INDUSTRY STANDARD FOR SUBMERSIBLE PUMPS FOR SEWAGE PUMPING STATIONS

WSA 101—2008

Replaces WSA 101—2005

WATER SERVICES ASSOCIATION
OF AUSTRALIA

PREFACE

The objective of this Standard is to provide design, manufacturing and performance requirements for manufacturers of submersible electric pumps and ancillary equipment.

The 2008 edition of this Standard:

(a) abandons the concept of interchangeability by deleting prescribed standard dimensions for the pump pedestal;

(b) uses the correct term Working Load Limit (WLL) in lieu of Safe Working Load (SWL);

(c) corrects referenced Standards for bolts, screws and dowels;

(d) amends references to Standards and corrects many Clause reference errors in Appendix C identified in the review undertaken by the Water Corporation.

While the initial cost of a pump is important manufacturers should be aware that with increasingly onerous legislative requirements – both in terms of demonstrating fiscal prudence and managing environmental risk – Water Agencies are increasingly focused on reducing total life cycle costs of asset management of network infrastructure.

Statements expressed in mandatory terms in notes to tables and figures are deemed to be requirements of this Standard.

This Standard was prepared by the Water Services Association of Australia (WSAA), its members and individual manufacturers.

Support and contribution is acknowledged from:

Brisbane Water

Gold Coast Water

Grundfos Pumps Pty Ltd

ITT Flygt Limited

Mono Pumps (Australia) Pty Ltd

South Australia Water Corporation

Sydney Water Corporation

Water Corporation

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

CONTENTS

WSAA Standard

Submersible pumps for sewage pumping stations

1 SCOPE AND GENERAL

1.2 SCOPE

This Standard specifies 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.

NOTES:

1 This standard may be used for supply of multiple pumps.

2 Reference to the asset owner shall be understood to refer to the asset owner representative or project manager.

1.3 SCOPE OF SUPPLY

The supply of a pump unit shall include:

(a) the pump unit, including all integral equipment required for the operation of the pump in the intended service including drive motor and associated power and control cables;

(b) a pump pedestal and discharge connection (‘duck foot’ type discharge bend);

(c) guide rails, guide rail support brackets and lifting chain, as appropriate;

(d) fasteners and anchor bolts;

(e) motor over-temperature protection device; and

(f) seal failure detectors and associated cores in cables.

The pump unit shall be supplied completely assembled, with the other ancillary equipment supplied separately.

NOTES:

1 Installation of the pump and ancillary equipment may be required.

2 Supply of cable support stockings and hooks may also be required.

1.4 REFERENCED DOCUMENTS

The documents referred to in this Standard are listed in Appendix A.

1.5 DEFINITIONS

For the purpose of this Standard, the definitions given in AS 1359, AS 2417 and those below apply:

1.5.1 Asset Owner

An agency, authority, board, company, corporation, council, department, individual, utility or other legal entity who is the owner of the asset and/or who will have ultimate responsibility for the asset.

NOTE: The asset owner in many instances will not be the Purchaser of the submersible pump.

1.5.2 Centrifugal pump

A kinetic machine for converting mechanical energy into hydraulic energy through centrifugal activity.

1.5.3 Coating

A corrosion-inhibiting medium applied to the surface of a component.

1.5.4 Coating defect

A detectable weakness or discontinuity in a coating which renders suspect its ability to protect component substrates from corrosion during normal service life.

1.5.5 Pumpset

A submersible pump, electric motor and other ancillary items.

1.5.6 Submersible pump

A submersible pump is one in which the electric drive motor is designed to be immersed in the pumped liquid when operating, but may operate unsubmerged.

2 MATERIALS AND COMPONENTS

2.1 MATERIALS

Table 2.1 provides basic materials for the manufacture of the submersible pumps and ancillary equipment. Materials listed are the minimum acceptable standard materials. Other materials may be used, provided they are equivalent in performance, particularly with respect to strength, corrosion-resistance, pump operation and durability. See Appendix B for alternative materials.

Non-metallic materials used in the componentry of pumps and ancillary equipment shall be fit for the intended purpose and shall exhibit dimensional stability after extended periods of time immersed in sewage.

NOTE: Material equivalence will be considered by a ruling committee of asset owners and suppliers selected by the Water Services Association of Australia, (WSAA).

2.2 DEZINCIFICATION-RESISTANT MATERIALS

Copper alloy pump unit components shall be dezincification resistant and shall comply with AS 2345.

2.3 STAINLESS STEEL

Stainless steel castings, plate and bar subjected to welding, including repair welding, during the manufacture of any component shall be a low carbon or stabilized grade. Stainless steel castings shall be heat treated in accordance with AS 2074. All stainless steel components except for fasteners shall be passivated in accordance with ASTM A380.

Graphite greases, graphite packing and graphite compounds shall not be used in contact with stainless steel.

2.4 PROTECTIVE COATINGS

The pump design shall be such that the corrosion protection system shall be fully effective for all surfaces exposed to sewage or sewer gases. All surfaces that cannot be coated and tested shall be of corrosion-resistant material.

The design of all components shall be such that a polymer coating can be applied and tested fully for conformity with AS/NZS 4158. The coating shall be continuous across the full width of all joint gaskets and seals.

Surface coatings shall be applied after all hydrostatic testing has been completed.

Auxiliary items, unless they are manufactured from corrosion-resistant materials, shall be hot-dip galvanized to AS/NZS 4680 or coated with a protective coating to AS/NZS 4158.

NOTE: Other protective coating systems may be permitted by agreement between the supplier and the asset owner. For example, a 2-pack epoxy-mastic system complying with GPC-C-29/7S applied at a minimum dry film thickness of 400 μm over a Class 3 finish with surface profile 38 μm may be acceptable.

