SA Water

SOUTH AUSTRALIAN WATER CORPORATION

TS 146b

TECHNICAL STANDARD

REQUIREMENTS FOR PUMP SPECIFICATION, PROCUREMENT AND TESTING AND THE PREPARATION OF PUMP DATASHEETS

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Only the current version of this Standard should be used, available on the SA Water website.

MAJOR CHANGES INCORPORATED IN THIS EDITION

- Anti-clogging requirements for Wastewater pumps added.
- Document re-formatted.

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Section 1: Referenced Documents

1.1. GENERAL

1.2. STANDARDS

1.2.1. Australian

AS 2625.1-2003	Mechanical vibration - evaluation of machine vibration by measurements on non-rotating parts - general guidelines
AS 2417-2001	Rotodynamic pumps - hydraulic performance acceptance tests - grades 1 and 2
AS/NZS 4087-2011	Metallic flanges for waterworks purposes
AS/NZS 4020-2005	Testing of products for use in contact with drinking water
AS/NZS 3709-1989 (ISO 1940-1:2003)	Vibration and shock - balance quality of rotating rigid bodies Note: ISO standard to be used
AS 4680-4680	Hot-dip galvanised (zinc) coatings on fabricated ferrous articles
AS 1214-1983	Hot-dip galvanised coatings on threaded fasteners (ISO metric coarse thread series)
AS 2382-1981	Surface roughness comparison specimens
AS 3894.1-2002	Site testing of protective coatings - non-conductive coatings - continuity testing - high voltage ('brush') method
AS 3894.3-2002	Site testing of protective coatings - determination of dry film thickness
AS 4024.1601-2006	Safety of machinery - Design of controls, interlocks and guarding - Guards - General requirements for the design and construction of fixed and movable guards
AS 4024.1602-2006	Safety of machinery - Interlocking devices associated with guards - Principles for design and selection
AS 4024.1603-2006	Safety of machinery - Design of controls, interlocks and guards - Prevention of unexpected start-up
AS 4024.1604-2006	Safety of machinery - Design of controls, interlocks and guarding - Emergency stop - Principles for design

1.2.2. WSA

WSA 03-2011 v3.1	Water Supply Code of Australia
WSA 04-2005 v2.1	Sewage Pumping Station Code of Australia
WSA 101-2008	Industry Standard for Submersible Pumps for Sewage Pumping Stations
WSA 131-2011	Industry Standard for ISO End Suction Centrifugal Motor Pumps

Section 2: Scope

TS146b is applicable to all water and wastewater pumps, with the exception of the following:

- sludge handling pumps in water and wastewater treatment plants with solids > 1.0%
- dosing pumps for chemical processes

WSA 130 ISO End Suction Centrifugal Pumps (2010) and WSA 131 ISO End Suction Centrifugal Motor Pumps (2010) apply to the design, manufacture, inspection and testing, packaging, transportation and delivery of bare shaft ISO end suction centrifugal pumps to be direct coupled to the driver. WSA 130 (and/or WSA 131) is intended to apply to end suction pumps with up to DN200 suction flanges and DN150 discharge flanges. End suction pumps with flanges exceeding these dimensions should also comply with WSA 130 (and/or WSA 131) up to DN200 discharge flanges, a pressure class of PN16 and flow of 250L/s.

TS146b applies to centrifugal, axial, column, can, multistage, self-priming and all other types of water pumps except those specifically excluded by this clause. WSA 130 (and/or WSA 131) shall be applied, in addition to TS146b, for pump types and sizes outside the scope of WSA 130 (and/or WSA 131) if technically relevant. In the event of inconsistency between the requirements of WSA 130 (and/or WSA 131) and TS146b SA Water Engineering shall be contacted for direction.

WSA 101 Submersible Pumps for Sewerage Pumping Stations (2008) applies to the design, manufacture, inspection and testing, packaging, transportation and delivery of electrically driven submersible type centrifugal pumps and ancillary equipment for use in sewage pumping stations. WSA 101 applies to submersible type centrifugal pumps of all sizes.

TS146b incorporates the requirements of WSA 101 except where TS146b stipulates a more stringent requirement. TS146b applies to submersible, dry well submersible, line shaft and all other types of wastewater pump except those excluded. WSA 101 shall be applied, in addition to TS146b, for pump types and sizes outside the scope of WSA 101 if technically relevant. In the event of inconsistency between the requirements of WSA 101 and TS146b SA Water Engineering shall be contacted for direction.

The requirements of WSA 04 Sewerage Pumping Station Code of Australia (2005) apply to the specification and preparation of datasheets for pump procurement and testing in addition to the requirements of TS146b. In the event of inconsistency between the requirements of WSA 04 and TS146b SA Water Engineering shall be contacted for direction.

The above interrelationships between WSA standards and TS146b are summarised visually in the diagram below.

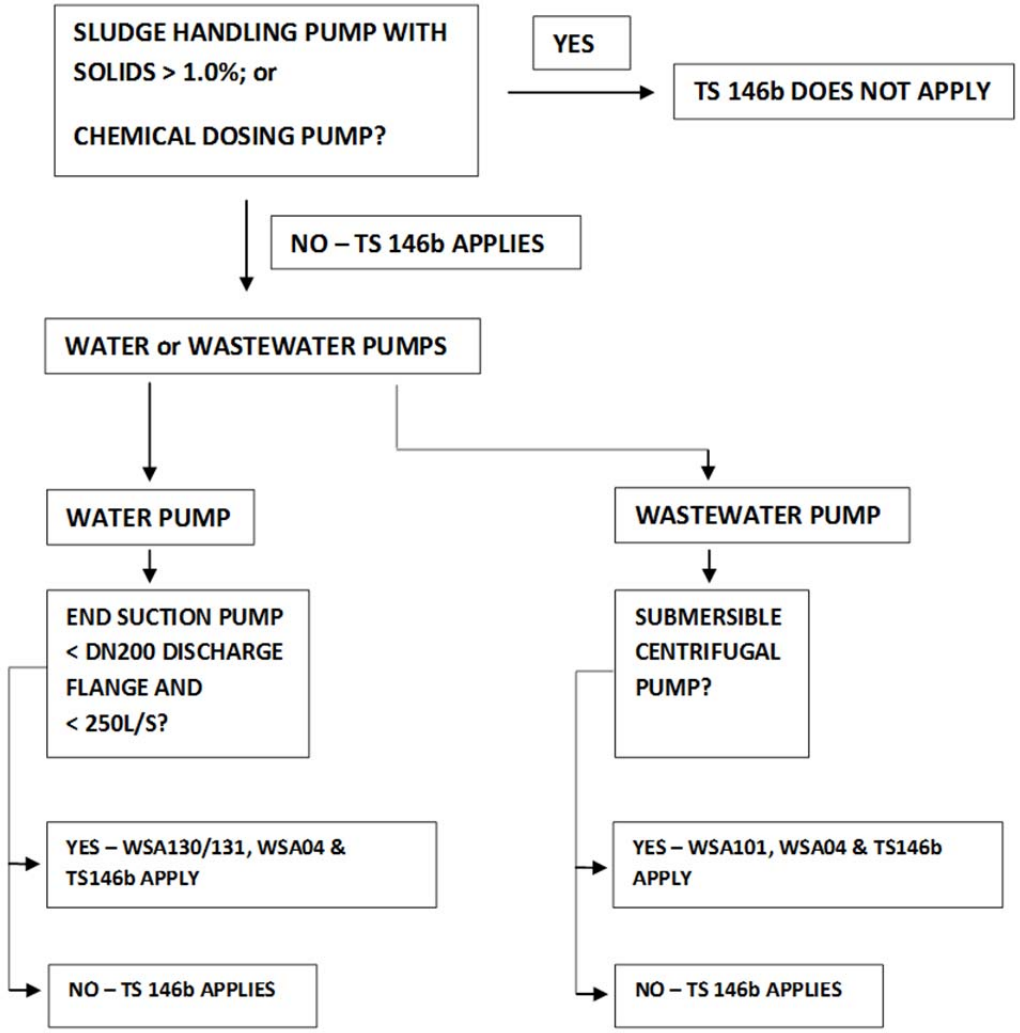

Diagram of scope of application of TS146b

The requirements of TS 146b apply to designers, contractors and/or pump vendors. It is recognised that the roles of designers, contractors and/or pump vendors vary in the specification, procurement, testing and preparation of datasheets for pumps within different contractual frameworks (e.g., designers (for SA Water or a contractor) typically prepare datasheets for issue to pump vendors who then return the datasheet with either statements of compliance, non-compliance or other comments). All contracts must provide for the requirements of TS 146b to be met by either designers, contractors and/or pump vendors.

