoided.

After commissioning, the take-up mass (for gravity take-ups) or normal running belt force (for automatic take-ups), shall be measured by the Contractor. The above measurement shall be witnessed by the Engineer.

The certified mass in kilograms or force in kilonewtons shall be stencilled on the take-up carriage in 100mm high lettering.

4.2.4 Supporting Steelwork

The conveyor main structure shall be designed that it can safely withstand all conditions of belt-tension.

Conveyor stringers shall be fabricated from standard channels and shall be installed with the flange toes facing outwards.

Decking plates shall be provided in the following areas :-

- From the tail pulley to 3m beyond the end of the loading chute skirtboard
- For 3m at the discharge pulley
- For 3m at all intermediate loading points
- For 2m on each side of the vertical centre line through the vertical gravity take-up pulley

Decking plates shall be made of mild steel, thicker than 2,5mm, unless otherwise specified. Refer to the Standard Specification on Painting for surface treatment.

Safety guards and all other safety precautions shall comply fully with the South African Mines and Works Act and Regulations, as well as BS 2890.

Suitable guards shall be provided for the following:

- All pulleys
- All drive components, including anti-runback and couplings
- All take-up mechanisms
- Gravity take-up and counter-weight boxes
- All other moving parts

All safety guards shall be of open mesh construction and shall be easily removable. Mesh guards shall be with 18mm openings and shall be at least 3mm thick.

Unperforated guards shall be fitted around all fluid couplings and shall contain any splashing oil in the event of a fusible plug blowing.

4.2.5 Chutes

Chutes shall be designed in such a way that the material shall be deposited onto the receiving belt in accordance with the following conditions:

- The material must be flowing in the same direction as the receiving belt
- The horizontal speed shall closely match that of the receiving belt
- The major part of the load impact shall be on chute-components and not on the belt
- The chute shall ensure central loading of the belt at maximum and low feed rates

- Spillage shall be reduced to an absolute minimum

All chutes feeding onto conveyor belts shall have dead boxes wherever the flow directions change, or where their use can lead to a reduction of liner wear or improved guidance of the flowing material.

Removable lip liners shall be provided at the wearing edges. All chutes are to be lined and shall have removable sides to facilitate the liner replacement.

All bearings shall be located outside chute side-plates.

Chute layouts shall be submitted to the Engineer for approval before final layout design commences.

Chute side-plates shall have the following minimum thickness:-

- 8mm : for belt width of 900mm and less
- 100mm : for belt width of over 900mm

All chute-plates shall be properly stiffened and supported.

The inside of all chutes shall be easily accessible for maintenance, cleaning and inspection purposes.

4.2.6 Belting

Conveyor belts with synthetic carcasses shall conform to the following:

SABS 1173 or BS 490 Part 1

All synthetic carcasses shall be either nylon and/or polyester wraps.

The permanent growth plus elastic-stretch at belt tensions, Tu/10, shall be less than 2,5% of Lt, where: Lt = conveyor centre distance in m, and Tu = ultimate or breaking strength of belt carcass in kilonewton per metre.

The quality of rubber used for covers shall be suitable for conveying the applicable material.

4.2.7 Conveyor Pulleys

All pulleys shall be lagged, unless specified otherwise. Lagging shall be done by the Contractor before delivery to site. Lagging shall have the following thicknesses:

- For pulleys of 800mm diameter and under : 10mm
- For pulleys over 800mm and under 1200mm diameter : 12mm

The rubber lagging shall have a diamond pattern grooved for drive pulleys and shall be plain or ungrooved for non-drive pulleys.

“Slide-lag” lagging shall have a minimum thickness of 10mmm for all pulley diameters.

4.2.8 Belt Cleaning

Suitable belt cleaning systems shall be provided on all conveyors. The Contractor shall submit full particulars of the proposed systems for the Engineer’s approval.

The cleaning system shall clean all slimes and solids from the return belt on both sides, and shall be as near as possible to the head or discharge pulley on the outside belt surface.

The belt cleaning system shall be so designed and installed that easy maintenance and inspection access to all components are provided.

4.2.9 Idlers

All rollers of a multi-roll idler set shall be identical and fully interchangeable. The Contractor shall, before manufacturing commences, submit to the Engineer for approval, drawings of all idler sets indicating main dimensions, wall thickness, bearing and seal details.

All idler rollers shall be so designed and constructed that they cannot be dislodged during normal operation and that they can be easily removed for repair work. They will be suitable for a 24 hour per day operation, when exposed to all weather conditions and dusty atmosphere, while carrying wet, sticky or dry abrasive material.

All idler rollers shall be of the factory "greased for life" type. All bearings shall be sealed on machined surfaces.

Deep-groove ball bearings are acceptable.

As an alternative, modified taper roller bearings, having specifically profiled rollers and races, which permit angles of shaft deflection which are higher than those acceptable for normal taper roller bearings, may be offered.

Troughing idlers shall be of the rigid frame type. They shall have three rollers for belt widths of under 1200mm. The standard troughing angle shall be 35º. Idlers shall be spaced so that manufacturer's load ratings are not exceeded when the conveyor carries the design capacity. Troughing idlers shall be spaced so that the maximum permissible belt sag is not exceeded.

Return idlers shall be spaced at intervals, preferably equal to a multiple of the troughing idler spacing, but not greater than 4000mm.

Straining idlers shall be installed ahead of the tail, take-up and intermediate drive pulleys.

4.3 SCREW CONVEYORS

Where screw conveyors are specified or required, it shall be provided with an inlet hopper feeder and an outlet chute.

The hopper feeder shall be adequately sized for the duty of the capacity of the screw conveyor.

The wearing plates of the hopper feeder shall be suitable for the abrasion properties of the material being handled. This will also apply to the discharge chute.

Removable inspection plates shall be provided on the conveyor casing at regular intervals.

Shaft deflection shall be minimised by positioning guide bearings along the shaft length at the intervals as specified by the manufacturer.

These bearings shall be adequately protected against the material to be conveyed and shall be factory grease-packed and sealed. Adequate provision shall be made in the shaft design to remove the intermediate supporting bearings.

Careful consideration must be given to the material used for the construction of the worm and casing. The abrasion and corrosion properties of the material being handled must be taken into account, and if necessary, special lining material must be applied.

The screw conveyor shall in all cases slope towards the discharge chute.

Water connections, via a shut-off valve, shall be provided at 1,2m intervals on the conveyor casing. A 25mm water supply must be connected to each of these connectors to flush the conveyor in the case of a power failure or after prolonged use.

4.4 HANDLING OF INCOMING MATERIALS INSIDE BUILDINGS

A suitably designed trolley shall be provided on site for the handling of chemicals and other fluids stored in 200l drum containers.

These trolleys shall be designed in such a way that a single person can load and remove the container on a level surface.

Small, suitable trolleys to load bags of dry powder chemicals, shall be provided and shall be fitted with castor wheels.

Each of these trolleys shall be designed to carry a load of at least 300kg at a time.

These trolleys will only be used for on and off-loading of materials being stored on site.