TABLE 2.1

BASIC MINIMUM MATERIAL REQUIREMENTS[1]

Component	Material	Standard	Minimum Grade
Pump casing	Grey cast iron	AS 1830	250
Impeller	Grey cast iron	AS 1830	250
Impeller locknut	Stainless steel	ASTM A276	316 or 420 or 431
Replaceable casing wear rings, if applicable	Nickel-chromium abrasion resistant white iron	AS 2027	Ni Cr 4-600 HT3
Replaceable impeller sealing rings[2]	Phosphor bronze	AS 1565	C90250–continuous, chill or centrifugal casting only
Shafts	Stainless steel	ASTM A276	316 or 431
Shaft mechanical seal face (rotating and stationary) - motor side - Rotating face - Stationary face - medium side	Wear resistant material		 Carbon/ceramic or silicon carbide Silicon carbide
Shaft mechanical seal spring material	Stainless steel	ASTM A276	316, 420 and 431
Seals (O-rings and lip seals)	Synthetic elastomer	ASTM D3187	EPDM and NBR
Motor housing, pedestal bend, discharge connection and mounting brackets	Grey cast iron	AS 1830	T220
Lifting brackets or lifting eye bolts	Stainless steel	ASTM A276	316
Chains[3]	Stainless steel	ASTM A276	316
Guide rails	Stainless steel	ASTM A276	316
Delivery hose covered with black conductive SBR for abrasion, ozone and fire resistance	Unreinforced SBR/NR blend	AS 2660	Class C rated to 10 bar
Fasteners - Bolts - Nuts - Washers	Stainless steel Stainless steel Stainless steel	ASTM F593 ASTM F594 ASTM F844	316 316 316
Nameplates	Stainless steel	ASTM A480M	316
Cable sheathing	Synthetic elastomer	AS/NZS 3116	CR
O-rings for flanges	Synthetic elastomer	WSA 109	EPDM and NBR
Gaskets for flanges	Synthetic elastomeric or compressed non-asbestos fibres	WSA 109	

NOTES:

1 For alternative materials see Appendix B. Approved alternative materials will be added to Appendix B following decisions by the ruling committee (see Clause 2.1).

2 Used with shrouded impellers.

3 A Standard for stainless steel chains is being developed.

3 DESIGN AND MANUFACTURE

3.1 GENERAL

Pumps and ancillary equipment shall:

(a) comprise a close-coupled motor and centrifugal pump;

(b) be suitable for submerged operation in sewage;

(c) be designed for installation with the shaft vertical, unless otherwise specified;

(d) be suitable for operating with the motor unsubmerged and without water for periods up to 4 h;

(e) be suitable for pumping unscreened sewage; and

(f) be able to be fitted to a standard pump pedestal with or without fitment of an adaptor.

The design criteria of the pumps and ancillary equipment shall be based on a minimum life expectancy of 20 years.

3.2 DESIGN OPERATING PRESSURE

The design operating pressure of the pump and cooling jacket (where applicable) shall be rated in excess of the maximum operating pressure that may be developed at maximum speed i.e. maximum suction head plus maximum discharge head of the pump under any conditions including zero flow.

3.3 ARRANGEMENT

The pump unit shall be a composite of the drive motor and the hydraulic end. The pump impeller shall be mounted on a one-piece motor shaft.

The pump unit shall be oriented with the shaft vertical and the motor fitted above the pump.

The pump unit shall be supported on a separate discharge bend manufactured with integral mounting feet (refer Clause 3.7.8.1).

Where specified by the Purchaser, provision shall be made for mounting a nominated flush valve to the pump casing.

3.4 REVERSE ROTATION

All pump components shall be capable of withstanding without damage the effects of reverse rotation due to reverse flow through the pump up to 120% of normal direction rated speed.

3.5 MACHINING

Machining shall be concentric, square to line and true. All sharp edges and burrs shall be removed.

Bolt holes shall be drilled and spot-faced for bolt head and nut. Mating parts shall be match-marked.

All components and the assembled rotating element shall be interchangeable for pumps of the same type, designation and size.

Bosses shall be provided for all tappings. The use of set-screws in castings shall be avoided. Dowels shall be provided between components requiring accurate location in position.

3.6 FREEDOM FROM DEFECTS

All components shall comply with the following requirements:

(a) Castings shall in all respects be sound and free from laps, blowholes and pitting. External and internal surfaces shall be free from sand.

(b) Components shall be free from defects.

(c) The internal and external surfaces shall be free from burrs, fins, and sharp edges. The minimum radius of edges to be protective coated shall be 3 mm.

3.7 PUMP

3.7.1 Solids Handling Capacity

Unless otherwise specified by the asset owner, the pump shall be required to pump unscreened sewage, which includes:

(a) frangible solids;

(b) hard solids, e.g. grit, sand and stones;

(c) fibrous solids, e.g. rags, ropes, plastic sheeting, disposable clothing and sanitary napkins

(d) mineral and other oils.

The pump housing, impeller and casing ports shall be capable of pumping all solids typically found within unscreened raw sewage without clogging, which, by either type testing [option (i)] or installation trial [option (ii)], shall demonstrate that the pump housing, impeller and casing ports are capable of:

(i) passing a sphere of the minimum diameters given in Table 3.1; or

(ii) providing endorsements by end users of proven in-service clog free operation.

NOTES:

1 End users endorsements will be considered for acceptance by a ruling committee of asset owners and operators selected by the Water Services Association of Australia (WSAA).

2 Cutter and grinder type pumps are considered outside the scope of this Standard and should be referred to the asset owner for acceptance.

TABLE 3.1

SPHERE PASSING CAPABILITY

Discharge port diameter mm	Minimum diameter of sphere passing mm
<100	60
100–300	80
>300	150

3.7.2 Impeller

The impeller shall be designed to pump unscreened raw sewage and be of a proven design to provide non-clogging performance [see Clause 3.7.1(ii)].

The impeller shall be:

(a) accurately machined to reduce friction, leakage loss and recirculation.