Where power level is referred to in this standard this means input shaft power to the pump.

Section 3: Specification

3.1. GENERAL

A standard form datasheet is to be supplied to pump vendors in the form of a returnable schedule. Example datasheets are included in the appendix to TS146b including datasheets for:

- Potable Water Pumps
- Raw Water Pumps
- Dry Well Submersible Pumps
- Wet Well Submersible Pumps
- Line Shaft Pumps

Pump vendors must return the datasheet with all requested information supplied or an explanation if information is not provided.

The requirements in TS79 for pump motors are to be included in the specification of pumps.

The required pump design life is 25 years.

The required pump warranty is 1 year minimum from the time at which the pump is first operated, after the commissioning completion and first in-service operation, and not from the time of delivery. Commercially negotiated extensions for longer warranty periods are preferred.

The pump vendor shall be informed if the pump motors are to be operated using Variable Speed Drives (VSDs) so that harmonic currents and voltage stresses on the motors can be taken into account by the pump vendor.

3.2. PUMP CURVES

For pumps with either fixed speed motors or variable speed drive (VSD) driven motors, pump curves shall be provided by the pump vendors showing the:

- head versus flow
- efficiency
- NPSHr
- absorbed power

for the pump over the full range of potential operation from shutoff head to the highest flow (lowest head) operation that is warranted by the vendor for operation at 100% speed.

For pumps with variable speed drives connected to their motors, pump curves shall be provided by the pump vendors showing the:

- head versus flow
- efficiency
- NPSHr
- absorbed power

for the pump over the full range of potential operation from shutoff head to the highest flow (lowest head) operation that is warranted by the vendor for operation at 90%, 80%, 70%, 60% and 50% speed.

The vendor must superimpose the head versus flow relationships for the nominated pumps over the system curves provided in the specification and datasheet.

Operation above 100% speed (overspeeding) shall not be permitted (and not relied on to cater for anticipated operational circumstances).

Operation at 50% speed shall be confirmed with the vendor to ensure that this can be achieved. Operation below 50% speed (25Hz) shall not be permitted unless specifically confirmed and warranted by the vendor.

Minimum and maximum flows for continuous operation shall be shown on all pump curves for all operating speeds.

Where a pump vendor is unable to supply curves for variable speed operation of a pump, but is supplying the pump as a variable speed pump, affinity laws must be used to calculate the pressure versus flow relationships for the pumps at the above listed operating speeds. The pump vendor should then be requested to confirm the calculated pressure versus discharge relationships.

Affinity law equations

$$\frac{Q_1}{Q_2} = \left(\frac{n_1}{n_2}\right) \qquad \frac{H_1}{H_2} = \left(\frac{n_1}{n_2}\right)^2 \qquad \frac{P_1}{P_2} = \left(\frac{n_1}{n_2}\right)^3$$

where Q = flow, H = head, P = power and n = rotational speed

The accuracy of the affinity law for pump power is affected by changes in efficiency with pump size and shall not be used unless authorised and confirmed as accurate by the pump vendor.

For both fixed speed and variable speed pumps, input shaft power curves shall be obtained from the vendor for the maximum operating speed.

Shutoff head may not be specified for some classes of wastewater pumps. In this case, the vendor must stipulate the conditions under which the pump must be started and stopped (see Clause 3.4).

Impeller size offered and maximum impeller size (100% speed curves) shall be provided by the pump vendor.

Pump curve inflections are not preferred and pumps with such inflections should not be selected unless it is clearly demonstrated by the vendor that the inflections will not lead to problematic operation. A pump curve “inflects” where head is not continuously rising as flow decreases. An inflection can be gradual over a larger flow range (e.g., for an end suction pump where the head at the best efficiency point is greater than the head at shutoff) or sharp over a smaller flow range (e.g., for high head and efficiency split case centrifugal pumps where head can dip down with decreasing flow, over a proportion of the pump operating range, and then recover at shutoff).

For both fixed speed and variable speed pumps, Net Positive Suction Head required (NPSHr) curves, as defined in AS2417 and distinct from NPSH3, shall be provided by the vendor for all operating speeds.

The Net Positive Suction Head required (NPSHr) for a pump shall be provided by the pump vendor for all feasible operating conditions including:

- minimum flow operation for fixed speed operation
- maximum flow operation for fixed speed operation
- minimum speed operation at lowest flow for variable speed applications
- maximum speed operation at highest flow for variable speed applications
- maximum speed operation at highest pressure (if different from that at highest flow) for variable speed applications

The vendor must superimpose the calculated Net Positive Suction Head available (NPSHa) values provided in the specification and datasheet over the Net Positive Suction Head required (NPSHr) curves for the nominated pumps and confirm pump operation will not be limited by either the available or required NPSH.

Self-priming pumps can be used to lift water or wastewater from reservoirs, tanks or non-pressurised pipes subject to vendor requirements and limitations to the diameter and length, and height above water level, of suction pipework. The maximum self-priming pump start lift above storage water level must be determined from the pump vendor for all possible operating conditions ranging from minimum to maximum flow pumping for fixed speed pumps and minimum flow and pressure to maximum flow and pressure for variable speed pumping.

The speed corresponding to particular maximum suction lifts must be obtained from the pump vendor to determine if faster than normal pump operation is required for a self-priming pump to prime before the pump can slow back down to its normal operating speed.

NPSHr and suction lift requirements must not be confused and each must be determined separately to determine the suitability of a self-priming pump for any particular application.

3.3. PUMP EFFICIENCY

For both fixed speed and variable speed pumps, pump efficiency curves shall be obtained from pump vendors for the pump over the full range of potential operation from shutoff head to the highest flow (lowest head) operation warranted by the vendor for operation at 100% speed.

For variable speed pumps, pump efficiency curves shall be provided by the pump vendor for the pump over the full range of potential operation from shutoff head (if available) to the highest flow (lowest head) operation warranted by the vendor for operation at 90%, 80%, 70%, 60% and 50% speed.

The pump efficiency shall be clearly and separately identified from the motor efficiency.

3.4. STARTING AND STOPPING PUMPS

The rate of speed increase and time over which a pump:

1. starts from 0% speed and reaches Qmin
2. stops from Qmin and reaches 0% speed
3. starts from 0% speed and reaches 100% speed
4. stops from 100% speed and reaches 0% speed

must be agreed with the vendor before procuring a pump in addition to the vendor providing the following information:

- any vendor restrictions to pump operation at flows below Qmin while a pump is starting must be identified in terms of the maximum time the pump can operate below Qmin while ramping up and the maximum and minimum rate at which the change from zero to Qmin flow needs to occur
- any vendor restrictions to pump operation below Qmin flows while a pump is stopping must be identified in terms of the maximum time the pump can operate below Qmin while ramping down and the maximum and minimum rate at which the changes from Qmin to zero flow needs to occur
- any vendor restrictions to pump operation above the maximum flow rate nominated on the pump curve (for fixed and variable speed pumps), and at any operating speed (for variable speed pumps), in terms of the maximum permissible flow exceedance and the length of time over which the flow exceedance occurs, during pump start up, or during pump transitions where multiple pumps are operated in parallel, must be identified. If this mode of operation is required, then this must be clearly identified in the specification and datasheet and the pump vendor must accept these pump start-up or transition conditions (e.g., pumps may need to start in low static head systems with short term operation to the right hand side of the pump curve limit until sufficient dynamic head develops for the pump to operate on its curve)
- the vendor must specify the maximum vibration levels from the pump during starting and stopping (i.e., under dynamic operating conditions) in addition to operation at the duty point and maximum speed (under steady operating conditions)

If a pump is to be operated at shutoff head (no flow) during normal starting and stopping operation then this must be communicated to the pump vendor to ensure the pump supplied will perform adequately under such operating conditions.

All of the above information is critical in determining the system control philosophy, likely pump vibration performance and the surge characteristics of the system across the full range of pump operating conditions.

3.5. GENERAL PUMP CONFIGURATION

3.5.1. Parallel Pumps

If a parallel pump configuration is intended then the pump vendor must be informed, by the designer or contractor, of the number of parallel pumps and the operating flow and pressure range for each pump when 1, 2, 3 …. n pumps are operating in parallel (with the maximum number of parallel operating pumps being n).

