Assets Planning and Delivery Group
Engineering

Strategic Product Specification

SPS 515
Axially-Split Casing Centrifugal Pumps

VERSION 2
REVISION 2
MAY 2022

FOREWORD

Each Strategic Product Specification has been prepared to inform Water Corporation staff, consultants, contractors and land developers of the requirements for selecting and acquiring a manufactured product to be used in strategic Corporation infrastructure. The definition of 'Product' includes items that comprise assembled components, equipment or plant for mechanical, electrical and civil infrastructure applications.

The objective of a Strategic Product Specification is to specify fit-for-purpose Product which will contribute to the provision of effective water services at least whole-of-life cost and with least risk to service standards and safety. A Strategic Product Specification also provides uniform standards for compatibility of new water infrastructure with existing water assets.

Many Strategic Product Specifications have drawn on the design, asset management and operational experience of Product performance in live service gained by the Corporation over time. Some Strategic Product Specifications have drawn on the experience of the water industry nationally by referencing Australian or WSAA standards.

Strategic Product Specifications are intended for reference and use in the following typical procurement scenarios:

- Capital funded infrastructure design and construction work;
- Private developer funded subdivision infrastructure for takeover by the Corporation;
- Operationally funded infrastructure design and construction work;
- Corporation period contracts for Product purchases;
- Product purchases for stock or for miscellaneous minor work.

A published Strategic Product Specification will, in some cases, comprise technical content that is typical of a range of products of the same type (type specification) but may exclude specific requirements that should apply to a particular project or application. In such cases, the project Designer is required to document the supplementary project specific requirements in the appropriate Clause of the 'Project Specific Requirements' Appendix of the Specification.

The text of a published Specification should not be directly modified. In the event that a text variation is considered necessary to accommodate the needs of a particular project or application, the text modification should be documented in the appropriate Clause of a 'Project Specific Requirements' Appendix.

Enquiries relating to the technical content of this Specification should be directed to the Senior Principal Engineer, Mechanical Section, Engineering Business Unit to whom all enquiries relating to the technical content of the Specification should be directed. Future Specification changes, if any, will be issued to registered Specification users as and when published.

Head of Engineering

This document is prepared without the assumption of a duty of care by the Water Corporation. The document is not intended to be nor should it be relied on as a substitute for professional engineering design expertise or any other professional advice.

It is the responsibility of the user to ensure they are using the current version of this document.

REVISION STATUS

The revision status of this specification is shown section by section below:

REVISION STATUS						
SECT.	**VER./ REV.**	**DATE**	**PAGES REVISED**	**REVISION DESCRIPTION (Section, Clause, Sub-Clause)**	**RVWD.**	**APRV.**
1	0/0	25.06.02	All	New Edition	EJP	AAK
1	0/1	30.07.02	6	AS2625.4 Description updated	EJP	AAK
1	1/0	Mar 08	All	Generally rewritten	SE	AAK
1	2/0	Jun 13	All	Various Additions	SE	MH
1	2/1	Aug 18	All	Guidance on bid evaluation added	GD	SE
All	**2/2**	**16.05.22**	**n/a**	**Periodic review, no changes required**	**SE**	**SE**
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2	0/1	30.07.02	8	Impeller drive key material specified	EJP	AAK
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2	2/0	Jun 13	All	Generally revised	SE	MH
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3	0/0	25.06.02	All	New Edition	EJP	AAK
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3	2/1	Aug 18	All	Generally revised Requirement to provide performance verification removed Guidelines to address readability in submitted tender curves added. Pump interchangeability requirements included. References to tilting pad bearings deleted. Guidance on the use of 'spacer' couplings added.	GD	SE
4	0/0	25.06.02	All	New Edition	EJP	AAK
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4	2/1	Aug 18	All	Generally revised Pump internal coatings to be applied in accordance with coating manufacturer's instructions as minimum Pump Baseplates to be HDG	GD	SE
5	0/0	25.06.02	All	New Edition	EJP	AAK

REVISION STATUS						
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14	2/0	Jun 13	All	New	SE	MH

Strategic Product Specification
SPS 515
Axially-Split Casing Centrifugal Pumps

CONTENTS

1 Scope and General

1.1 Scope

This Specification sets out requirements for the manufacture, testing, supply, handling and delivery of axially-split casing centrifugal pumps of the following types and configurations, and as further detailed in this Specification:

(a) Single stage or multi-stage (2 stage maximum);

(b) Single or double entry impeller;

(c) Single or double volute;

(d) Horizontal or vertical orientation.

The pumps will be used by the Corporation for the purpose stated in the *Purchasing Schedule*, which may be one or more of the following:

- in water supply systems for general pumping and pressure boosting of raw water or treated water;
- in sewage treatment plants for the pumping of effluent;
- in process plants (e.g. desalination) for the pumping of seawater or brine.

The Specification also details the means by which compliance with the Specification shall be demonstrated and the criteria for acceptance of Product.

1.2 Evaluation of Bids

Evaluation of bids received against this specification for a specific order shall be undertaken by the Designer in consideration of the following:

- Approved product status (ie. listed in the Strategic Product Register)
- Suitability of the product offered for specified duty requirements
- Overall compliance with standard and project specific requirements of this specification
- Quality and completeness of the bid received
- Whole of life cost to be evaluated using standard spreadsheet Aqua #19333383 available on request from The Corporation Design Manager.

1.3 Referenced Documents

The following documents are referenced in this Specification:

1.3.1 Australian Standards (AS)

The following Australian Standards are referenced by AS, AS/NZS, AS/NZS/ ISO or AS/ISO/IEC as relevant.