(b) dynamically balanced in accordance with AS 3709, grade G6.3 prior to assembly.

Replaceable impeller sealing rings shall be fitted to pumps with shrouded impellers.

Adjustable components and replaceable wear rings shall be capable of being readily replaced on site to enable maximum efficiency and flow capacity of the hydraulic unit to be maintained. Endorsement of ready in-situ replacement shall be provided by end users.

NOTE:End users endorsements will be considered for acceptance by a ruling committee of asset owners and operators selected by the Water Services Association of Australia (WSAA).

3.7.3 Casing

The volute shall be shaped so that the discharge nozzle aligns with the centreline of the pump, such that the pump induces a single plane moment only on the discharge support bend.

The pump casing shall incorporate either a:

(a) “no bolts” discharge connection for attachment to a standard pump pedestal; or

(b) a spigot connection suitable for attachment of a:

(i) DN 80 delivery hose; or

(ii) DN 100 delivery hose; or

(iii) DN 150 delivery hose.

NOTES:

1 DN 100 hose—102 mm ID, 114 mm OD, 6 mm wall thickness.

2 DN 150—152 mm ID, 166 mm OD by 7 mm wall thickness.

3.7.4 Wear Rings

Either replaceable casing wear rings shall be fitted to pumps with shrouded impellers or adjustable axial impeller clearance using external adjusting screws shall be provided.

Where fitted, casing wear rings shall:

(a) be mechanically secured to the casing to prevent rotation. Machined recesses shall be provided to receive the casing wear rings in order to provide smooth contours throughout the internal casing surface.

(b) be of dissimilar corrosion and erosion resistant materials to sealing ring(s); and

(c) have a Brinell hardness a minimum of 50HB higher than the impeller sealing ring(s) to prevent galling during operation.

3.7.5 Pump and Motor Shafts

Shafts shall be of rigid construction and designed such that:

(a) for fixed speed pumps, the first lateral critical speed is at least 150% higher than the maximum operating speed of the pump.

(b) for pumps required to operate at varying speeds, the first lateral critical speed is at least 300% higher than the maximum operating speed of the pump.

The first lateral critical speed shall be calculated for the maximum diameter impeller able to be fitted to the pump, without any support from wearing ring(s) or neck ring(s).

The maximum lateral deflection of the shaft shall be determined to establish permissible internal clearances, taking into account all lateral hydraulic reactions on the impeller and any external loads. Support by the mechanical seals shall not be considered when determining shaft deflection, but allowance may be made for the hydrodynamic bearing effect or running clearance.

The shaft shall be manufactured from a single piece of forged barstock and have a ground finish over its entire length. The shaft shall be stepped for ease of assembly of the components with the steps radiused to reduce stress raisers.

3.7.6 Shaft Seal and Seal Chamber

Sealing of the shaft between the pump and the motor shall be achieved by mechanical seals. Each mechanical seal shall contain one stationary and one positively driven rotating corrosion resistant rotating face and each seal interface be held in contact by an independent spring system e.g. bellows type. The seals shall not require maintenance or adjustment nor depend on direction of rotation for sealing.

The following seal arrangements are acceptable—

(a) A tandem mechanical seal arrangement consisting of two independent seals assembled into one plug-in unit (cartridge).

(b) Two independent mechanical seals consisting of—

  (i) a lower (medium side) mechanical seal with silicon carbide in both the stationary seat and rotating face; and

  (ii) an upper (motor) mechanical seal with silicon carbide, chrome steel or carbon ceramic at the stationary seat and silicon carbide or carbon ceramic at the rotating face.

(c) A mechanical seal and radial lip seal consisting of—

  (i) a lower (medium side) mechanical seal with silicon carbide in both the stationary seat and rotating face; and

  (ii) an upper (motor) radial lip seal.

Each mechanical seal shall be:

  (A) of robust construction, designed to withstand the adverse operating conditions associated with sewage pumping; and

  (B) designed for a minimum operating life of 5000 h under normal sewage pumping conditions.

The seal chamber shall incorporate a leakage detection device in pump units 7.5 kW and over to ensure that excessive water leakage past the mechanical seals is detected and alarmed.

3.7.7 Electric Motors

3.7.7.1 *General*

The motors shall be in accordance with the requirements of AS 1359 and be of a type tested design. Motors shall be capable of sustaining at least the number of starts per hour in accordance with Table 3.3.

TABLE 3.3

MOTOR STARTS PER HOUR

Limiting Motor Rating, kW	Starts per Hour
≤15	12
>15	8

Motors shall:

(a) be the 415-Volt, 50 Hz, 3-phase, 4 pole induction type with a maximum synchronous speed of 1500 rpm, unless otherwise specified by the Purchaser;

(b) have a power factor of ≥0.80 when running at 75% load;

(c) have an efficiency of ≥85% when running at 75% load;

(d) be rated IP68 for submerged operation, in accordance with AS 1939;

(e) be resistant to corrosive gases such that may be found in sewers;

(f) have 10% greater power than the maximum required at the pump shaft for the selected impeller;

(g) be suitable for direct-on-line (DOL) and reduced-voltage starting, using either auto transformer, electronic soft starter/soft stop or VSD types; and

(h) have an earthing terminal provided within the power supply terminal box.

The motor manufacturer shall be informed if the motor is to be used in conjunction with a VSD of the PWM type so that the manufacturer can take into account the increased level of harmonic currents and the increased voltage stress on the insulation. Motor windings shall have an impulse withstand voltage rating and a dV/dt rating engineered to the characteristic output of the VSD and the length of cable between the motor and VSD. Furthermore, the effects of common mode currents flowing through the bearings shall be taken into account by the motor manufacturer.

The locked rotor current shall not exceed a maximum of 7 times the rated full-load current.