The pump vendor is to be informed, by the designer or contractor, whether n pumps in parallel are delivering flow to hydraulically common or separate discharge pipe manifolds. This information must be reflected in the system curves supplied to the pump vendor.

If different pumps are to operate in parallel but with the same common discharge pressure then the pump vendor is to be informed, by the designer or contractor, of this intended operation and the control setpoints, and system protections, intended to ensure neither of the different pumps is subject to reverse flows (if delivering flow to a hydraulically common discharge manifold).

3.5.2. Series Pumps

If pumps configured in series are intended then the pump vendor must be informed, by the designer or contractor, and told the number of pumps to be operated in series. SA Water Engineering should be informed in writing if more than two pumps are proposed to be used in series configuration by the designer, contractor and/or pump vendor.

The pump vendor must confirm the pressure rating of the casing of each series pumps is sufficient to withstand the pressure created by upstream (suction side) pumps.

The pump vendor must confirm the required system hydraulic conditions and control setpoints for pumps configured in series during starting, stopping and steady state operation.

The starting and stopping sequence of the two or more staged pumps must be specifically addressed by the pump vendor with the following identified:

- Time from start of first pump (and full dead head pressure is reached) to the start of second pump (and third etc... pumps if applicable)
- Ramp time for the second pump to reach first pump's flow (and third etc... pumps if applicable)
- Ramp time for the second pump to stop and for first pump to reach full dead head pressure (and third etc... pumps is applicable)
- Time from the stop of the second pump (under full dead head pressure) to the stop of the first pump (and third etc... pumps if applicable)
- Alternatively, time from start of both series pumps together to Qmin (including any lag from the first to second pumps)
- Time from the stop of both series pumps together from Qmin to zero flow (including any lag from the second to first pumps)
- Total time for flow to be established through the series pump train
- Total time for flow through the series pump train to be stopped

The vendor must declare the effect on the cavitation, noise and vibration performance of the pump operating in series in addition to the performance of the pumps operating as single pumps.

3.5.3. Multistage Pumps

Multistage pumps may be specified for water pumping applications where the discharge pressure requirement is difficult to achieve using single stage pumps or where significant efficiency gains can be made by using multistage pumps.

It is not anticipated that multistage pumps will be used for wastewater pumping applications unless the discharge pressure requirement for the pumps exceeds the range of single stage wastewater pumps. If multi-stage pumping is used for wastewater pumping applications then single stage wastewater pumps are to be used in combination rather than any multistage impeller pump.

3.6. **WATER PUMP DETAILS**

The following parameters are to be specifically identified in the pump specifications with items listed to be raised and closed out with pump vendors by designers and/or contractors (with confirmation in writing to SA Water that this has occurred) before any pump is procured:

3.6.1. Water Quality Parameters

The following physical and chemical water quality parameters must be identified in all specifications and datasheets. Sensitivity to particulate matter in the pumped water must be addressed by the pump vendor in the specification and datasheet for all pumps.

Characteristics of pumped water including chemical composition and physical consistency (raw or treated water):

Physical composition

- Solids content (and size or grading of solids if applicable)
- Temperature range
- Water density
- Percentage of entrained air (if applicable)

Pumps must be able to achieve the design life specified in this standard when exposed to, and operated in, the physical environment defined in the specification datasheet.

Chemical composition

- pH
- Conductivity
- Total Dissolved Solids
- Chlorides
- Free chlorine
- Other chemicals

Pumps must be able to achieve the design life specified in this standard when exposed to, and operated in, the chemical environment defined in the specification datasheet.

All components of pumps that come into contact with potable water must comply with AS4020.

3.6.2. Configuration

The pump configuration must be identified in the specification and datasheet.

The location and type of couplings (e.g., flexible, semi-flexible, geared etc...) must also be identified together with alignment and balancing requirements for the couplings.

Couplings must be capable of transmitting 150% of the full starting torque of the motor and secured against circumferential and axial movement relative to the connected shafts.

Couplings must be dynamically balanced with the impeller and shaft as described in Clause 3.6.3.

3.6.3. Impeller

Dynamic performance (and hydraulic balance) of the impeller must be verified by the pump vendor.

G6.3 balancing to ISO1940-1:2003 is the minimum requirement. The impeller shall be statically and dynamically balanced at the maximum pump operating speed.

The impeller must be secured to the shaft in a way that prevents circumferential and axial movement and shall be hydro-dynamically balanced. The impeller and shaft assembly shall be dynamically balanced to G6.3 at the maximum pump operating speed. The overall combination of rotating elements comprising the final pump and motor train, including all other rotating elements (e.g., couplings, flywheels, etc...), shall be dynamically balanced to G6.3 unless G2.5 balancing is offered in which case the later is preferred.

The geometry and number of vanes for the impeller are to be nominated by the pump vendor in the specification and the datasheet.

One piece construction is required (manufacture with more than one cast or fabricated layer comprising the impeller is not permitted). The manufacturing technique used in the casting or fabrication of the impeller must be nominated by the pump vendor.

The impeller material must be identified in the specification and datasheet and be such that the design life of the pump can be achieved given the identified physical and chemical properties of the water pumped.

Pump selection with smaller than maximum impeller size is to be considered if comparing two proposed pump offers with one including the maximum impeller for the range and one that has an intermediate impeller.

Any inherent hydraulic or mechanical characteristic of the impeller that may lead to a reduction in the design life of the pump, or impeller, below the requirement nominated in this standard must be disclosed by the pump vendor before procurement of the pump. For example, inherent characteristics of impellers with lower numbers of vanes and consequential potential cavitation, vibration, noise and lack of hydraulic balance must be declared by the pump vendor prior to procurement of the pump.

3.6.4. Volute

The type, geometry, material and method of fabrication (e.g., cast or plate fabricated) and wall thickness of the volute must all be nominated by the pump vendor in the specification and datasheet.

The allowable operating pressure for the volute, and suction and discharge flanges, must be identified and meet the minimum requirements identified in the specification and datasheet.

3.6.5. Wear Rings

The type, geometry, material and thickness of the wear rings must all be identified in the specification and the datasheet.

The following three considerations must be explicitly raised with the pump vendor by the designer and/or contractor so that the pump vendor can confirm that no detrimental performance will result due to:

- Corrosion between wear rings either in contact (or near contact) with each other or other dissimilar metals
- Galling (or other damaging metallurgical phenomena) between wear rings that come into occasional contact when the wear rings are made of the same material or materials with insufficient differences in hardness (casing wear ring to have a Brinell hardness of greater than 50HB higher than the impeller wear rings)

- Chemical attack on the wear rings from the pumped water

The vendor must raise any other issues that might detrimentally affect performance in addition to the three considerations listed above.

The wear ring clearance shall be specifically identified, if applicable, together with the operational requirements for adjustment.

Casing wear rings should not be able to rotate.

Wear rings (and other components intended for periodic replacement) shall be capable of being replaced on site (and not corrode or otherwise stick together).

3.6.6. Shaft

Balancing is to be in accordance with Clause 3.6.3.

The shaft shall be of one piece construction with separate shaft sleeves.

The shaft and shaft sleeve shall be machined with suitable tolerances at the location of mechanical seals and bearing surfaces.

The stiffness of the pump shaft shall be sufficient to ensure that, under for all operating conditions, pump, motor and any other components (whether rotating or stationary) cannot come into unintended contact and result in excessive vibration, wear or other damage to equipment.

Maximum shaft deflection, assessed for all operating conditions, shall be nominated by the pump vendor.

Interlocking systems between shafts and shaft sleeves (e.g., pressed fit, threaded, nut, keyed or other) shall be nominated by the pump vendor in the specification and datasheet and shall be confirmed as adequate by designers and/or contractors (with confirmation in writing to SA Water Engineering that this has occurred) prior to procurement.

Keyed shaft to impeller interlocking systems are acceptable subject to assessment by designers and/or contractors (with confirmation in writing to SA Water Engineering that this has occurred) prior to procurement.

Heat shrinking to connect the shaft to any other pump or motor component, if proposed, must be declared by the pump vendor prior to the procurement of the pump and shall be confirmed as adequate by designers and/or contractors (with confirmation in writing to SA Water Engineering that this has occurred) prior to procurement.