5 AIR BLOWERS

5.1 SCOPE

This standard specification covers the general requirements for blowers used as aerators, vacuum chamber blowers or blowers for scouring sand filter beds.

5.2 GENERAL

Air blowers shall be of the centrifugal fan type, multi or single stage, depending on the required duty. Positive displacement, rotary air blowers are not preferred.

Blowers shall be directly coupled to electric motors and the motors shall be mounted on suitable rigid supports, which are attached to the main casing of the blowers. Provision shall be made in the shaft coupling for any angular and axial misalignment.

The whole blower/motor assembly shall be isolated from the floor structure by means of anti-vibration floor mountings.

Circular sound attenuators, containing a centre pod each, shall be provided on the suction and delivery side of the blower.

Sound attenuators shall be selected to provide insert losses to enable the blowers to operate quietly. Selections shall be done by the suppliers of the equipment and figures shall be submitted to the Engineer for approval prior to ordering of the equipment.

The design total system resistance as required for the satisfactory operation of the blower, for the duty as specified in the project specification, shall be finally checked by the Sub-Contractor, when all information on selected system elements is available.

Blowers handling air with abnormal qualities shall be selected for the relevant application.

Bearings shall be of the ball or roller anti-friction type and shall be cleaned and repacked with new grease before commissioning. Lubrication points shall be extended to the outside of the blower casing.
Blowers with diameters over 1000mm shall be provided with access doors fitted to the blower casing.

The blower casing and blower wheel shall be adequately cleaned and protected against corrosion as specified in Standard Specification for Cleaning, Corrosion Protection and Painting.

5.3 ANCILLARY ITEMS

5.3.1 Pipework

A flexible connection shall be provided in the pipepwork upstream of the attenuator on the suction side and downstream of the attenuator on the delivery side.

These flexible connections shall be suitable to prevent transmission of vibration from the blower to the rest of the pipework or structure.

Pipework to and from the blower shall be flanged and flanges shall be provided in the pipework to disconnect and remove the blower completely from the system for maintenance purposes.

5.3.2 Valves

Each blower shall be fitted with a hand operated valve on the suction and delivery sides of the blowers.

A non-return valve shall be fitted on the suction side of blowers used in vacuum applications and on the delivery side of blowers used for pressure systems.

5.3.3 Gauges

Glycerine filled dial type pressure gauges shall be fitted to the pipework on blowers to measure their performance.

Vacuum gauges shall be selected to indicate the required duty range.

6 CLEANING, CORROSION PROTECTION AND PAINTING OF SURFACES

6.1 SCOPE

This specification covers the procedures to be followed for cleaning, corrosion protection and painting of all visible and invisible surfaces on mechanical equipment.

For the coatings of steel pipes and specials refer to a separate standard specification, namely : Linings and Coatings for Steel Pipes and Specials.

6.2 GENERAL

In addition to the basic coating provided, all plant and exposed pipepwork shall be painted in accordance with the following :-

- All paints, primers, thinners and cleaning materials shall be SABS approved. The colour of the final coat shall be advised by the Engineer.

- All substrates shall be cleaned and prepared strictly in accordance with the Paint Manufacturer's instructions and recommendations.

6.3 CLEANING

The Contractor shall take all reasonable precautions to protect equipment and materials installed under this Contract against damage by other trades, from delivery to site, to handover.
Equipment delivered to site shall be suitably crated, which protection shall only be removed once equipment can be moved into a protected storage area. If equipment cannot be stored in an enclosed storage area, then a PVC covering of sufficient strength shall be wrapped around the equipment to eliminate the ingress of moisture and dust. This covering shall be kept in an acceptable condition until the equipment can be moved into a secure and protected area.

Water piping systems shall be thoroughly flushed and drained to remove dirt and loose scale prior to the testing and running of the equipment.

Water strainers shall be regularly removed and cleaned during commissioning until the water system is in a satisfactory clean condition.

6.4 SURFACE PREPARATION

Non-ferrous metalwork shall be cleaned with an appropriate solvent prior to protective coatings being applied. Cast iron and steel surfaces shall be prepared according to SABS 064-1979.

The following methods of surface preparation shall apply :-

6.4.1 Shot-Blasting

All surfaces to be painted, galvanised, metal sprayed and treated with epoxy resin, coal tar, poly-urethane, chlorinated rubber, vinyl and resin coatings.

6.4.2 Pickling

May be used as an alternative to shot-blasting, only with the approval of the Engineer, but shall not be used on welded components.

6.4.3 Hand Cleaning

Includes degreasing, wire brushing and may be used on small surfaces prepared for the repair of coatings on site. Welds and adjacent parent metal shall be inspected and approved and all spatter shall be removed prior to surface coating.
The welded areas shall be abrasive-blasted and/or ground and all contaminants, such as flux, weld-spatter etc., shall be removed prior to surface coating. The weld area shall then be flushed with fresh water and be allowed to dry before receiving the full specified coating.

6.5 GALVANISING

Hot dipped galvanising shall be done in accordance with the requirements of SABS 763 - 1977, as amended. Electro-deposited zinc coating will also be acceptable for small parts.

Except where otherwise specified, for individual items, the thickness of coating shall not be less than 300/g/m^2 of surface covered. Wherever zinc coating after fabrication is specified herein, the Contractor may use mill-coated material, provided that all edges that are cut (sheared, punched, drilled etc), or deformed sufficiently to cause peeling of the zinc coating, are re-coated with a zinc dust, pigmented paint, or a suitable polymerized resin paint.

6.6 PAINTING

6.6.1 General

Paintwork shall be done only by Specialists. Neatness of the final coat shall be to the satisfaction of the Engineer.

Surfaces which are to rest on concrete or other floors shall receive the full paint system prior to positioning.

Areas where previously painted surfaces have been damaged during transportation, or by any means whatsoever, shall be repaired as follows :-

- Rust spots shall be removed by means of a wire brush, or emery paper and the surrounding paint which is still intact shall be feathered for a distance of 20mm beyond the damaged area.

- Spot priming shall consist of all of the coats previously applied and shall overlap the damaged area by 20mm. The same treatment shall apply to damaged or scratched paint surfaces.

Paint dry-film thicknesses shall be measured using a non-destructive thickness gauge, such as the MIKROTEST or equivalent.

The Engineer shall use his discretion in deciding on the tolerances to be followed.

All surfaces to be painted shall be moisture-dry and shall be free of soluble salts and airborne contaminants.

6.6.2 Galvanised Surfaces

Galvanised surfaces shall be cleaned with Plascon Galvanised Iron Cleaner, or approved equivalent and then cleaned by brush prior to painting.

The surface shall then be washed clean with water and dried thoroughly.

A Calcium Plumbate Primer, according to SABS 912 - 1972, shall be applied to the galvanised surfaces as a primer.

A final decorative coat of Gloss-enamel paint shall be brush applied to the colour specification provided by the Engineer, or in accordance with SABS Code of Practice 0140 Part III - 1978.