3.7.7.2 *Motor Housing*

The motor housing shall be designed to withstand submergence to a depth of 20 m head without leakage and to facilitate the cooling of the motor. The housing shall be machined from a one-piece casting except for:

(a) cable entry glands, and

(b) lifting brackets (or lifting eyes) such that the pump unit, when suspended, hangs vertically plumb,

which may be separate bolt-on arrangements.

3.7.7.3 *Motor Cooling*

Motors shall be rated to not overheat during continuous operation under any hydraulic conditions, including non-submerged conditions. Motor cooling may be achieved by utilising:

(a) the fluid that the pump is immersed in only; or

(b) an internal closed loop cooling system that cools using a water and glycol mixture as the heat transfer fluid; or

(c) pumping part of the pumped fluid through a water jacketed arrangement within the motor housing.

3.7.7.4 *Motor Protection*

The motor shall be protected from overheating by:

(a) at least one thermal switch, connected in series, fitted to each of the stator windings, which shall remain in the closed position and only open when the winding temperature reaches 140°C; or

(b) at least one positive temperature coefficient (PTC) thermistor in each phase of the stator windings. Each thermistor shall be connected in series to terminals adjacent to the stator terminals and encapsulated and compatible with the motor selected; or

(c) resistance temperature detector (RTD) elements (100 ohm).

A moisture detection device shall be fitted in the motor stator housing and the cable termination housing.

3.7.7.5 *Motor Insulation*

Winding insulation temperature rating shall be not less than Class 155 to AS 2768. Motors shall be designed not to exceed Class 130 assigned temperature at full load.

3.7.7.6 *Motor Cables and Entry Glands*

Cables shall be flexible, multi-core, insulated, sheathed and suitable for immersion in sewage. Cables shall comply with AS/NZS 3116.

Cables shall incorporate additional cores for the thermal switch or thermistor or RTD protection system, moisture detection and seal failure probe. The additional cores shall be provided with secondary sheaths.

All cables entering the motor shall be glanded to a single demountable flange.

Unless otherwise specified by the Purchaser, a continuous length of 15 m shall be provided.

3.7.7.7 *Bearings*

The motor bearings shall be:

(a) metrically dimensioned;

(b) fully sealed and pre-greased; and

(c) designed for a L_{10} rating fatigue life of at least 40,000 h at the maximum operating speed.

Bearing mountings shall be designed to allow for variations in shaft temperature.

Thrust bearings shall be fitted to take all axial loads due to hydraulic thrust.

3.8 PUMP PEDESTAL AND DISCHARGE CONNECTION

3.8.1 General

Submersible pumps may be mounted on ‘duck-foot’ type pedestal which is connected to pipework within the wet-well that in turn connects to the pressure main.

NOTE: In the design of wet-wells a standard pump pedestal may not always be required since the connection may be made at the top of the wet-well using a flexible pressure hose between the discharge outlet of the pump and a hose connection bend assembly supported from the top of the wet-well.

In design of sewage pumping stations it is best practice to limit the need for person access into the wet-well.

3.8.2 Purpose

The pedestal enables secure location of the pump to the wet-well floor without the need to tighten bolts or drain the wet-well. The pedestal connection is designed to be capable of resisting all static and dynamic loads induced by the pump and discharge pipework

The pedestal connection enables the pump to be manipulated from the top of the wet-well by lifting or lowering the pump without the need of special devices. The discharge connection joint should be capable of maintaining a watertight seal between pump and the discharge pipework under normal operational conditions.

3.8.3 Design

The discharge connection shall provide:

(a) an anchor point for mounting of two vertical guide rails, located to ensure that the pump can by raised and lowered in the wet-well without lateral deviation; and

(b) a vertical flanged discharge port complying with Figure B2 of AS 4087.

3.8.4 Standard Dimensions

The standard pump pedestal dimensions shall be by agreement between the Purchaser and the Supplier.

3.9 ANCILLARY ITEMS

3.9.1 Guide Rails

Where specified, twin guide rails to suit the standard dimensions for the pump pedestal (Refer to Figure C1) shall be supplied with each pump. The guide rails shall be designed to permit the pump to slide freely and seat correctly when lowered into the working position and shall be sized to suit the pump model.

Brackets shall also be designed to support and attach the guide rails to the pump discharge pipework (riser pipe) and the wet-well wall. Each pump shall be supplied complete with:

(a) a top mounting bracket for the guide rails; and

(b) intermediate mounting brackets for the guide rails, suitable for connection to discharge pipework.

The brackets shall be sufficient in number so that they can be spaced to avoid excessive deflection of the guide rails and permit the pump to slide freely.

3.9.2 Lifting Chains

Unless otherwise specified by the Purchaser, each pumpset shall be fitted with a 12 m length of lifting chain with a Working Load Limit (WLL) in excess of the mass of the pumpset.

Lifting chains shall be designed such that the pump unit, when suspended from the motor housing lifting bracket [see Clause 3.2.7.2 (b)], hangs vertically plumb and does not rotate.

Lifting chains shall:

(a) have rectangular links at 3 m intervals;

(b) be fitted with a shackle complying with AS 2741 suitable for hook entry at the top end and just below the wet-well cover; and

(c) be tagged for lifting capacity.

All lifting chains shall comply with Table 2.1 and the testing requirements of AS 2321.

3.9.3 Bolts, Screws and Dowels

Each pumpset shall be supplied with all fasteners, washers and gaskets, required for its installation.

All bolts, screws, studbolts, dowels and nuts shall be manufactured from stainless steel in accordance with Table 2.1. All bolts, studbolts and nuts shall comply with AS 1111.1 and AS 1112.3.

Galling prevention compounds shall be applied to all stainless steel threads prior to assembly.

Flange bolting shall comply with Clause 3.2 of AS 4087. Studbolts shall not be used unless required for tapped holes.

3.9.4 Seals

Seals shall be manufactured from materials that are not injuriously affected by sewage or environmental conditions to which they will be subjected in service. The seal hardness shall be as required by the seal design for the pressure specified and, if required, shall be reinforced with high modulus aramid fabric.