3.6.7. Seals

Maintenance and adjustment free mechanical seals are preferred.

Single inside mounted or cartridge type mechanical seals are preferred. If the pumped water is potable then an internal flushing passage or externally piped flushing system can be specified. If the pumped water is raw water (or other non-potable water) then a separator upstream of the mechanical seal is required.

Gland packed seals will be considered by SA Water Engineering, for particular applications, upon request by designers, contractors and/or pump vendors.

The type of gland water required (if applicable) shall be specified by the pump vendor.

Particular operational and/or maintenance requirements for the seals must be identified by the pump vendor, including lubrication and access for maintenance requirements, in the returned datasheets prior to pump procurement.

3.6.8. Bearings

The L_{10} bearing rating fatigue life is to be > 100,000hrs at the maximum operating speed unless otherwise approved in writing by SA Water Engineering upon request by designers, contractors and/or pump vendors.

The L_{10} bearing rating fatigue life should be interpreted as formally defined in ISO 281 and is the life that 90% of bearings of the relevant type will exceed before the spalling area reaches $6mm^2$.

Thrust bearings, if required, shall be specified that are able to resist all axial loads and radial loads if applicable.

Bearings shall be able to accommodate variations in shaft geometry with temperature.

The materials used in the bearings are to be identified by the pump vendor.

Maximum and minimum operating and alarm temperatures for pump bearings are to be identified in the specification and the datasheet. Provisions for the monitoring of temperature within the pump, motor and all other bearings (e.g., flywheel) are to be identified by the pump vendor.

The maintenance requirements for the bearing systems are to be identified by the vendor in the returned datasheets prior to the procurement of the pump. Bearings should be supplied pre-greased.

3.6.9. Lubrication Media Between Moving Pump Components

The use of potable water or other water for lubrication must be identified by the pump vendor in the returned datasheets prior to pump procurement.

Requirements to ensure water is maintained in compartments within the pump outer housing or elsewhere must be identified by the pump vendor in the returned datasheets prior to pump procurement.

Requirements for food grade, or other potable water contact rated oils, for lubrication must be identified by the pump vendor in the returned datasheets prior to pump procurement.

3.6.10. Operating Temperature, Motor Cooling And Starts Per Hour

Totally enclosed fan cooled (TEFC) motors are acceptable subject to the environmental conditions in the pump station being maintained at the levels specified by the pump and motor vendor as required for the motor to be effectively cooled.

Water cooled motors are acceptable subject to the specification for pipework, reservoir and pumps required for the water cooling system (heat transfer calculations must be submitted to designers and/or contractors for approval, with written confirmation to SA Water Engineering that this has occurred, before the specification of water cooled motors).

Class F motor insulation is the minimum requirement (class H is preferred).

Motors shall be protected from overheating by monitoring temperature and setting temperature thresholds for shutting motors down.

3.6.11. Vibration Performance

Vibration levels must comply with the requirements of AS2625 for the relevant class and/or power level of any pump.

Pump vendors are required to state maximum vibration levels for pumps as identified in the specification and datasheet. If a pump vendor is unable to state vibration levels then designers and/or contractors must contact SA Water Engineering for further direction.

The likelihood of any detrimental wear or damage to any pump due to excursions from the nominal pump operating range (low or high flow excursions) must be identified by the pump vendor in the returned datasheets (and this information provided to SA Water Engineering) prior to the procurement of the pump. The pump vendor is to consider:

- 20 operational excursions, with flow between zero and Qmin (from the pump curve), for a time period of 180s
- 20 operational excursions, with flow greater than Qmax (from the pump curve) and head greater than zero, for a time period of 180s

when stating the likelihood of any detrimental wear or damage to any pump

Requirements for vibration mitigation measures including isolators and flexible or fully rigid mounting systems, or stiffening of hold down bolts or baseplate elements, must be raised by designers and/or contractors with the pump vendor prior to procurement of the pump. Information regarding the suction and discharge pipework and associated pipeline restraint systems must be provided as an annexure to the datasheet to enable the pump vendor to make an assessment of the likely vibration performance of the pump once it has been installed in a pump station.

Resonant modes must be raised by designers and/or contractors with the pump vendor prior to the procurement of the pump to enable the pump vendor to make an assessment of the likelihood of a problematic natural frequency arising for the pump and motor once installed in a pump station.

If the pump vendor is unable to assist in either a vibration mitigation and/or resonance assessment then this shall be taken into account in making pump selections if alternative vendors are able to offer such assessments.

Vibration levels should be determined at maximum power duty points during factory testing and after in-situ installation of the pumps (and associated equipment) in accordance with Section 3 of this standard.

Designers and/or contractors shall confirm with SA Water Engineering whether the specification is to state that vibration monitoring equipment will be permanently installed to monitor the vibration performance of the pumps.

3.6.12. Dimensional And Structural Considerations

The size of the suction and discharge flanges of the pump must be nominated by the pump vendor in the specification and datasheet.

The relative orientations of the suction and discharge flanges must be identified including options for adjusting the relative suction and discharge positions (and any adverse effects on pump performance from such configuration adjustments).

The suction and discharge flanges of the pump must meet the requirements of AS4087.

The suction and discharge flanges of the pumps must be rated for the maximum and minimum system pressures experienced at the pump (under all operating conditions including surge).

Suction and discharge flange nozzle loads (axial, shear and bending) must be identified in the specification and datasheet. Connected suction and discharge pipework must be specified to prevent gravity, pressure thrust and thermal loads from acting above the load limits for the pump flanges (refer to TS159a for detailed requirements of the analysis of pipework restraints).

The suction and discharge flanges, and pump casing, must be able to withstand the static and dynamic forces transmitted from the suction and discharge pipework as identified in the specification and datasheet.

Hold down anchors must be specified to resist all static and dynamic loads from the pump, motor and any other associated equipment. SA Water Engineering are to be notified by designers, contractors and/or pump vendors of all proposed hold down systems and baseplate specifications for pumps with power ratings over 100kW and may require Finite Element Analysis (FEA) of the potential dynamic modes for the pump and motor over supporting baseframe.

Details of supporting plates, plinths and frames are to be submitted by the pump vendor for all pumps. These details must nominate the geometry and mass of all elements, as well as the fixings (flexible or rigid), required to ensure that the vibration performance nominated in Clause 3.6.11 can be achieved.

Fabricated base frames for pumps, motors and associated equipment, which are supplied by pump vendors, are to be constructed with sufficient stiffness to avoid misalignment and displacement (including flexing) under load as well as with frame members and stiffeners such that no resonant vibration modes are caused by the interaction of the pumps, motors and associated equipment under any operating conditions. The base frames are to be fully welded.

The dimensional tolerances of the base frame are critical and must not be distorted during galvanising or otherwise upon installation.

All requirements, including in-fill grout within the frame, to achieve the required stiffness of the base frames must be identified by the pump vendor.

3.6.13. Noise Levels

Pump vendors shall be requested to provide the following noise level information as identified in the specification and datasheet:

Table 2.1

	Overall	***Octave band centre frequencies (dBA pressure) and (dB power)***							
		63Hz	***125Hz***	***250Hz***	***500Hz***	***1kHz***	***2kHz***	***4kHz***	***8kHz***
Sound pressure level (@1m)	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sound power level	✓	✓	✓	✓	✓	✓	✓	✓	✓

The information provided by the pump vendors shall be used to draw relative comparisons between the pumps presented and determine their suitability for installation for a particular project.

Designers and/or contractors shall contact SA Water Engineering for direction if a pump vendor is unable to provide the requested noise data.

3.6.14. Air Relief Valves

Where air relief is critical to pump performance, during start or otherwise, the pump vendor shall be requested to confirm this and the performance requirements for the air relief valve(s). Refer to SA Water TS144 for requirements regarding air valves.

3.6.15. Coatings

All applicable SA Water Materials Science Standards must be referenced, including TG25, in the specification and datasheets.

Belzona or equivalent internal coatings are preferred for internal pump coatings to reduce corrosion and loss of efficiency in the pumps. Internal coating of pumps with cast iron volutes is mandatory. An option for the internal coating of pumps with volutes made from materials other than cast iron must be requested of the pump vendor in the specification and datasheet.

External coatings are required and shall be nominated by the pump vendor and provided for assessment by the designer and/or contractor. The outcomes of the assessment by the designer and/or contractor, including compliance with TG25, shall be communicated to SA Water Engineering in writing.