6.6.3 Items Permanently Underwater

At the Manufacturer's works, the metal surfaces shall be blast-cleaned in accordance with this specification and painted with a 2-pack Polyamide cured high-build epoxy, to a minimum dry film thickness of 200 microns. The maximum dry film thickness shall be between 300 and 500 microns.

After erection of the equipment, the paintwork shall be inspected and repaired in accordance with this specification if necessary.

6.6.4 Items Above Water Level, Decorative Finish

The items shall be blast cleaned in accordance with this specification at the Manufacturer's Works and a zinc rich epoxy primer as specified in SABS 926 - 1968, as amended, shall be applied to the surfaces.

After erection and installation, the primer shall be repaired in accordance with this specification. The final decorative paint shall be one coat or vinyl co-polymer enamel, to a minimum dry film thickness of 40 microns and a maximum thickness of 50 microns.

Colours shall be as specified by the Engineer or in the case of pipework items, according to SABS Code of Practice 0140, Part III 1978.

6.6.5 Painting of Structural Steel

The surfaces shall be prepared in accordance with paragraph 6.4 in the fabricator's yard.

If the structure is to be welded during construction, then an epoxy primer to SABS Specification 926 - 1968, shall be applied.

The primer shall be applied within four hours of surface preparation.

The Contractor shall ensure that the primer is applied to clean steel.

If the structure is to be bolted and priming is carried out after all the welding has been done, then a suitable sealed primer shall be applied on site.
After erection, damaged areas shall be repaired and spot-priming shall be applied.

Two coats of chlorinated rubber paint shall be applied, to give a dry film thickness of not less than 150 microns. The total dry film thickness for the complete system shall not be less than 250 microns.

Consecutive coats of the final coat shall not be applied within 24 hours of each other.

6.7 PUMPS, MOTORS AND OTHER MECHANICAL EQUIPMENT

Cast iron valves, fittings etc shall be supplied uncoated by the Manufacturer. They shall be cleaned in accordance with the specification on surface preparation and painted as follows :-

- **Internally**, one coat of self-etching vinyl-wash primer to SABS 723, shall be applied and then painted with a two-pack polyamide cured high build epoxy, to a minimum dry film thickness of 200 microns.

- **Externally,** the valves shall be painted in accordance with the specification for items permanently above water.

- Nuts and bolts shall be painted in accordance with the specification governing the items they are bolting. During erection a nickel based anti-seize compound shall be applied to the bolt threads.

- Pumps and motors shall be delivered to site with the Manufacturer's standard coating.

- They shall then be degreased, rubbed with emery paper and washed and painted in accordance with the above standard specification for items permanently above water.

6.8 LININGS AND COATINGS FOR STEEL PIPES, SPECIALS AND FITTINGS

6.8.1 Scope

This section covers epoxy lining and coating of steel pipes and specials all applied under shop conditions.

6.8.2 Supporting Specifications and Definitions

Supporting Specifications

The latest editions of the following standards are referred to in this specification.

British Standards Institution

BS534 Steel pipeline and specials for water and sewerage.

Swedish Standards Institute

SIS 055900 Pictorial surface preparation standards for painting steel surfaces.

Definitions

For the purpose of this specification the definitions given in the applicable specifications listed and the following definitions shall apply:

Lining - Covering layer applied to protect the pipe internally.

Coating - Covering layer applied to protect the pipe externally.

6.8.3 Materials

Epoxy Resins: These shall be approved and suitable for spray application in single or multiple coats of contrasting colour. The epoxy shall also be suitable for lining and coating potable water pipes and must therefore be chemically and physically inert to free chlorine gas in concentrations of up to 10mg/l in water solution or to ozone concentrations of up to 5mg/l in water solution. The dried epoxy shall furthermore be chemically and physically stable with time over pH ranges from 4 to 10. It shall not impart odours, taste or colour to potable water under all conditions of service at the normal ambient temperatures that can be expected. The final dried and fully cured lining and coating must be able to withstand pigging with a wire brush without tearing or pulling off.

6.8.4 Epoxy Lining and Coating

Details to be Submitted with Tender.

The Tenderer is to clearly indicate the brand and type of epoxy and resin that is offered and may include all relevant information the supplier wishes to submit on his product.

The Tenderer should have the following details in his possession as he may be required to submit them at short notice to assist in the adjudication of the offers :-

- Mixing and thinning instructions
- Recommended type and quantity of solvent required for thinning during application
- Pot life of the mixed product
- Maximum recommended dry film thickness per coat
- Recommended minimum and maximum pipe surface temperatures during application
- Time for complete drying and curing on steel surfaces
-

Surface Preparation

After completion of tests and inspection of bare pipes and specials, surfaces shall be prepared for lining and coating as follows :-

Remove weld spatter, slag, loose scale and other protrusions by chipping or grinding.

Remove deposits of oil, grease, bitumen, coal-tar or other contaminants by scraping and final wiping with rag soaked in white spirit.

Grit blast to produce a bright steel finish in accordance with SIS 055900, Grade Sa 2,5. Where this degree of cleanliness does not accurately match steel colour, use standard of 95% average, obtained by photo electric reflectance meter which is calibrated for the steel and type of grit being used, taking 100% as the degree of finish obtained when no further increase in reflectance is obtained by extended blasting. All air used for grit blasting shall be free of all oil and moisture. Grit shall be dry and free of foreign matter such as saline or clay contents, bitumen or bituminous type contaminants, oil or other deleterious substances. Particle size shall be such as to produce an anchor pattern profile exceeding 50 microns in depth, but not exceeding 75 microns in depth as determined by micrometer gauge or portable microscope fitted with a calibrated focusing knob.

After blasting all duct and debris shall be removed by vacuum cleaning, dry brushing or dry air blast to a degree such that a piece of clear adhesive tape pressed to the grit blasted surface and thereupon transferred to a white tile, shall show no dust or debris pick up, when compared with a standard pattern.

Application of Epoxy

Within two hours of completion of surface preparation, the first coat of epoxy resin shall be applied. Should immediate lining or coating not be possible for reasons of breakdown etc., or should any atmospheric oxidation take place between the completion of blast cleaning and commencement of lining or coating, such oxidisation shall be removed by open nozzle type localised blasting to restore the specified surface finish.

For linings the epoxy shall be applied by a retractable boom spray and each coat shall be allowed to dry for a minimum of 24 hours and a maximum of 72 hours (or such other interval as specified by the

supplier of the epoxy resin in writing) during which time the epoxy shall be protected against contamination by dust or other foreign matter and shall be kept dry and shaded from direct sunlight.

Each application shall be free of all tears, runs, pinholes, holidays and dust particles.

Alternate applications shall be tinted different colours (preferably with red and pale oxide) in order to ensure complete and correct coverage.

The thickness of the first application shall be a minimum of 40 microns above the peaks of the blast profile. The lining shall have a final dry film thickness of not less than 250 microns and the coating of not less than 350 microns in any area. Thickness measurement shall be by means of an approved eddy current system.

The lining and coating shall be allowed to dry completely and cure for the time specified by the supplier of the epoxy resin in writing.