Elastomeric seal compounds shall comply with AS 1646.

3.9.5 Flange Gaskets and O-rings

Flange gaskets and O-rings shall comply with WSA 109.

4 PERFORMANCE REQUIREMENTS

4.1 GENERAL

Pumps shall be capable of:

(a) satisfying total head and capacity requirements;

(b) running continuously;

(c) pumping unscreened sewage;

(d) operating automatically and unattended;

(e) being housed in a below-ground structure used to store sewage until pumped;

(f) being adaptable to existing Australian water industry standard pump discharge connections as required by the Asset Owner;

(g) being easily removable from the pumping station for maintenance and repair without the need for personnel to enter the wet-well;

(h) providing efficient cost-effective pumping; and

(i) meeting specified acoustic requirements.

4.2 PUMP CHARACTERISTICS

The manufacturer shall supply the pump characteristics using the data sheet performance schedule in Appendix C. The following values shall be guaranteed by the manufacturer at a nominated speed of rotation, which shall not exceed 1500 rpm[1]—

(a) Outlet rate of flow of pump, L/s.

(b) Total head of pump, m.

(c) NPSHR, m.

(d) Pump efficiency, %.

(e) Motor efficiency, %.

(f) Overall efficiency, %.

NOTES:

1 For high head applications, higher speed pumps may be specified with the agreement of the asset owner.

2 The required guarantee point is given for the purposes of performance testing in accordance with Clause 5.2.

Secondary duty points shall be given for the purpose of defining the required shape of the pump head-capacity (flow) characteristic curve. Allowable deviation from these secondary points for performance tests shall be as follows—

outlet rate of flow of pump, L/s	±3.0 %
total head of pump, m	±3.0 %

4.3 MINIMUM SUBMERGENCE

The manufacturer shall nominate the minimum submergence level at which the pump can operate continuously (using the data sheet performance schedule in Appendix C) without formation of vortices.

5 TESTING

5.1 TYPE TEST CERTIFICATES

5.1.1 General

The pump manufacture shall supply certified pump data and motor type test certificate for each pump model and series at the time of offer. The information supplied will act as the manufacturer's performance guarantee. This information shall include as a minimum the following information—

(a) Certified head and flow.

(b) Input power.

(c) Shaft power.

(d) Overall efficiency.

(e) Hydraulic efficiency.

(f) NPSHR.

(g) Rated power.

(h) Rated current.

(i) Start current.

5.2 PERFORMANCE (WORKS ACCEPTANCE) TESTS

5.2.1 General

When performance testing is required the tests shall be performed in accordance with AS 2417 for different motor sizes as follows—

(a) ≤10 kW – AS 2417 Annex A

(b) >10 kW and <50kW – AS 2417 Grade 2

(c) ≥50kW and above – AS 2417 Grade 1

5.2.2 Hydrostatic Test

Hydrostatic testing of mass produced pumps manufactured under cover of a quality system to ISO 9001:2000 which has been certified by a Certification Body[1], do not require routine hydrostatic testing.

Notwithstanding, if the purchaser requires hydrostatic testing to be performed, it shall be in accordance with Clause 1.6.4 of ANSI/HI 11.6 which specifies test parameters, test procedure, acceptance criteria and test records.

NOTES:

1 Certification Bodies shall be accredited for the appropriate purpose by the Joint Accreditation System of Australia and New Zealand (JAS-ANZ) or by an equivalent international accreditation system that is recognised by JAS-ANZ.

2 Manufacturers and/or suppliers of mass produced pumps shall make available upon request copies of the factory performed hydrostatic tests for each pump type and/or model.

5.2.3 Coating Tests

Each coated casting shall be tested in accordance with AS/NZS 4158. Defects found during testing may be repaired, where allowable, in accordance with AS/NZS 4158.

Where a coating defect cannot be repaired, the coated component shall be rejected.

6 MARKING,LABELLING, PACKAGING, SPARE PARTS AND DOCUMENTATION

6.1 MARKING

6.1.1 Motor Marking

Motors shall have a nameplate fixed with screws located in an easily readable position and permanently and indelibly marked with at least the following—

(a) Motor kw rating.

(b) Manufacturer's details.

(c) Motor type and serial number.

(d) Locked rotor and full load current.

(e) Voltage.

(f) Current.

(g) Power factor.

(h) Class of insulation.

(i) Degree of protection.

(j) Speed of rotation and direction.

Motors with thermal switches/thermistors/RTDs fitted shall include the following additional information on the nameplate in accordance with AS 60947.8:

(k) Manufacturer of thermal switch/thermistor/RTD.

(l) Type.

(m) Tripping temperature.

(n) Number of thermal switches/thermistors/RTDs per phase of winding.

(o) Resistance of each thermal switch/thermistor/RTD at the tripping temperature.

(p) A warning on the thermal switch/thermistor/RTD terminal box stating:

WARNING

THERMAL SWITCHES* OR THERMISTORS* OR RESISTANCE TEMPERATURE DETECTORS* INSTALLED

DO NOT MEGGER

*Delete as appropriate

Nameplates and fixing screws shall comply with Table 2.1.

6.1.2 Pump Marking

Each pump shall have a nameplate fixed with screws located in an easily readable position and permanently and indelibly marked with at least the following—

(a) Manufacturer's name.

(b) Model and series number.

(c) Year of manufacture.

(d) Class (pressure).

(e) Duty flowrate, L/s.

(f) Duty head, m.

(g) Pump running speed, rpm.

(h) Impeller size, mm.

(i) Free passage, mm.

(j) Total mass, kg.

NOTE: Markings may also be cast on the pump casing.

Nameplates and fixing screws shall comply with Table 2.1.

6.1.3 Pump Pedestal and Discharge Connection

Each pump pedestal and discharge connection shall have the following cast on the body:

(a) Manufacturer's name or mark.