Stainless steel pump volutes should be requested by designers and/or contractors if internal pump coatings cannot be applied and the physical and/or chemical properties of the pumped wastewater are likely to result in corrosion and a reduction in design life to less than 25 years.

3.6.16. Hydraulic Requirements

The following hydraulic requirements shall be identified in the specification and datasheet:

- Maximum and minimum suction head (under all operating conditions)
- Maximum (e.g., shutoff) and minimum differential head (under all operating conditions)
- Pump curves (from pump vendor) satisfying system curves and all required duty points
- Pump efficiency curves
- Pump NPSHr curves
- Priming lift height and pump operating speed information for self-priming pumps
- Fixed speed or variable speed drive (VSD) operation
- Parallel or series pump configurations

The nominated duty points at which the pump is intended to operate shall be nominated as follows:

- where the system only requires the nomination of a single duty point, this will be the guaranteed point for testing (refer to Section 3) and the point at which tendered pumps are compared

- where a system requires a range of operating conditions, a number of duty points shall be nominated, such that the system and pump operation is properly defined, and guaranteed duties points identified to ensure all operating conditions will be met. These will be the guaranteed points for testing (refer to Section 3) and the points at which tendered pumps are compared

The following parameters shall be nominated by the pump vendor for each duty point:

- flow
- total pump head
- efficiency
- input shaft power
- NPSHr

The minimum immersion depth for submersible wastewater pumps shall be nominated by the pump vendor so that vortex formation and air entrainment into the pump can be avoided. The minimum immersion depth shall be specified by the pump vendor for pump cooling requirements.

3.6.17. Miscellaneous

The pump curve number, model number, manufacturer and country of origin must be stated as identified in the specification and datasheet.

Guards must be provided for otherwise exposed rotating elements in accordance with the Australian Standards referenced in Section 4 of this standard.

Lifting lug locations and capacities and weight of components must be stated as identified in the specification and datasheet.

Rotating elements must be restrained from axial, radial, rotational or any other form of movement during transportation.

3.7. WASTEWATER PUMPS

The minimum requirements identified in WSA 101-2008, in all regards, shall apply if not exceeded in the following clauses and/or specification datasheet.

The following parameters are to be specifically identified in the pump specifications with items listed to be raised and closed out with pump vendors by designers and/or contractors (with confirmation in writing to SA Water that this has occurred) before any pump is procured:

3.7.1. Wastewater quality parameters

The following physical and chemical wastewater quality parameters must be identified in all specifications and datasheets. Sensitivity to particulate matter in the pumped wastewater must be addressed by the pump vendor in the specification and datasheet for all pumps.

Characteristics of pumped wastewater including chemical composition and physical consistency:

Physical Composition

- Solids content (and size or grading of solids if applicable)

- Temperature range
- Wastewater density
- Rheology of wastewater pumped (sludge or other similar fluids)
- Percentage of entrained air or gas

100mm minimum diameter solids must be passed by the pump if above 15kW size and otherwise 80mm minimum diameter solids must be passed (refer to clause 3.7.3 below).

Pumps must be able to pump, without clogging, unscreened sewage including frangible solids, hard solids (e.g., grit, sand and stones), fibrous solids and mineral and other oils as stated in WSA 101-2008.

Pumps must be able to achieve the design life specified in this standard when exposed to, and operated in, the physical environment defined in the specification datasheet.

Chemical Composition

- pH
- Conductivity
- Total Dissolved Solids
- Chlorides
- Free chlorine
- Free gases
- Other chemicals

Pumps must be able to achieve the design life specified in this standard when exposed to, and operated in, the chemical environment defined in the specification datasheet. If the chemical composition gives rise to free gases and the potential for an explosive atmosphere then the pump vendor must take this into account.

3.7.2. Configuration

The pump configuration must be identified in the specification and datasheet.

The location and type of couplings (e.g., flexible, semi-flexible, geared etc...) must also be identified together with alignment and balancing requirements for the couplings.

Couplings must be capable of transmitting 150% of the full starting torque of the motor and secured against circumferential and axial movement relative to the connected shafts.

Couplings must be dynamically balanced with the impeller and shaft as described in Clause 3.6.3.

3.7.3. Impeller

Balancing, Construction And Materials

Dynamic performance (and hydraulic balance) of the impeller must be verified by the pump vendor.

G6.3 balancing to ISO1940-1:2003 is the minimum requirement. The impeller should be statically and dynamically balanced at the maximum pump operating speed.

The impeller must be secured to the shaft in a way that prevents circumferential and axial movement (unless axial movement is design function required for choke clearing) and shall be hydro-dynamically balanced. The impeller and shaft assembly shall be dynamically balanced to G6.3 at the maximum pump operating speed. The overall combination of rotating elements comprising the final pump and motor train, including all other rotating elements (e.g., couplings, flywheels, etc...), shall be dynamically balanced to G6.3 unless G2.5 balancing is offered in which case the later is preferred.

The geometry and number of vanes for the impeller are to be identified in the specification and the datasheet.

One piece construction is required (manufacture with more than one cast or fabricated layer comprising the impeller is not permitted). The manufacturing technique used in the casting or fabrication of the impeller must be nominated by the pump vendor.

The impeller material must be identified in the specification and datasheet and be such that the design life of the pump can be achieved given the identified physical and chemical properties of the wastewater pumped.

Pump selection with smaller than maximum impeller size is to be considered if comparing two proposed pump offers with one including the maximum impeller for the range and one that has an intermediate impeller.

Any inherent hydraulic or mechanical characteristic of the impeller that may lead to a reduction in the design life of the pump, or impeller, below the requirement nominated in this standard must be disclosed by the pump vendor before procurement of the pump. For example, inherent characteristics of impellers with lower numbers of vanes and consequential potential cavitation, vibration, noise and lack of hydraulic balance must be declared by the pump vendor prior to procurement of the pump.

Non-clogging Performance

SA Water has a range of pumps in our network wastewater pump stations with the majority having duty/assist pumps with less than 15kW motors. There are a lesser number of pumps with 15-30kW motors and a lesser number again with over 30kW motors. The impeller designs available to reduce clogging vary between pump vendors and also across these pump sizes. Typically, SA Water has vortex, shredder, grinder, line shaft channel, channel and other types of specialised non-clogging impellers.

Design characteristics of the impeller that reduce pump clogging must be explicitly advised by the pump vendor (if any). Vortex, shredder and/or grinder type pumps are available at smaller sizes (typically less than 15kW) and have good non-clogging performance but generally less hydraulic efficiency. Channel impeller designs are the most common with two or more vanes. These channel impellers are relatively hydraulically efficient but can be more prone to “soft” clogging and a relatively slow reduction in flow through the pump (i.e., a gradual build-up of solid materials within the wastewater stream on the pump impeller with the eventual formation of a choke in the pump volute). In some locations within the wastewater network, “hard” clogging can occur when larger solid accumulations form upstream of a pump station and then get caught in the pump impeller and volute leading to a relatively rapid reduction in flow through the pump.

Some of SA Water's wastewater pump vendors have specialised proprietary impeller designs, for a range of their pumps, which improve non-clogging performance in wastewater flows with relatively higher solids content. These pumps are able to reduce the number of "soft" clogging events in such networks because of impeller solids passing design features (not necessarily related to only the volute passing diameter).

The determination of whether a channel impeller is satisfactory for any particular pump station, or whether some other form of impeller design is required with enhanced non-clogging performance, must be made by the panel designer or contractor with reference to factual information obtained from SA Water Operations regarding the historical performance of any existing pumps in the network at the pump station or nearby locations (the best information available must be obtained from SA Water Operations with the next nearest pump station being the worst case option).

The clogging frequency for any pump to be replaced, or otherwise for the nearest existing pump station and pump to any new pump, must be identified before specifying the maximum acceptable clogging frequency for any new pump. The maximum acceptable clogging frequency for any new pump must be less than 1 choke per 6 months or equal to the clogging frequency for any existing pump being replaced if this frequency is less than 1 choke per 6 months (e.g., if an existing pump is clogging at a frequency of 1 choke per 12 months then any new pump must match this performance).

While the hydraulic efficiency of any impeller design is important, and must be taken into account, the non-clogging performance of the pump impeller is more important and adherence to the clogging frequency identified above is mandatory.

Methods of starting and stopping the pumps to reduce the risk of clogging must be specifically advised by the pump vendor in writing in the returnable datasheets prior to the procurement of the pump.