Pipe Ends

For flanged pipes or specials and pipes or specials intended for joining with flexible couplings or for site welding by means of double sleeve weld on couplings, the lining and coating shall extend to the ends of pipes and specials including edges and shall overlap by at least 75mm on the outside of the pipe. Sharp edges around pipe edges shall be rounded off to a 3mm radius before application of epoxy. For pipes and specials intended for site butt welding, lining and coating shall extend up to a distance of 100mm from the pipe ends. The unlined circumferential strip, 100mm wide at pipe ends shall be protected by a 120mm wide strip of pressure sensitive plastic tape which shall be firmly pressed into the surface to exclude all air, moisture and dust and to give temporary protection to the grit blasted surface between the works and the site.

6.8.5 Marking

All pipes and specials shall be clearly marked with durable paint, in characters not less than 50mm in height with the contract and item number, the grade and thickness of steel and the nominal diameter in mm.

6.8.6 Sampling and Compliance with the Specification

Lining and Coating Thickness

On the first pipe and thereafter on at least one pipe selected at random from every day's production but not less than one pipe out of every ten shall be measured.

At least four readings at equally spaced intervals around the inner and outer circumferences, approximately 300mm from each end of the pipe shall be taken. One reading shall be over the weld bead if it is visible. An additional four readings shall be taken at equally spaced intervals around the outer circumference in the centre of the pipe and where practicable on the inner circumference in the centre of the pipe.

The tolerances on the thickness of linings and coating shall comply with the following :-

- Epoxy Linings and Coatings + 100 microns, -0 microns

Lining and Coating Continuity

There are to be no defects when lining and/or coating is tested in accordance with Clause 6.8.7 and none of the visual defects listed in Clause 6.8.7 will be acceptable.

6.8.7 Inspection and Methods of Test

Contractor's Inspection

The Contractor shall provide a fully equipped materials laboratory staffed with competent personnel, or shall utilise the services of an approved firm which is equipped to carry out all tests specified herein, together with any additional tests on the coatings and linings on pipes and specials considered necessary by the Contractor to ensure that all such materials comply with the specified requirements. The cost of providing the laboratory, test equipment, labour, consumables, etc., together with the cost of carrying out such tests shall be included in the rates for the supply of the pipes and specials.

Engineer's Inspection

As soon as manufacture of lining and coating of pipes and specials in this contract commences, the Engineer may appoint one or more Inspectors to make periodic visits to the factory. The Inspector(s) shall have free access to any part of the works which is involved in the execution of this contract and may witness any or all tests carried out by the Contractor in compliance with the contract.

The Inspector(s) shall have power in accordance with the relevant clause of the General Conditions of Contract and shall be subject to the limitations contained therein. The Inspector(s) shall be at liberty to reject at any stage of manufacture any material or workmanship which does not comply with the specification or subsequent modifications agreed upon between the Engineer and the Contractor.

Where required the Contractor shall at his own expense furnish the Inspector(s) with reasonable office accommodation, facilities and space for inspection, testing and obtaining any information desired regarding the character of material used and the progress and condition of the work.

Inspections shall not relieve the Contractor of his responsibility for performing the work in accordance with the specification. The Engineer will reject any work that does not comply with the requirements set forth in this specification, whether the work has been previously passed by the Inspector or not.

Visual Inspection

Before leaving the shop the lining and coating of every pipe and special shall be inspected visually for all defects including, but not restricted to, the following :-

Epoxy lining and coating - tears, runs, visible pinholes, embedded dust and other deleterious blemishes.

Electrical Test for Continuity

A variable voltage (Holiday) detector shall be used to examine all pipe coatings and where practicably possible epoxy linings for faults in the protection by means of a high tension scanning electrode. The spark length from the apparatus is to be set to 10mm or twice the minimum thickness of coating (or lining), whichever is the greater. A wet sponge-type scanning electrode is to be used when testing epoxy coated and lined pipes. A metallic brush or a jointed spiral spring type of scanning electrode is to be used when testing bitumen coating of pipes.

Lining and Coating Thickness

Shall be measured by any means adequate to measure compliance within the specified tolerance limits and may include eddy current instrumentation and cover meters. The Engineer or Inspector may at their discretion supplement the above tests by checking wet film on any or all pipes during application of linings and coatings.

7 PIPE INSTALLATIONS

7.1 SCOPE

Pipework, valves etc., of diameter up to 900mm under working pressures of up to 2 MPa, used for the transportation of water in waterworks installations, is covered in this specification.

7.2 MATERIALS

All pipework (including valves and fittings), shall comply with the following requirements with regards to material selection :-

PIPEWORK CONTENTS	MATERIAL OR MANUFACTURE OR TRADE NAME	PRESSURE RATING
Water/Sludge	PVC ABS FIBRE CEMENT (Bitumen-coated and lined) STAINLESS STEEL GALVANISED STEEL (Less than 80mm NB) HDPE POLYPROPYLENE POLYCOP MILD STEEL (Epoxy coated and lined)	Pressure as Appropriate Minimum 600 kPa
Air	PVC (Not exposed to UV) ABS STAINLESS STEEL (304 GRADE) POLYCOP COPPER POLYPROPYLENE	Pressure as appropriate Minimum 600 kPa Note: Pipework subject to vacuum shall have a minimum pressure rating of 900 kPa
Polyelectrolyte	STAINLESS STEEL PVC POLYCOP	Pressure as Appropriate Minimum pressure rating 600 kPa

7.3 GENERAL

Flexible couplings shall be provided wherever a pipe section is fixed at both ends, to facilitate removal of the pipework, for maintenance or any other reason.

For steel pipework, these couplings shall comply with the relevant requirements of BS 534.

Flanges shall be provided in all pipework going through walls, within 200mm of the wall surface on both sides. In pipes where flanges are provided, flanges will be installed at regular intervals. Pipework which are joined by means of screwed couplings shall have unions at regular intervals.

All pipework which form part of the water treatment installation, except for pipework used for the bulk transportation of water, shall be laid in trenches. These pipe trenches shall be sized for the amount of pipes, shall be accessible from the top and shall be to the general requirements of the Engineer. No pipework will be buried underground without the explicit written consent of the Engineer.

Flow direction arrows shall be painted on all pipes. The painting of pipework shall be in accordance with the standard specification on painting.

All pipes larger than 150mm diameter, connected to equipment or fittings, or where specifically indicated, shall be flanged to SABS 1123 - 1977 as amended. All other piping with a diameter larger than 150mm shall be welded except where galvanised pipes are used.

Galvanised piping shall be screwed when smaller than 50mm and flanged above 50mm.

Matched flanges shall correspond in construction and dimensions to flanges on equipment. Matched flanges shall be provided with the correct bolts, nuts and packing rings. All piping shall be clean before connections are made.

Buried flanges and flexible couplings (where permitted), shall be wrapped with “Denso” tape.

Bolts and nuts shall be galvanised and shall comply with the relevant requirements of SABS 135 - 1985 and SABS 136 - 1985.

The length of each bolt shall be such that, after the bolt has been tightened, the end of the bolt is flush with the outside of the nut, or projects above the nut by not more than 2 full threads.