(b) Nominal size of inlet/outlet, eg. 150/200.

(c) Year of manufacture.

(d) Class (pressure).

6.2 LABELLING

All items shall be individually labelled prior to packing. Labels shall include the following information:

(a) Manufacturer.

(b) Batch Number.

(c) Contract/Order Number (if applicable).

(d) Item or Part Number.

Where items are manufactured for specific mating component parts, they shall all bear individual identification numbers and reference to the mating part identification numbers.

6.3 PACKAGING

All items shall be individually packaged for long term storage in a tropical environment, with external labelling duplicating the information specified in Clause 6.1.

Crating of items for transportation shall be designed and constructed to withstand the loads imposed during transportation.

NOTE: Goods received in damaged packaging or crating may be returned to the Contractor for re-manufacture and/or re-inspection and testing.

Crates shall be clearly marked in black stenciled lettering with the following information:

(a) Contract/order number.

(b) Consignee name and delivery address as given in the order or contract.

(c) Consignor name and contact point.

6.4 SPARE PARTS AND TOOLS

The manufacturer shall have available:

(a) a complete list of spare parts available for each pumpset.

(b) any special tools required for the dismantling, servicing and re-assembly of the pump unit.

6.5 DOCUMENTATION

The manufacturer shall prepare and make available installation, commissioning and maintenance manuals and technical data sheets in accordance with the relevant chapters of Appendix D.

APPENDIX A REFERENCED DOCUMENTS

(Normative)

ANSI

HI 11.6 Centrifugal Pump Tests

NOTE: Available from the Hydraulic Institute www.pumps.org

AS

1111.1 ISO metric hexagon bolts and screws - Product grade C - Bolts

1112.3 ISO metric hexagon nuts - Product grade C

1214 Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)

1237.1 Part 1: Plain washers for metric bolts, screws and nuts for general purposes - General plan

1237.2 Part 2: Plain washers for metric bolts, screws and nuts for general purposes - Tolerances

1359 Rotating electric machines—General requirements

1442 Carbon steels and carbon-manganese steels—Hot-rolled bars and semifinished products

1444 Wrought alloy steels—Standard, hardenability (H) series and hardened and tempered to designated mechanical properties

1565 Copper and copper alloys—Ingots and castings

1646 Elastomeric seals for waterworks purposes

1830 Iron castings—Grey cast iron

1939 Degrees of protection provided by enclosures for electrical equipment (IP Code)

2027 Iron castings—Abrasion-resistant white iron

2074 Steel castings

2317 Collared eyebolts

2321 Short-link chain for lifting purposes (non-calibrated)

2345 Dezincification resistance of copper alloys

2417 Rotodynamic Pumps—Hydraulic performance acceptance tests—Grades 1 and 2

2660 Hose and hose assemblies - Air/water - For underground coal mines

2741 Shackles

2768 Electrical insulating materials—Evaluation and classification based on thermal endurance

3709 Vibration and shock - Balance quality of rotating rigid bodies

4087 Metallic flanges for waterworks purposes

AS

60947.8 Low-voltage switchgear and controlgear - Control units for built-in thermal protection (PTC) for rotating electrical machines

AS/NZS

1111 ISO metric hexagon commercial bolts and screws

1112 ISO metric hexagonal nuts, including thin nuts, slotted nuts and castle nuts

3116 Approval and test specification—Electric cables—Elastomer insulated—For working voltages up to and including 0.6/1 kV

4158 Thermal-bonded polymeric coatings on valves and fittings for water industry purposes

4680 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles

ASTM

A276 Standard Specification for Stainless Steel Bars and Shapes

A380 Standard Practice for Cleaning, Descaling and Passivation of Stainless Steel Parts, Equipment and Systems

A480M General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip

D3187 Standard Test Methods for Rubber-Evaluation of NBR (Acrylonitrile-Butadiene Rubber)

F593 Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

F594 Standard Specification for Stainless Steel Nuts

F844 Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use

WSA

109 Flange Gaskets and O-Rings

APPENDIX B ALTERNATIVE MATERIAL REQUIREMENTS

(Normative)

Component	Material	Standard	Grade
Pump casing	Austenitic cast iron	AS 2027	Cr 27
Impeller	High chromium abrasion-resistant white iron	AS 2027	Cr 27
Impeller locknut			
Replaceable casing wear rings, if applicable	Chromium steel	AS 2074	H3A
Replaceable impeller sealing rings[1]	Steel	AS 1442 or AS 1444	Fully killed fine grained, normalised 0.30% max C 0.045% max P 0.050% max S
Shaft mechanical seal face (rotating and stationary) - motor side - Rotating face - Stationary face - medium side	Wear resistant material		Chromium alloy steel
Seals (O-rings and lip seals)	Synthetic elastomer	AS 1646.1 and AS 1646.2 or AS 1646.3	EPDM and NBR
Lifting brackets or lifting eye bolts	Hot-dip galvanised steel[2]	AS 2317, Section 4 and AS 1214	
Chains	Hot-dip galvanised steel[2]	AS 2321, Section 6 and AS/NZS 4680	L
Guide rails	Hot-dip galvanised steel[2]	AS 1442 and AS/NZS 4680	Fully killed fine grained, as-rolled or normalised 0.20% max C 0.045% max P 0.050% max S
Fasteners Bolts Nuts Washers	Hot-dip galvanised steel[2]	AS 1111.1 AS 1112.3 AS 1237.1 & AS 1237.2	Hot-dip galvanised to AS 1214

NOTES:

1 Used with shrouded impellers.

2 May only be used with approval of Asset Owner.

APPENDIX C DATA SHEET PERFORMANCE SCHEDULE

(Normative)