3.7.4. Volute

The type, geometry, material and method of fabrication (e.g., cast or plate fabricated) and wall thickness of the volute must all be nominated by the pump vendor in the specification and datasheet.

The allowable operating pressure for the volute, and suction and discharge flanges, must be identified and meet the minimum requirements identified in the specification and datasheet.

3.7.5. Wear rings

The type, geometry, material and thickness of the wear rings must all be identified in the specification and the datasheet.

The following four considerations must be explicitly raised with the pump vendor by the designer and/or contractor so that the pump vendor can confirm that no detrimental performance will result due to:

- Corrosion between wear rings either in contact (or near contact) with each other or other dissimilar metals
- Galling (or other damaging metallurgical phenomena) between wear rings that come into occasional contact when the wear rings are made of the same material or materials with insufficient differences in hardness (casing

wear ring to have a Brindell hardness of greater than 50HB higher than the impeller wear rings)

- Erosion of the wear rings due to solids in the wastewater
- Chemical attack on the wear rings from the pumped wastewater

The vendor must raise any other issues that might detrimentally affect performance in addition to the four considerations listed above.

The wear ring clearance shall be specifically identified, if applicable, together with the operational requirements for adjustment.

Casing wear rings should not be able to rotate.

Wear rings (and other components intended for periodic replacement) shall be capable of being replaced on site (and not corrode or otherwise stick together).

3.7.6. Shaft

Balancing is to be in accordance with Clause 3.7.3.

The shaft shall be of one piece construction with separate shaft sleeves.

The shaft and shaft sleeve shall be machined with suitable tolerances at the location of mechanical seals and bearing surfaces.

The stiffness of the pump shaft shall be sufficient to ensure that, under all operating conditions, pump, motor and any other components (whether rotating or stationary) cannot come into unintended contact and result in excessive vibration, wear or other damage to equipment.

Maximum shaft deflection, under all operating conditions, shall be nominated by the pump vendor.

Interlocking systems between shafts and shaft sleeves (e.g., pressed fit, threaded, nut, keyed or other) shall be nominated by the pump vendor in the specification and datasheet and shall be confirmed as adequate by designers and/or contractors (with confirmation in writing to SA Water Engineering that this has occurred) prior to procurement.

Keyed shaft to impeller interlocking systems are acceptable subject to assessment by designers and/or contractors (with confirmation in writing to SA Water Engineering that this has occurred) prior to procurement.

Heat shrinking to connect the shaft to any other pump or motor component, if proposed, must be declared by the pump vendor prior to the procurement of the pump and shall be confirmed as adequate by designers and/or contractors (with confirmation in writing to SA Water Engineering that this has occurred) prior to procurement.

3.7.7. Seals

Mechanical seal configurations for submersible pumps shall be in accordance with WSA 101-2008.

Maintenance and adjustment free mechanical seals are preferred.

Particular operational and/or maintenance requirements for the seals must be identified by the pump vendor, including lubrication and access for maintenance requirements, in the returned datasheets prior to pump procurement.

3.7.8. Bearings

The L_{10} bearing rating fatigue life is to be > 50,000hrs at the maximum operating speed unless otherwise approved in writing by SA Water Engineering upon request by designers, contractors and/or pump vendors.

The L_{10} bearing rating fatigue life should be interpreted as formally defined in ISO 281 and is the life that 90% of bearings of the relevant type will exceed before the spalling area reaches $6mm^2$.

Thrust bearings, if required, shall be specified that are able to resist all axial loads and radial loads if applicable.

Bearings shall be able to accommodate variations in shaft geometry with temperature.

The materials used in the bearings are to be identified by the pump vendor.

Maximum and minimum operating and alarm temperatures for pump bearings are to be identified in the specification and the datasheet. Provisions for the monitoring of temperature within the pump, motor and all other bearings are to be identified by the pump vendor.

The maintenance requirements for the bearing systems are to be identified by the vendor in the returned datasheets prior to the procurement of the pump. Bearings should be supplied pre-greased.

3.7.9. Lubrication media between moving pump components

The use of potable water, wastewater or other water for lubrication must be identified by the pump vendor in the returned datasheets prior to pump procurement.

Requirements to ensure wastewater is maintained in compartments within the pump outer housing or elsewhere must be identified by the pump vendor in the returned datasheets prior to pump procurement.

Requirements for trade waste approved grade oils for lubrication must be identified by the pump vendor in the returned datasheets prior to pump procurement.

3.7.10. Operating temperature, motor cooling and starts per hour

Submersible pumps may be cooled by immersion in the pumped wastewater. The pump vendor must supply the minimum immersion depth required to maintain the required pump motor cooling. The pump vendor must also supply the maximum number of hours the pump can be operated when not immersed and/or the motor de-rating when air cooled.

Dry well submersible pumps are to be specified with either:

- an internal closed loop using a water and/or glycol mix as a heat transfer fluid; or
- a cooling jacket with potable water pumped through it within the motor housing

Wastewater is not preferred as a cooling medium for dry well submersible pumps and should only be accepted after assessment and acceptance by the designer and/or contractor (with the written notification of this acceptance to SA Water Engineering).

For line shaft, self-priming or other wastewater pumps, totally enclosed fan cooled (TEFC) motors are acceptable subject to the environmental conditions in the pump station being maintained at the levels specified by the pump and motor vendor for the motor to be effective cooled.

For line shaft, self-priming or other wastewater pumps, water cooled motors are acceptable providing the specification for the pipework, reservoir and pumps required for the water cooling system is supplied to the designers and/or contractor for approval (heat transfer calculations must be submitted to designers and/or contractors for approval, with written confirmation to SA Water Engineering that this has occurred, before specification of water cooled motors).

Pumps (all wastewater types) are to be able to start 15 times per hour as identified in the specification and datasheet.

A reduced number of starts per hour may be acceptable for larger pumps (>50kW) subject to approval by the designers and/or contractors (with written confirmation by SA Water Engineering that this has occurred).

Class F motor insulation is the minimum requirement (class H is preferred).

Motors should be protected from overheating by monitoring temperature and setting temperature thresholds for shutting motors down in accordance with pump vendor requirements.

3.7.11. Vibration performance

Vibration levels must comply with the requirements of AS2625 for the relevant class and/or power level of pump. Vibration levels are also required to comply with the requirements of ANSI HI 11.6. SA Water Engineering should be contacted if an exemption to compliance with ANSI HI 11.6 is sought.

Pump vendors are required to state maximum vibration levels for pumps as identified in the specification and datasheet. If a pump vendor is unable to state vibration levels then designers and/or contractors must contact SA Water Engineering for further direction.

The likelihood of any detrimental wear or damage to any pump due to excursions from the nominal pump operating range (low or high flow excursions) must be identified by the pump vendor in the returned datasheets (and this information provided to SA Water Engineering) prior to the procurement of the pump. The pump vendor is to consider:

- 20 operational excursions, with flow between zero and Qmin (from the pump curve), for a time period of 180s
- 20 operational excursions, with flow greater than Qmax (from the pump curve) and head greater than zero, for a time period of 180s

when stating the likelihood of any detrimental wear or damage to any pump

Requirements for vibration mitigation measures including isolators and flexible or fully rigid mounting systems, or stiffening of hold down bolts or baseplate elements, must be raised by designers and/or contractors with the pump vendor prior to procurement of the pump. Information regarding the suction and discharge pipework and associated pipeline restraint systems must be provided as an annexure to the datasheet to enable the pump vendor to make an assessment of the likely vibration performance of the pump once it has been installed in a pump station.

Resonant modes must be raised by designers and/or contractors with the pump vendor prior to the procurement of the pump to enable the pump vendor to make an assessment of the likelihood of a problematic natural frequency arising for the pump and motor once installed in a pump station.

If the pump vendor is unable to assist in either a vibration mitigation and/or resonance assessment then this shall be taken into account in making pump selections if alternative vendors are able to offer such assessments.

Vibration levels should be determined at maximum power duty points during factory testing and after in-situ installation of the pumps (and associated equipment) in accordance with Section 3 of this standard.

Designers and/or contractors shall confirm with SA Water Engineering whether the specification is to state that vibration monitoring equipment will be permanently installed to monitor the vibration performance of the pumps.

3.7.12. Dimensional and structural considerations

The size of the suction and discharge flanges of the pump must be nominated by the pump vendor in the specification and datasheet.