Satisfactory temporary end-covers shall be provided for protection of flanges, prepared ends of open-ended pipes and fittings and screwed ends, to prevent damage to internal lining during transportation and during handling on site.

7.4 STEEL PIPES

Pipes of nominal bore up to 150mm shall be of medium class with screwed ends and shall comply with the applicable requirements of SABS 62 - 1971, as amended.

Steel pipes of nominal bore over 150mm shall comply with the applicable requirements of SABS 719 - 1971, as amended.

Flanging of steel pipework shall be in accordance with the requirements of SABS 1123 - 1977, as amended.

Screw-ended pipes shall comply with the relevant requirements of SABS 1109 - 1976.

7.5 ABS AND PVC PIPE SYSTEMS

ABS and PVC pipework will be in accordance with SABS 1059 - 1985, as amended.

Pipework will only be accepted if supplied by a SABS 0157 - listed company.

The requirements for the material and performance of the pipes shall be in accordance with the specific maximum working pressure requirements of the pipe installation.

Refer to paragraph 7.2 of this specification for material selection.

Only pipes bearing the SABS mark of approval will be accepted.

Provision shall be made in the selection of pipe routes for excessive thermal expansion.

Support centres shall be as specified by the pipe manufacturers, for the specific temperature application. In any event, the support centers shall not be greater than 2,5m apart.

The cold solvent cement welding of joints shall be done according to the manufacturer's specifications and only the prescribed cements shall be used. No jointing shall be done in rain or wet conditions.

ABS and PVC pipe systems shall be supported in a lateral manner to prevent radial movement of the pipe. At the same time these supports must allow free actual movement due to thermal expansion. Pipe clips recommended by the Pipe Manufacturer will be acceptable.

Adequate provision for expansion loops shall be provided for long pipe lengths where temperature variations occur. All ABS and PVC pipework which is exposed to sun will be painted. Refer to the Standard Specification on Paintwork for further details.

PVC pipework components shall conform to SABS 966 - 1976, as amended.

PVC piping shall be joined, installed and laid according to the SABS Code of Practice 0112 - 1971.

All bends and fittings shall be moulded. Fabricated bends and fittings shall not be permitted. All fittings shall be manufactured in accordance with the stipulations of BS 5750 Part 1.

7.6 POLYPROPYLENE PRESSURE PIPES

Polypropylene piping provided and installed under this contract shall conform totally with the provisions of SABS 1315 - 1981, as amended. All joints shall be done in accordance with the manufacturer's specifications. General installation procedures etc shall be identical to that specified under Paragraph 7.5.

8 THE COMMISSIONING OF EQUIPMENT AND ACCEPTANCE TESTS

8.1 SCOPE

This specification covers the general requirements for the commissioning of equipment as well as the standards laid down for acceptance tests of material and equipment.

8.2 GENERAL

Commissioning procedures as stipulated by the suppliers of equipment shall at all times be strictly adhered to.

The commissioning of specialised equipment shall be undertaken by the supplier or an approved specialist.

All safety protection systems shall be fully commissioned and set points properly checked out and adjusted before equipment shall be allowed to run for commissioning purposes.

The responsible Commissioning Technician shall be present to supervise the operation and adjustment of the equipment during the entire commissioning stage. All instrumentation required to measure flows, electrical power absorbed, temperatures, pressures, velocities or sound, shall be provided by the Contractor. All commissioning data shall be fully tabulated in conjunction with the design data and submitted to the Engineer prior to any performance inspections or acceptance tests being carried out by the Engineer.

Where the Engineer is to witness tests, the Contractor shall ensure that the Engineer receives one week's prior notice in writing before such tests commence. Tests to demonstrate the capacity specified and general operating characteristics of all apparatus etc., shall be made under the direction of the Engineer at the time of final inspection under conditions imposed by him.

After completion, either in part or as a whole, the complete installation shall be subject to acceptance tests by the Engineer.

The Contractor must assist the Engineer during any test carried out and must supply tools and instruments for testing purposes.
The Contractor must allow for reasonable assistance to the Engineer during the following inspections:-

a) First physical and mechanical installation acceptance inspection

The completeness and correctness of the installation will be checked, all workmanship and materials will be checked for compliance with the specification.

b) Final physical and mechanical installation acceptance inspection

The remedial work pointed out in (a) above will be checked. Any new items noticed will also be pointed out to the Contractor.

c) First performance acceptance inspection

The operation of all equipment in the installation will be checked.

d) Final performance acceptance inspection

The remedial work pointed out in (c) above will be checked. Any new items noticed will also be pointed out to the Contractor.

e) Handover Inspection

The outstanding items in (a) and (c) will again be inspected. The Contractor will be given two weeks for remedial work and re-inspection.

f) Handover will be taken after this inspection only if the Engineer is satisfied that only minor items are outstanding.

The guarantee period will start at handover, on the condition that the Contractor does all remedial work within three months from handover. If not the guarantee period will start three months after the date of the handover.

Certificates confirming inspections and listing faults will be issued by the Engineer for every inspection held.

The Contractor must ensure that the installation is correct, complete and to specification before calling for an inspection.

The cost of any abortive inspections, where the Engineer is called to site, but finds the Contractor ill-prepared for it, will be deducted from the Contract price by variation order.

The Engineer's or his Representative's time will be taken at the SAACE published time rate.

The Contractor shall provide a competent person to accompany the Engineer or his Representative during inspections.

This person shall know the installation, shall be in a position to accept and carry out instructions and shall take notes during the inspections, so that the remedial work can commence immediately and is not held up while waiting for the inspection certificate.

The Contractor must replace any portion of the installation that does not meet with the requirements of this specification as may be imposed thereon by test or inspection. Such replacements shall be done at his own costs.

The Contractor must preferably keep an inspection register of all tests to be witnessed and all inspections to be held by the Engineer.

The times and dates for tests and inspections must be agreed to by all parties after the receipt by the Engineer of the Contractor's written application for such tests to be witnessed or inspections to be held.

Application for acceptance tests can only be made when the Contractor is satisfied that the section for which the application is being made complies fully with the specification.
The Contractor shall carry out all reasonable tests and measurements requested by the Engineer to prove that the system or parts thereof complies with the specification document.

The Engineer can request that any part of the system or the complete system be re-tested, recorded and measured as part of the acceptance inspections if reasonable doubt exists about the accuracy of the test.

The actual performance of all outlet points on any water, gas, air or vacuum system, must be provided by measurements when operating under design conditions.

Where required by the Project Specification, the Contractor shall guarantee to output and efficiency where applicable, of all machines, which guarantees shall be binding under the contract.

8.3 MAINTENANCE AND OPERATING MANUALS

The Contractor shall prepare and submit to the Engineer four copies of the comprehensive maintenance and operating manuals in the language of the tender documents for the service installations specified in this document.

One draft copy of the manuals shall be submitted to the Engineer at least two months prior to the programmed commissioning starting date for his comments and approval.