	Guarantee Point		Secondary Duty Point Nr 1		Secondary Duty Point Nr 2		Secondary Duty Point Nr 3		Maximum Achievable Rate of Flow	
	Required	Offered	Required	Offered	Required	Offered	Required	Offered	Required	Offered
Flow, L/s										
Head, m										
NPSHR, m										
Efficiency (Pump), %										
Power factor	≥0.80		≥0.80		≥0.80		≥0.80		≥0.80	
Efficiency (Motor), %	≥85		≥85		≥85		≥85		≥85	
kWh/1000 L										
Speed, rpm										

NOTE: *In Issue 2 Item and Clause numbering corrected throughout Data Sheet.*

Section 1 General		
1.1	Manufacturer's name	
1.2	Manufacturer's address	
1.3	Agent's name	
1.4	Agent's address	
1.5	Model number	
1.6	Years in production	

Section 2 Pump Hydraulic and Dynamic Design			
		Required	Offered
2.1	Motor shaft speed	Clauses 3.7.7.1(a)	
2.2	First critical speed	Clause 3.7.5(a)	
2.3	Maximum speed on flow reversal	Clause 3.4	
2.4	Suction eye area		
2.5	Impeller type	Clause 3.7.2	
2.6	Impeller free passage	Clause 3.7.1	
2.7	Impeller diameter		
2.7.1	Fitted		
2.7.2	Maximum		
2.7.3	Minimum		
2.8	Minimum submergence	Clause 4.3	

Section 3 Pump Mechanical Design			
		Required	Offered
3.1	Casing		
3.1.1	Design	Clause 3.7.3	
3.1.2	Volute type (single/double)		
3.1.3	Suction port diameter		
3.1.4	Discharge port diameter		
3.1.5	Discharge connection type	Clause 3.7.3	
3.1.6	Discharge connection resilient seal (for pedestal connections only)		
3.1.7	Material	Table 2.1	
3.2	Casing fasteners		
3.2.1	Bolts/studs material	Table 2.1	
3.2.2	Nuts material	Table 2.1	
3.2.3	Anti-galling compound Application method/material	Clause 3.7.8.4	

Section 3 Pump Mechanical Design			
		Required	Offered
3.3	Impeller		
3.3.1	Type		
3.3.2	Non-clogging performance	Clauses 3.7.1 and 3.7.2	
3.3.3	Material	Table 2.1	
3.3.4	Attachment method		
3.3.5	Retention method		
3.3.6	Locknut material	Table 2.1	
3.4	Impeller sealing ring		
3.4.1	Material	Table 2.1	
3.4.2	Surface hardness	Clause 3.7.4	
3.4.3	Fixing method/material		
3.5	Casing wear ring		
3.5.1	Material	Table 2.1	
3.5.2	Surface hardness	Clause 3.7.4	
3.5.3	Dissimilar material to sealing ring	Clause 3.7.4	
3.5.4	Fixing method/material		
3.6	Shaft		
3.6.1	Design	Clause 3.7.5	
3.6.2	Finish	Clause 3.7.5	
3.6.3	Maximum lateral deflection	Clause 3.7.5	
3.6.4	Material	Table 2.1	
3.6.5	Diameter at impeller		
3.6.6	Diameter in seal chamber		
3.6.7	Diameter maximum		
3.7	Shaft mechanical seal		
3.7.1	Type/Design	Clause 3.7.6	
3.7.2	Arrangement		
3.7.3	Manufacturer		
3.7.4	Model number		
3.7.5	Rotating face material	Table 2.1	
3.7.6	Stationary face material	Table 2.1	
3.7.7	Spring material (s)	Table 2.1	
3.7.8	Elastomer material	Table 2.1	
3.7.9	Estimated design life		
3.7.10	Leakage detection	Clause 3.7.6	
3.8	Seal chamber		
3.8.1	Material	Table 2.1	
3.8.2	Oil filling point incorporated?		
3.8.3	Drain point incorporated?		
3.8.4	Recommended oil		

Section 3 Pump Mechanical Design			
		Required	Offered
3.9	Leakage detection device	Clause 3.7.6	
3.9.1	Manufacturer		
3.9.2	Type		
3.9.3	Model		

Section 4 Motor Electrical Design			
		Required	Offered
4.1	Power supply	Clause 3.7.7.1(a)	
4.2	Insulation	Clause 3.7.7.5	
4.3	Protection	Clause 3.7.7.4	
4.3.1	PTC		
4.3.2	RTD		
4.3.3	Moisture protection		
4.4	Rating, kW		
4.5	Nr poles	Clause 3.7.7.1(a)	
4.6	Efficiency, %		
4.6.1	Full load		
4.6.2	¾ load	Clause 3.7.7.1(c)	
4.6.3	½ load		
4.7	Power factors		
4.7.1	Full load		
4.7.2	¾ load	Clause 3.7.7.1(b)	
4.7.3	½ load		
4.8	Locked rotor	Clause 3.7.7.1(h)	
4.8.1	Torque, Nm		
4.8.2	Current, A		
4.9	Full load		
4.9.1	Speed, rpm		
4.9.2	Torque, Nm		
4.9.3	Current, A		
4.10	Motor cables		
4.10.1	Type	Clause 3.7.7.6	
4.10.2	Additional cores	Clause 3.7.7.6	
4.10.3	Demountable flange	Clause 3.7.7.6	
4.10.4	Length	Clause 3.7.7.6	

Section 5 Motor Mechanical Design			
		Required	Offered
5.1	Temperature	≥Class 155	
5.2	Temperature rise at full load	Class C	
5.3	Rotor characteristics	AS 1359	

Section 5 Motor Mechanical Design			
		Required	Offered
5.4	Bearings	Clause 3.7.7.7	
5.4.1	Manufacturer		
5.4.2	Type		
5.4.3	Series number–DE		
5.4.4	Series number–NDE		
5.4.5	Rating fatigue life, L_{10}	40,000 h	
5.5	Motor housing	Clause 3.7.7.2	
5.5.1	Material	Table 2.1	
5.5.2	Coating	Clause 2.4	
5.5.3	Watertightness at 20 m head	Leaktight	
5.5.4	Cable entry glands	Clause 3.7.7.6	
5.5.5	Hangs vertically plumb	Clause 3.7.7.2(b)	
5.6	Motor cooling	Clause 3.7.7.3	
	Convectional air cooling		
	Jacketed housing		