The relative orientations of the suction and discharge flanges must be identified including options for adjusting the relative suction and discharge positions (and any adverse effects on pump performance from such configuration adjustments).

In the case of submersible pumps which can be dropped into or lifted out of a discharge support, the pump and discharge flange shall be such that only a single plane moment is induced in the discharge support bend in accordance with WSA 101-2008.

The suction and discharge flanges of the pump must meet the requirements of AS4087.

The suction and discharge flanges of the pumps must be rated for the maximum and minimum system pressures experienced at the pump (under all operating conditions including surge).

Suction and discharge flange nozzle loads (axial, shear and bending) must be identified in the specification and datasheet. Connected suction and discharge pipework must be specified to prevent gravity, pressure thrust and thermal loads from acting above the load limits for the pump flanges (refer to TS159a for detailed requirements of the analysis of pipework restraints).

The suction and discharge flanges, and pump casing, must be able to withstand the static and dynamic forces transmitted from the suction and discharge pipework as identified in the specification and datasheet.

Hold down anchors must be specified to resist all static and dynamic loads from the pump, motor and any other associated equipment. SA Water Engineering are to be notified by designers, contractors and/or pump vendors of all proposed hold down systems and baseplate specifications for pumps with power ratings over 100kW and may require Finite Element Analysis (FEA) of the potential dynamic modes for the pump and motor over supporting baseframe.

Details of supporting plates and plinths are to be submitted by the pump vendor for dry well submersible and line shaft wastewater pumps. These details must nominate the geometry and mass of all elements required to ensure that the vibration performance nominated in Clause 3.7.11 can be achieved.

Details of supporting frames are to be submitted by the pump vendor for dry well submersible and line shaft wastewater pumps. These details must nominate the geometry and mass of all elements, as well as the fixings (flexible or rigid), required to ensure that the vibration performance nominated in Clause 3.7.11 can be achieved.

Details of duckfoot base mounting systems for submersible pumps (including dimensional drawings) must be supplied to designers and/or contractors for assessment and must be consistent with requirements of SA Water Assets for base mounting and rail systems (SA Water Engineering are to be notified in writing of the details of the base mounting and rail systems).

If a base frame is proposed by a vendor for a wastewater pump installation then it must comply with the requirements identified in Clause 3.6.12 (for a water pump installation).

3.7.13. Noise levels

Pump vendors shall be requested to provide the following noise level information as identified in the specification and datasheet:

Table 2.2

	Overall	***Octave band centre frequencies (dBA pressure) and (dB power)***							
		63Hz	***125Hz***	***250Hz***	***500Hz***	***1kHz***	***2kHz***	***4kHz***	***8kHz***
Sound pressure level (@1m)	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sound power level	✓	✓	✓	✓	✓	✓	✓	✓	✓

The information provided by the pump vendors shall be used to draw relative comparisons between the pumps presented and determine their suitability for installation for a particular project.

Designers and/or contractors shall contact SA Water Engineering for direction if a pump vendor is unable to provide the requested noise data.

3.7.14. Air relief valves

Where air relief is critical to pump performance, during start or otherwise, the pump vendor shall be requested to confirm this and the performance requirements for the air relief valve(s). Refer to SA Water TS144 for requirements regarding air valves.

3.7.15. Coatings

All applicable SA Water Materials Science Standards must be referenced, including TG25, in the specification and datasheets.

Belzona or equivalent internal coatings are preferred for internal pump coatings to reduce corrosion and loss of efficiency in the pumps. Internal coating of pumps with cast iron volutes is mandatory. An option for the internal coating of pumps with volutes made from materials other than cast iron must be requested of the pump vendor in the specification and datasheet.

External coatings are required and shall be nominated by the pump vendor and provided for assessment by the designer and/or contractor. The outcomes of the assessment by the designer and/or contractor, including compliance with TG25, shall be communicated to SA Water Engineering in writing.

Stainless steel pump volutes should be requested by designers and/or contractors if internal pump coatings cannot be applied and the physical and/or chemical properties of the pumped wastewater are likely to result in corrosion and a reduction in design life to less than 25 years.

3.7.16. Hydraulic requirements

The following hydraulic requirements shall be identified in the specification and datasheet:

- Maximum and minimum suction head (under all operating conditions)
- Maximum (e.g., shutoff) and minimum differential head (under all operating conditions)
- Pump curves (from pump vendor) satisfying system curves and all required duty points
- Pump efficiency curves
- Pump NPSHr curves
- Priming lift height and pump operating speed information for self-priming pumps
- Fixed speed or variable speed drive (VSD) operation
- Parallel or series pump configurations

The nominated duty points at which the pump is intended to operate shall be nominated as follows:

- where the system only requires the nomination of a single duty point, this will be the guaranteed point for testing (refer to Section 3) and the point at which tendered pumps are compared
- where a system requires a range of operating conditions, a number of duty points shall be nominated, such that the system and pump operation is properly defined, and guaranteed duties points identified to ensure all operating conditions will be met. These will be the guaranteed points for testing (refer to Section 3) and the points at which tendered pumps are compared

The following parameters shall be nominated by the pump vendor for each duty point:

- flow
- total pump head
- efficiency
- input shaft power
- NPSHr

The minimum immersion depth for submersible wastewater pumps shall be nominated by the pump vendor so that vortex formation and air entrainment into the pump can be avoided. The minimum immersion depth shall be specified by the pump vendor for pump cooling requirements.

3.7.17. Miscellaneous

The pump curve number, model number, manufacturer and country of origin must be stated as identified in the specification and datasheet.

Guards must be provided for otherwise exposed rotating elements in accordance with the Australian Standards referenced in this standard.

Lifting lug locations and capacities and weight of components must be stated as identified in the specification and datasheet.

Rotating elements must be restrained from axial, radial, rotational or any other form of movement during transportation.

Section 4: Testing:

4.1. FACTORY TESTING

The factory tests under Clauses 4.1.1 or 4.1.2 must be requested of the pump vendor. SA Water Engineering must be contacted to determine which testing is required if unclear. Required tests shall be identified in the specification and datasheet. No pump, within the ranges identified in Clauses 4.1.1 or 4.1.2, shall be shipped from the factory until all required tests have been conducted, the results communicated to SA Water Engineering and SA Water Engineering have formally confirmed the test results.

4.1.1. Factory Testing (Unwitnessed)

Unwitnessed pump test results (factory test results) are required by SA Water Engineering for all water and wastewater pumps with power levels below 200kW unless SA Water Engineering specifically request witnessed tests for pumps less than 200kW.

Unwitnessed factory pump test results obtained by the pump vendor must be forwarded to SA Water Engineering, or its nominated representative (e.g., a designer), for approval before the pump(s) are shipped from the factory. SA Water Engineering, or its nominated representative, will assess the unwitnessed factory test results and approve or disapprove shipping within 10 working days.

4.1.2. Factory Testing (Witnessed)

Witnessed pump test results (factory test results) are required by SA Water Engineering for all water and wastewater pumps with power levels above 200kW unless SA Water Engineering specifically indicate that unwitnessed tests for pumps greater than 200kW are acceptable.

These witnessed tests need to be coordinated with SA Water Engineering and witnessing may be undertaken by a third party witness engaged through the relevant project. The contractor and/or pump vendor must provide 20 working days notice of upcoming factory testing so that arrangements can be made for SA Water Engineering or third party witnessing of the tests. Pump vendors may offer third party witnessed testing of pumps in which case the 20 working days notice can be reduced.

Witnessed factory pump test results obtained by the third party witness, whether arranged by SA Water, a contractor and/or pump vendor, must be forwarded to SA Water Engineering, or its nominated representative, for approval before the pump(s)

are shipped from the factory. SA Water Engineering will assess the witnessed factory test results and approve or disapprove shipping within 10 working days.