The operating manual shall consist of the following sections :-

- Operations Section covering all starting up and stopping procedures.
- Comprehensive data logging sheets to be kept by the owner.
- The maintenance manual shall consist of the following sections :-
    - General System Description.
    - General Controls Description.
    - Schedule of Plant and Equipment listing all model numbers and optional extras and/or modifications included for. This schedule shall include all electrical loadings for the equipment.
    - All orifice plates, balancing valves, pumps etc data.
    - Schematic wiring diagrams and equipment ratings.
    - Detailed monthly, three-monthly, six-monthly and yearly preventative maintenance instructions.
    - Manufacturer's literature indicating lubrication points, lubricants to be used and any other related data.
    - Commissioning data of all equipment and systems, indicating in tabulated form, the design requirements and the actual measured performance. Operating points for pumps and blowers to be indicated on performance curves.

- List of equipment suppliers with addresses and telephone numbers.
- Spare parts list for all equipment.
- Fault-finding procedures.
- Specialist drawing schedule.
- Coded equipment guarantees.

The maintenance and operating manuals shall be complete with an index and be bound in a suitably identified hard cover binder.

The Contractor must allow for the tuition of the Client's personnel during the commissioning of the works. Additional tuition might be required and as specified in the project specification or as later instructed.

Tuition must be done by a person or persons suitably qualified to explain in detail the functioning of the system and equipment. The complete manuals must be used during such tuition periods.

The Contractor shall operate the works and be responsible for all maintenance and for consumable materials required for maintenance, from the time the installation is scheduled for operation, until the system is handed over to the owner. During this period the works must be kept in good running order.

The Contractors must allow for twelve months free maintenance after handover on all equipment and shall visit the works and carry out the maintenance in accordance with the schedules prescribed by the suppliers, or as specified in their project specification.

The Contractor shall be responsible for all consumable materials required during the free maintenance period. The Contractor must submit to the Engineer a quotation for a maintenance contract with the Client, for the period after the specified twelve months free maintenance period. The proposal must include details of regular inspections, checks, rates and claims for payment.

Where required by the Machinery and Occupational Safety Act, the Contractor shall provide all charts and log books properly bound and identified in such a manner that it is acceptable to the Inspector of Machinery.

8.4 ACCEPTANCE TESTS FOR PUMPS

The Contractor shall guarantee the output and efficiency of all pumps under this contract. These guarantees shall be verified at the Contractor's works in accordance with BS 5316 Part 2, Class B and on site in accordance with BS 5316 part 1, Class C.

Test curves shall be drawn from the test data obtained from the purchased pumps and shall include the following :-

Head (m)
Quantity of Fluid Pump (l/s)
Efficiency (%)
Power Absorbed (kW)
Rotational Speed (rpm)

The NPSH available shall be determined on site and shall be compared with the required NPSH for that particular pump at the duty point.
Refer to the standard specification for pumps for acceptable values.

As specified in the standard specification for pumps, vibration limits and noise generated shall be checked on site and compared with the laid down requirements.

The Contractor shall ensure that the pumps deliver the required minimum discharge specified in the project specification or the discharge required in the specific application for which the pump is intended.

Pump casings shall be hydraulically tested at the factory to at least 1,5 times of the maximum possible working pressure of the pumps before any corrosion protection is applied.

Pumps and pipework shall be hydraulically tested on site by the Contractor to 1,5 times the working pressure for the pumps at their duty point, or 1,3 times the pump shut-off pressure, whichever is the greater. These tests shall be carried out in the presence of the Engineer or his Representative.

The plant will not be accepted if pumps, pipework, valves, specials or joints show any signs of leaks.

8.5 VALVES

All valves shall be hydraulically tested in the manufacturer's works to at least twice the guaranteed working pressure.

All valves larger than 300mm nominal bore diameter, shall be supplied with a certificate certifying that it complies with the requirements of this specification and that it has been tested and inspected.

8.6 PIPEWORK

Piping installations shall be tested with fluid pressure of not less than 700 kPa, or 1,5 times the maximum working pressure, whichever is greater, at the lowest point in the system.

Care shall be taken to avoid putting excessive pressures on mechanical seals, safety devices etc.

The system shall be filled and all air vented at least 24 hours before the actual test pressure is applied.

Test pressure should be applied when the fluid temperature and average ambient temperatures are approximately equal and constant. The pressure must be maintained for not less than 30 minutes without appreciable drop after the force pump has been disconnected.

Leaks in screwed fittings shall be corrected by remaking the joints. Leaks in welded joints shall be cut out and rewelded. Caulking of leaks will not be permitted. Tests must be witnessed by the Engineer.

The tests shall be repeated until the Engineer is satisfied that the pipework under test complies with the set requirements.

Compressed air piping (except low pressure control piping) shall be tested at not less than 1000 kPa. This pressure shall be maintained for 1 hour, without pumping. The correction of the final pressure of not more than 12,5 kPa for each 3ºC change in average ambient temperature during the test will be permitted.

Leaks shall be corrected as specified for water piping. The test must be witnessed by the Engineer.

9 CHEMICAL DOSING

9.1 SCOPE

This specification covers the requirements for equipment installed as part of chemical dosing plants for water treatment works.

9.2 GENERAL

Chemical dosing systems shall be either manually controlled or shall have closed loop control systems, depending on the duty and the requirements specified in the project specification.

If closed loop control systems are specified, electronic sensing equipment, electronic controllers and other control circuits shall be in accordance with the requirements of the section on controls contained in the Electrical Standard Specification.

All storage tanks containing chemicals shall have sight glasses on the outside to indicate the level of the fluid inside.

9.3 LIME DOSING

A lime mixer/feeder shall be supplied and installed where required on the raw water side to the treatment works, to dose the required quantities of lime into the system. The discharge of this feeder shall be fed via a small screw conveyor into an open channel discharge which will in turn flow into the main water stream.
The rotational speed of the worm must be adjustable to cater for different dosage rates. A selector must be provided on the feeder with pre-calibrated quantities, corresponding to the various settings, to enable an Operator to adjust the supply according to the requirements.

A mechanical vibrator must be provided on the hopper feeder to dislodge settled lime against the sides. This vibrator must be automatically controlled to operate at set intervals.

A 25mm hose connection shall be provided on the side of the feeder section of the lime feeder to enable an Operator to flush the system after a period of prolonged use or when it is deemed necessary.

A mechanical materials handling system must be provided to fill the hopper from floor level, if the layout is such that the hopper is above the storage area level. Details of this system must be submitted to the Engineer for approval prior to manufacturing and installation.

Refer also to the Standard Specification for Materials Handling.

9.4 POLYELECTROLYTE

Polyelectrolyte, if required by the process, shall be dosed via a positive displacement dosing/metering pump. Refer to the Standard Specification on Pumps for the requirements.

The dosage rate shall be as required for the properties of the water to be treated, or as specified in the project specification. The flow rate of the pumps shall be adjustable within the range 0 - 120% of the required anticipated dosage rate.

Provision must be made to gravitate the chemical from the container in which it is being supplied to the site, via a suitable adaptor which is screwed onto the drum outlet.

This gravity system will contain an in-line filter, as well as a shut-off valve. Between the shut-off valve and the rest of the system, a pipe connector must be supplied to enable the Operator to disconnect the pipework and remove the drum.