Section 6 Ancillary Equipment			
		Required	Offered
6.1	Pump pedestal and discharge connection (if applicable)	Clause 3.8	
6.1.1	Design	Clause 3.8.3	
6.1.2	Dimensions	Clause 3.8.4	
6.1.3	Material	Table 2.1	
6.1.4	Coating	Clause 2.4	
6.1.5	Discharge flange rating	AS 4087 Figure B2	
6.2	Guide rails	Clause 3.9.1	
6.2.1	Type		
6.2.2	Material	Table 2.1	
6.2.3	Size		
6.2.4	Bracket spacing, m		
6.2.5	Bracket deflection, mm	Clause 3.9.1	
6.2.6	Bracket material	Table 2.1	
6.3	Lifting chains		
6.3.1	Type	Clause 3.9.2	
6.3.2	Rectangular links at 3 m intervals	Clause 3.9.2	
6.3.3	Shackle	Clause 3.9.2	
6.3.4	Material	Table 2.1	
6.3.5	WLL, kg	Clause 3.9.2	
6.3.6	Tagged	Clause 3.9.2	
6.3.7	Pumpset mass, kg		

Section 6 Ancillary Equipment			
		Required	Offered
6.4	Bolts, screws and dowels		
6.4.1	Type	Clause 3.9.3	
6.4.2	Flange bolting	Clause 3.9.3	
6.4.3	Material	Table 2.1	
6.4.4	Anti-galling compound Application method/material	Clause 3.9.3	
6.5	Seals	Clause 3.9.4	
6.5.1	Material	Table 2.1	
6.5.2	Seal reinforcement		
6.5.3	Seal hardness, IRHD		
6.6	Flange gaskets and O-rings	Clause 3.9.5	
6.6.1	Type		
6.6.2	Material	Table 2.1	
6.6.3	Hardness, IRHD		

Section 7 Other			
		Required	Offered
7.1	Spare parts list	Clause 6.4	
7.1.1	Where listed?		
7.2	Special tools	Clause 6.4	
7.2.1	List		
7.2.1	Availability		
7.3	Manuals and technical data sheets	Clause 6.5	
7.2.1	Documentation list		
7.2.1	Availability		

APPENDIX D DOCUMENTATION

(Informative)

D1 SCOPE

The manuals and technical data sheets shall fully describe all specified equipment and clearly show its mode of operation and, as a minimum, contain the following information:

(a) a concise description of each pump type and ancillary equipment, together with a complete performance specification (see Appendix C and production test results);

(b) a concise description of the mode of operation of each part or sub-system;

(c) procedures for installation and commissioning of each part or sub-system;

(d) procedures to be followed for testing, maintenance and fault finding. The fault finding table shall list faults indication, possible causes and remedies;

(e) special precautions to be taken in replacement and/or adjustment of each item;

(f) a comprehensive routine maintenance and testing program based on that recommended by the manufacturer;

(g) a spare parts list for all items plus component / assembly drawings of pumps and ancillary equipment;

(h) a list of supplier's names and addresses to enable any parts to be ordered correctly;

(i) copies of software manuals for each item of software installed, including licensed copies of operating software. PLC programming manuals shall be vendor's manuals;

(j) any software or hardware required to communicate with the PLC;

(k) two copies of the PLC program on disc;

(l) any other information or instructions necessary to fully operate and maintain the equipment in a complete and satisfactory manner; and

(m) a set of A3-size assembly drawings and a an electronic set on floppy disc or CD in the format required by the asset owner.

D2 FORMAT AND PRESENTATION

The format and presentation of manuals and data sheets shall be set out in accordance with the following:

Title sheet containing:

(i) Manufacturer/manufacturer’s agent;

(ii) Contract/order details, if applicable;

(iii) Names of suppliers of spare parts and ancillary equipment; and

(iv) Contact details for service calls.

Chapter

1 Description—a full description of the equipment with a tabulation of dimensions and performance rating

2 Technical Data Sheets—a completed copy of the applicable schedules of technical requirements of the contract and actual equipment test curves

3 Principles of Operation—a basic working description, including novel features and any automatic control

4 Operating Instruction—a step-by-step procedure organised into sections, entitled:

- 4.1 Checks before Starting
- 4.2 Starting
- 4.3 Continuous Operation
- 4.4 Stopping
- 4.5 Emergency Stopping
- 4.6 Abnormal Operation as applicable

5 Installation and Commissioning Instructions—details of standards and procedures for mounting or erecting, wiring and lubricating the equipment;

NOTE: The commissioning instructions shall include step-by-step procedures for checks to be carried out before the first start and checks to be made during the starting operational tests. They should be coordinated with Chapters: 3 and 8 and may refer to both.

6 Routine Maintenance—step-by-step procedures for preventative maintenance work carried out at intervals of two (2) weeks or less

7 Periodic Maintenance—step-by-step procedure for preventative maintenance work carried out at intervals in excess of 2 weeks, including replacement of consumables

8 Repair and Overhauling—step-by-step procedures for fault correction and for preventative maintenance, involving parts other than consumable. A list of any necessary special tools shall be included

9 Test Data and Troubleshooting—instructions to qualified trades persons for assessing the operational performance of the equipment

10 Spare Parts List—illustrations and schedules for identification and specification of all items of equipment. Exploded diagrams are preferred. The recommended spare parts stock must be indicated.

The information in Chapters 1 to 5 shall cover each item supplied, while the extent of information in Chapters 6 to 8 may vary with the complexity of the equipment.