4.2. PUMP TEST REQUIREMENTS

4.2.1. Test Grades

Water Pumps

All pump tests shall be conducted in accordance with the requirements of AS2417 as follows:

- a Grade 1 test shall be performed for water pumps with a power level > 50kW
- a Grade 2 test shall be performed for water pumps with a power level < 50kW

Wastewater Pumps

All pump tests shall be conducted in accordance with the requirements of AS2417 as follows:

- a Grade 1 test shall be performed for wastewater pumps with a power level > 50kW
- a Grade 2 test shall be performed for wastewater pumps with a power level < 50kW

4.2.2. Test Parameters To Be Measured

The scope of the pump tests must be agreed between designers, contractors and/or pump vendors, and the final scope issued to SA Water Engineering in writing for approval, and shall include (as a minimum):

- operating test point at shutoff head (unless pump type does not enable this test)
- operating test point at Qmin (for a fixed speed pump or 100% speed for a VSD driven pump)
- operating test points at the nominated pump duty (guaranteed point) in accordance with AS2417
- operating test point at Qmax (for a fixed speed pump or 100% speed for a VSD driven pump)
- four additional operating test points nominated by SA Water Engineering or its nominated representative with two between the Qmin and nominated pump duty and two between the nominated pump duty and Qmax as listed in or as an addendum to the pump datasheet
- NPSHr shall be tested for the pump operating at the nominated pump duty using one of the methods nominated in AS2417

The test points must be sufficient to completely describe the shape of the pump curve. If there are inflexions or other changes in shape along the pump curve then a sufficient number of additional test points must be obtained to completely define the pump curve.

The following test parameters must be measured and reported at all test points (unless noted otherwise):

- Flow through the pump (L/s)
- Suction head (m), discharge head (m) and total dynamic head (m)
- Motor efficiency (%) – if a slave motor (i.e., not the motor to be used with the delivered pump) is used for the testing then motor efficiency does not need to be recorded
- Pump efficiency (%)
- Overall efficiency (%) – if a slave motor (i.e., not the motor to be used with the delivered pump) is used then the overall efficiency does not need to be stated
- Power use (kW)
- Operating speed (rpm)
- NPSHr or NPSH3 (m) (at the nominated pump duty)

All test parameters shall be plotted as curves (or on curves).

Details of the factory test rig configuration must be agreed between designers, contractors and/or pump vendors, and must be submitted to SA Water Engineering in writing for approval, prior to testing being undertaken.

Where a pump vendor is supplying a pump and motor on base frame, or pump motor and other associated rotating equipment on baseframe, SA Water Engineering requires a factory string test to be undertaken unless an exemption is granted. SA Water Engineering should be contacted to determine whether a factory string test is required when equipment is being supplied in a string on a pump vendor supplied baseframe.

4.2.3. Vibration Tests

Below a power level of 50kW, pumps should be supplied with vendor estimates, based on real testing and field data for pumps, of the maximum vibration levels that are expected if the pump, motor and all associated equipment are operated at the maximum power duty point, or other operating point that results in maximum vibration, as nominated in the specification and datasheet. SA Water has the capability to measure the vibration level from the installed in-situ equipment supplied by the vendor and may do so during the commissioning phase, in accordance with TS146c, or after the pumps are in operational service but within the warranty period.

Factory vibration tests are required for pumps supplied with power levels over 50kW.

Factory tests should be conducted with the pump restrained properly in the factory test rig and operating at the maximum power duty point or other operating point that results in maximum vibration. Vibration levels should be measured to obtain root mean square (rms) velocities at the following locations using calibrated instruments (calibration certificates should be forwarded with the test results):

- Non-drive end of motor – axial, horizontal and vertical orientations
- Drive end of motor – axial, horizontal and vertical orientations
- Drive end of pump – axial, horizontal and vertical orientations
- Non-drive end of pump – axial, horizontal and vertical orientations

The drive or the motor and pump may be coincident on submersible and dry well submersible pumps.

The vibration tests should be repeated at least once and all measured data forwarded to SA Water Engineering, or its nominated representative, for assessment together with the balance of the factory test results.

The pump vendor may comment on whether the factory test results are considered representative of the likely vibration performance of the pump and/or pump string once delivered and installed in-situation in a SA Water pump station.

3.2.3.1 Vibration Testing Of Water Pumps

Under factory test conditions, the maximum vibration levels, measured with the pump, motor and all associated equipment being operated at the maximum power duty point, should be less than 4.5mm/s (rms) for water pumps for all power levels from 50kW to 1MW (allowing for some flexibility in the restraint conditions for the equipment in the factory). SA Water Engineering should be contacted for direction if the power level exceeds 1MW.

Once installed in-situ with all restraints applied, the target maximum vibration levels, measured with the pump, motor and all associated equipment being operated at the maximum power duty point, shall be less than 2.8mm/s (rms) for water pumps. The vibration performance of the supplied equipment will be assessed in accordance with TS146c. The vibration performance of multiple pumps operating simultaneously at any duty operating points shall be confirmed in accordance with TS146c.

3.2.3.2 Vibration Testing Of Wastewater Pumps

Under factory test conditions, the maximum vibration levels, measured with the pump, motor and all associated equipment being operated at the maximum power duty point, should be less than 9mm/s (rms) for submersible or dry well submersible wastewater pumps for all power levels from 50kW to 500kW (allowing for some flexibility in the restraint conditions for the equipment in the factory). SA Water Engineering should be contacted for maximum vibration levels if the power level exceeds 500kW and for line shaft type wastewater pumps. If ANSI HI 11.6 vibration limits are higher than 9mm/s (rms) then the later (lower) limit shall be adopted. If ANSI HI 11.6 vibration limits are lower than 9mm/s then the lower ANSI HI 11.6 limit shall be adopted.

Once installed in-situ with all restraints applied, the target maximum vibration levels, measured with the pumps, motor and all associated equipment being operated at the maximum power duty point, shall be less than 6mm/s (rms) for wastewater pumps. If ANSI HI 11.6 vibration limits are higher than 6mm/s (rms) then the later (lower) limit shall be adopted. If ANSI HI 11.6 vibration limits are lower than 6mm/s then the lower ANSI HI 11.6 limit shall be adopted. The vibration performance of the supplied equipment will be assessed in accordance with TS146c. The vibration performance of multiple pumps operating simultaneously at any duty operating points shall be confirmed in accordance with TS146c.

4.2.4. Noise Tests

Noise tests are required for pumps supplied with power levels over 50kW or otherwise for pumps that are being installed in noise sensitive installations such as where compliance with Environment Protection Agency (EPA) limits is required (if compliance with EPA limits is required then designers, contractors and/or pump vendors must make contact with SA Water Stakeholder Group to determine whether lower noise restrictions than stipulated by the EPA apply). Noise levels

should be measured at both ends and each side of a pump train to confirm sound pressure levels at 1m from the pump train when operating at the maximum power duty point.

The noise testing undertaken by the vendor must be sufficient to provide sound pressure levels (@ 1m) and sound power levels, for the pump, motor and associated equipment when operated at the maximum power duty point, both overall and at the frequencies identified in Table 2.1 (water) and Table 2.2 (wastewater) in this standard.

4.2.5. Other Tests

Extended period operation tests may be required by SA Water Engineering for submersible and dry well submersible pumps with power levels over 50kW. SA Water Engineering should be contacted to determine whether this requirement applies for a particular project.

Hydrostatic testing for all pumps must be undertaken to the maximum rated casing pressure for the pumps and certified results provided to SA Water Engineering or its nominated representative. No leakage from the pump or distortion of any component should occur during the hydrostatic test. If leakage or distortion does occur then the source or cause must be identified, rectifying work undertaken in the factory and a further hydrostatic test undertaken to confirm all leakage and/or distortion has been eliminated. The hydrostatic test pressure shall be applied for a duration of 20 minutes after the full test pressure has been reached.

The functionality of all permanently installed and/or integrated temperature probes for windings, bearings or any other motor or pump component shall be checked during the factory testing.

If external and/or internal coatings have been applied then testing and then certification of the method of application, coverage and thickness of the coating shall be provided to the designer and/or contractor for approval (and written notification of the results must be provided to SA Water Engineering confirming compliance with all SA Water Materials Group standards). If the testing or certification does not comply with SA Water Standards or Australian Standards then SA Water may request third party testing and certification of the external and/or internal coatings.

4.2.6. Certified Drawings

Certified dimensional engineering drawings of pumps, motors and/or other associated rotating equipment, regardless of whether supplied as individual components or together as a pump string on a baseframe, must be provided within 4 weeks of entering into a contract for the procurement of the equipment unless otherwise negotiated in the contract (if a longer period is negotiated by a designer, contractor and/or pump vendor then SA Water Engineering shall be notified of this in writing).

Any specific pipe, spool or other section used to establish particular flow conditions approaching a pump suction must be explicitly declared by pump vendors and certified dimensional engineering drawings of the pipe, spool or other section provided before pump procurement.