Refer to the Materials handling section for handling requirements of the container.

This gravity feed system will feed into a stainless steel 316 Grade storage tank. From this storage tank, the chemical will gravitate to a break pressure tank, of which the level is controlled by means of a float valve. A shut-off valve shall be installed upstream of the level control valve. Each dosing line shall contain the following components:

The outlet from the break pressure tank will be fitted with a shut-off valve, followed by a vertical sight glass which extends to the top level of the break pressure tank. This sight glass will be calibrated in cm. The metering pump shall draw its fluid from this sight glass and will be equipped with another sight glass on the discharge of the pump, installed vertically, containing a ball to indicate the flow.

The discharge of this sight glass will be taken to the dosage point.

All pipes will be uPVC piping.

9.5 CHLORINE DOSING

The chlorine dosing installation shall be sized for the anticipated chlorine flows and dosage rates. Refer to the project specification for Water Qualities etc.

The chlorine dosing installation will be divided in two main sections, namely :-

- The High Pressure and Storage Section.
- The Low Pressure/Injector Section.

The storage cylinders containing the liquified chlorine will be connected via pig-tail piping, to the automatic changeover valve arrangement. An auxiliary cylinder valve shall be provided at the cylinder connection. The pig-tail will connect into a header-valve which supplies the gas through a catch-pot to the automatic changeover valve arrangement.

This valve arrangement will ensure that one bank of cylinders is always in use and in the event of being empty, will automatically changeover to the opposite bank.

A by-pass valve arrangement must be provided across the changeover valve.

The gas will be supplied into a common header from which the respective dosing circuits will draw gas via the vacuum regulator. All the aforementioned equipment will be contained in the high pressure section of the installation.

The injector section will continue adjacent to the high pressure section and a brick wall fitted with a double glazed window will separate the two sections physically.

On the injector side, a chlorine gas flow indicator and sight glass will be provided in the line supplying the injector.

A valve arrangement on the discharge side of the injector must be provided to interconnect different injectors with different dosing lines in the case of a breakdown.

In the injector section all piping will be uPVC.

Refer to the required dosing rates as specified in the project specification or as required by the process.

If so required in the project specification the chlorine cylinders shall be mounted on a floor-mounted scale. This scale shall provide a digital read-out, electronically, to the injector section of the chlorine dosing plant.

Adequate provision must be made in the high pressure section of the plant to lift and load the empty and full cylinders onto a truck. Details of this handling equipment must be made available to the Engineer prior to the commencement of the installation.

9.6 BENTONITE DOSING

The capacity of the Bentonite dosing system shall be as required in the project specification or as required by the process. A concrete or steel Bentonite dissolving tank will be constructed and provided from which the suction pipe to the metering pump will draw off.

A mechanical mixer shall be provided in the dissolving tank to facilitate pre-mixing of the chemical.

Refer to the Standard Specification on Metering Pumps for the specification regarding the Bentonite Dosing Pump.

Shut-off valves shall be supplied on both sides of the pump.

A pressure regulating valve which is adjustable for the full working pressure obtained, shall be provided on the outlet of the pump to regulate the system downstream pressure.

A pressure relief valve shall also be provided on the discharge of a pump to open in case of a system over-pressure. The discharge of the pressure relief valve will be taken back into the dissolving tank.

A 25mm water connection shall be provided on the suction side of the metering pump to enable an Operator to flush the system after prolonged use or during regular maintenance.

A glycerine filled pressure gauge shall be fitted on the discharge side of the pump.

A sight glass and flowmeter shall also be provided in the discharge line to the dosing point to indicate whether flow is achieved and at what rate.

10 SPECIALISED MECHANICAL EQUIPMENT

10.1 SCOPE

This specification covers the supply and installation of the following specialised mechanical equipment used in water treatment works:

- Mixers
- Compressors
- Vacuum Pumps
- Centrifuges
- Gravity thickeners

10.2 Mixers

Mixers shall be of a robust design, suitable for an industrial application. All mixers shall be of the vertical spindle type, with an end-locating bearing at the bottom to guide the shaft. Shaft lengths without end-locating bearings shall be limited to 800mm.

The viscosity of the product to be mixed shall be ascertained before the rotational speed is determined.

Speed reduction from the electrical motor to the drive shaft shall be done via a gear box and drive belts will not be acceptable.

The mounting brackets to support the motor and gear box shall be properly secured to the sides of the mixing tank. Care shall be taken not to restrict the feed into the mixing tank.

Careful consideration shall be given to the material selection of the shafts and mixer blades. The material shall be able to withstand all abrasion and corrosion attacks which may be caused by the product mixed.

Motors can be mounted horizontally or vertically.

A shaft flexible coupling shall be provided in the drive chain, suitable for the torque applications.
The mixers shall normally be used in open tanks.

The blade design shall be suitable for the material being mixed and shall suit the depth of the tank. If necessary a dual turbine system shall be employed to achieve proper mixing.

Blade design may vary between the pitch blade, flat blade, curved blade, anchor or marine prop design depending on the properties of the fluid.

The scale of agitation shall vary between 3 and 5, where mixer application involves solid suspension duties.

10.3 COMPRESSORS

Air compressors shall be of the reciprocating or centrifugal type and shall be air or water cooled. All compressors shall be fitted with a primary air filter on the inlet side which shall have an efficiency of not less than 90% at 10 micron particle size.

All units shall be fitted with secondary filtration to remove all the moisture as well as fine particles from the air.

Air receivers shall be supplied in the compressed air system and shall be sized according to the following formula:

Receiver capacity in Cubic meters =

$$\frac{\text{Cubic meter of Free Air required}}{\text{Allowable pressure drop (bar)}}$$

The receivers shall be fitted with a moisture draining valve at the bottom, sockets for pressure gauges, a safety valve and inspection covers. The receivers shall conform in design to the Machinery and Occupational Safety Act. It shall be stamped by a recognised testing authority.

The compressors shall be directly coupled and the drive motor shall be mounted on the same base plate as the compressor. A 50mm thick anti-vibration cork mat or cork box shall be inserted below the bases, to absorb any vibration.

Anti-vibration pads consisting of compressed cork between neoprene layers is also acceptable (Tico pads).

10.4 VACUUM PUMPS

Receivers for vacuum pumps shall be similar in construction and to the same specification of receivers for compressed air specified in Paragraph 10.3.

Vacuum pumps shall be of the reciprocating type or of the liquid ring type. Liquid ring vacuum pumps shall be equipped with a top-up tank, a float valve regulating clean water into the top-up tank and re-circulating pipework. Pipe design shall be such that liquid carry over into the discharge line is not possible.

10.5 CENTRIFUGES

10.5.1 General

Centrifuge mechanisms shall be selected to handle the capacity as required by the capacity of the sludge discharge process.

The maximum moisture content of the discharge material under the specified sludge feed conditions shall be as laid down in the project specification.

Before fabrication takes place, a detailed working drawing of the centrifuge assembly must be submitted to the Engineer for approval. This approval will not relieve the Contractor or the Supplier of fulfilling the functional requirements of the centrifuge.

The performance of the centrifuge shall be as provided for in the project specification or as required in the process.

10.5.2 Centrifuge Frame

The frame supporting the rotating element and casing must be sufficiently rigid in construction to avoid any distortion either when handled or during operation.

Refer to the painting specification in the Standard Specification for Mechanical Installations, for details of the surface preparation and coatings to be applied in the exposed steelwork on the frame.

Anti-vibration spring mountings must be supplied and installed underneath the mounting plates of the frame. The selection of the spring mountings must take into account the vibration velocity and intensity at the various rotational speeds and should prevent transfer of such vibrational movements to the structure below. Sufficient rigidity must, however, be maintained to avoid any form of stresses on the connecting pipework to the machine.

Lifting lugs must be provided to lift the whole machine when handled.

10.5.3 Casing

The casing must enclose the bowl and collect the cake solids and centrate from their respective ports and discharge them through their flanged connections.

Dimensions must be adequate to prevent any re-contacting of dry cake solids with centrate.

The casing must be split horizontally along the centre line horizontal axis and must be flanged, gasketed and bolted together to prevent leakage.

Lifting lugs must be provided to lift the upper casing from the base in the event of maintenance taking place.

The entire casing must be manufactured from AISI 304 stainless steel.

10.5.4 Bowl Assembly

The bowl assembly must be manufactured from AISI 316 stainless steel. Stainless steel screws, bolts and nuts must be used as fasteners. Sufficient provision must be made to secure nuts and screws to prevent them from becoming loose during operation.

The bowl and shaft assembly must be balanced statically and dynamically prior to assembly and any imbalances must be corrected.

The conveyor assembly must be manufactured from AISI 316 stainless steel and must be supported at each bowl hub by a heavy duty bearing.

10.5.5 Gearbox and Drive Assembly

The gearbox must be fitted to the centrate hub and must be able to transmit a differential drive from the bowl to the conveyor. A sight glass must be provided to enable maintenance personnel to determine the oil level in the gearbox. The filler cap and drain plug must be easily accessible without the need to remove any other part of the machine to get access to it.

The electrical motor must be of the TEFC type and must in all respects conform to the requirements of the Standard Specification on Electrical Installations.

The motor must be suitably rated for the maximum anticipated duty, as well as the starting torque which will be encountered. Sufficient provision must be made for adjusting the electrical motor in order to maintain the drive belt tension.

An Eddy Current Brake scroll speed control unit or an hydraulic differential speed drive, to control the scroll and bowl differential speed, must be provided on the centrifuge. Any other acceptable method to achieve the rotational speed differential will be considered, in order to achieve a constant output cake quality under varying input sludge concentration conditions.

It must be stated in the attached information schedules whether DOL or star/delta starting methods are to be used.

10.5.6 Abrasion Control

All components subject to wear must be adequately protected as follows :-

Bowl Shell:

Provide with a replaceable liner to be changed when eroded.

Feed Sludge entry ports; cake discharge ports

Fit solid sintered carbide liners or other approved materials.

Conveyor Flights

Fit field replaceable solid sintered carbide tiles or approved alternative materials.

10.5.7 Lubrication System

The main bearings must be lubricated via a forced oil lubrication system, consisting of a reservoir from which oil is pumped through cartridge filters to each main bearing or by means of grease lubricated bearings. The system must incorporate pressure, temperature and flow switches to shut down the machine in the event of a lubrication failure.

10.5.8 Differential Speed Controller

A differential speed controller must be supplied and installed with the centrifuge. The unit must be a self contained programmable logic controller, which forms part of the drive system of the machine, providing an electronic means of automatically controlling the quality of the cake discharge from the centrifuge.

Facilities must be provided to indicate and control, when programmed via the key pad, the following characteristics :-

- Gearbox pinion speed control
- Bowl/conveyor differential speed control

10.5.9 Instrumentation and Safeties

The following safety interlocks must be provided in the machine assembly :-

Excessive gearbox torque:	Stop Motor
Oil lubrication to main bearings interrupted; high temperature condition or low pressure:	Stop Motor
Excessive vibration detection on main bearings, exceeding 7mm/s:	Stop Motor

Instrumentation read-out should include the following :-

- gearbox torque value
- rotational speeds of bowl and scroll
- differential speed between bowl and scroll

10.6 GRAVITY THICKENERS

10.6.1 General

Although every step has been taken by Umgeni Water to ensure that the product data provided in the project specification or enquiry on the thin sludge provided is correct, the correctness of the information is not guaranteed and Tenderers are advised to visit the site before submitting a price in order to establish for themselves the true quality of the thin feed sludge to the thickener, by taking samples and analysing it.

The machine construction shall be in accordance with the minimum requirements described in this document.

Any deviation from the technical or construction requirements specified herein, must be clearly stated in the tender offer, together with the possible effect it might have on the performance or the durability of the equipment.

10.6.2 Bridge Frame and Tank

The superstructure shall be supported by the tank wall and sufficient provision for the loads on the walkway must be made in the supporting structure of the tank wall.

Galvanised handrailing must be provided on the bridge frame to allow access to the drive assembly. A distance of at least 500mm must be allowed on all sides of the drive unit for servicing of the unit.

Galvanised floor grating must be provided on the bridge frame in the area enclosed by the handrailing. 100mm high galvanised kickplates must be provided on the perimeter of the platform. The bridge platform must extend across the full diameter of the tank.

The side wall depth of the tank shall satisfy the following requirements :-

$$l = 1{,}35 + 0{,}1\ d \text{ metres}$$

where l = side wall depth (in metres)

and d = diameter of thickener (in metres)

10.6.3 Drive Assembly

The drive assembly of the thickener shall be selected to deliver the required maximum torque for the sludge to be treated.

All the gears, gear components and bearings in the drive must be selected for a minimum continuous service life of 20 years.

The drive assembly must be fitted with a torque indicator, indicating the torque in the drive train from 0 to 100%. The maximum should correspond to the maximum continuous duty rated design torque of the machine.

Provision must be made for the following safety features on the drive unit :-

- At 50% of the design torque, an audible alarm must be activated. At this point, the sludge feed to the thickener will be stopped by an external control sequence activated by a pair of normally open and normally closed voltage-free contacts to be provided under this contract in the thickener control panel and thickened sludge will be drawn off.

- Should the torque indicator continue to rise, the electric drive motor will cut out at 85% of the maximum torque. A set of normally open and normally closed voltage free contacts must be provided in the thickener control panel to control the operation of the sludge feed pump.

A 4-20 mA unit output torque signal must be provided in the thickener control panel for remote monitoring purposes.

The gear assembly in the drive unit must be oil bath lubricated.

Design calculations must be submitted indicating how the drive torque and input power requirements have been calculated.

10.6.4 Rake Assembly

The rake assembly must have a minimum raking capacity as specified in the project specification.

The underwater blades mounted to the rake assembly must be manufactured from Grade AISI 304 stainless steel. The stainless steel blades must be attached by means of stainless steel bolts and nuts.