AS reference	Title	Equivalent Standard
1055.1	Acoustics – Description and measurement of environmental noise	
1081.1	Acoustics – Measurement of airborne noise emitted by rotating electrical machinery – Engineering method for free-field conditions over a reflective plane	
1081.2	Acoustics – Measurement of airborne noise emitted by rotating electrical machinery – Survey method	

1111.1	ISO metric hexagon bolts and screws – Product grade C - Bolts	ISO 4016:1999
1112.3	ISO metric hexagon nuts - Product grade C	ISO 4034:1999
1217.7	Acoustics – Determination of sound power levels of noise sources – Survey method Note: at the time of writing, AS 1217.7 has been withdrawn. ISO 1996-2:2007 may be applied as an alternative to AS 1217.7	
1269.2	Occupational noise management – Noise control management	
1275	Metric screw threads for fasteners	
1565	Copper and copper alloys – Ingots and castings	
1627.2	Metal-finishing – Preparation and pretreatment of surfaces – Power tool cleaning	ISO 8504-3:1993
1646	Elastomeric seals for waterworks purposes	
1830	Grey cast iron	ISO 185:2005
2074	Steel castings	
2317	Collared eyebolts	
2345	Dezincification resistance of copper alloys	
2382	Surface roughness comparison specimens	ISO 2632/3
2550.1	Cranes, hoists and winches – Safe use - General	
2550.3	Cranes, hoists and winches – Bridge, gantry and portal (including container cranes), jib and monorail cranes	
2550.5	Cranes, hoists and winches – Mobile	
2550.11	Cranes, hoists and winches – Vehicle loading cranes	
2700S	Colour standards for general purposes – Swatches	
2729	Rolling bearings – Dynamic load ratings and rating life	
4020	Testing of products for use in contact with drinking water	ISO 281:1990
4024.1	Safety of machinery	
4087	Metallic flanges for waterworks purposes	
4158	Thermal-bonded polymeric coatings on valves and fittings for water industry purposes	
4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles	
17025	General requirements for the competence of testing and calibration laboratories	
60529	Degrees of protection provided by enclosures (IP Code)	IEC 60529 ed.2.1:2001

1.3.2 International Standards Organisation (ISO)

1940/1	Mechanical vibration – Balance quality requirements for rotors in constant (rigid) state Part 1: Specification and verification of balance tolerances
10816-7	Mechanical vibration – Evaluation of machine vibration by measurements on non-rotating parts – Part 7: Rotodynamic pumps for industrial applications, including measurements on rotating shafts
9906- 2012	Rotodynamic pumps - Hydraulic performance acceptance tests - Grades 1, 2 and 3

1461	Hot Dip Galvanized Coatings on Fabricated Iron and Steel Articles

1.3.3 Europäische Norm (EN)

1092-1	Flanges and their Joints – Circular Flanges for pipes, valves, fittings and accessories, PN designated – Part 1: Steel flanges
1092-2	Flanges and their Joints – Circular Flanges for pipes, valves, fittings and accessories, PN designated – Part 2: Cast iron flanges
9906	Rotodynamic pumps – Hydraulic performance acceptance tests – Grades 1, 2 and 3
10088-3	Stainless Steels - Part 3: Technical Delivery Conditions For Semi-finished Products, Bars, Rods, Wire, Sections And Bright Products Of Corrosion Resisting Steels For General Purposes
60751	Industrial platinum resistance thermometer sensors

1.3.4 American Society for Testing and Materials (ASTM)

A380	Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment and Systems
A743	Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion-Resistant, for General Application

1.3.5 American National Standards Institute (ANSI)

ANSI/HI 14.6-2011	American National Standard for Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.

1.3.6 Corporation Specifications

A1	Surface Preparation for the Application of Protective Coatings on Steel or Cast Iron
F3	High Build Ceramic Filled Epoxy Coating on New and Existing Pumps
WS-1	Welding Specification Metal Arc Welding

1.3.7 SAA Guides

HB 18	Guidelines for third-party certification and accreditation
HB 18.2	Guide 2 - General terms and their definitions concerning standardization and related activities
HB 18.22	Guide 22 - Information on manufacturer's declaration of conformity with standards and other technical specifications
HB 18.23	Guide 23 - Methods of indicating conformity with standards for third-party certification systems
HB 18.28	Guide 28 - General rules for model third-party certification system for products
MP52	Manual of authorization procedures for plumbing and drainage products

1.4 Definitions and Notation

1.4.1 Abrasive Service

An application in which the water being pumped may intermittently contain abrasive particles in the form of sand, which has originated from the Cement Lining of Mild Steel Cement Lined (MSCL) pipework or other sources (e.g. groundwater bores). Applications with >1000m length of MSCL pipework installed upstream of the pump, or where abrasive particles may be present from any source, should generally be classified "*Abrasive Service*". The quantity of particles is likely to be in the order

of 0 to 10g per 1000lts, however this will depend on operating conditions, will vary over time, and will generally be difficult to accurately predict. Any available relevant data should be sought by the Designer and included in Table 11.2 of the *Purchasing Schedule.*

1.4.2 Allowable Operating Range (AOR)

The range of flow, nominated by the manufacturer and expressed as % BEP, within which the pump is designed to operate on an intermittent basis without reduction in reliability; and within which the relevant Vibration requirements in section 3.4.3 of this specification will be met.

1.4.3 Best Efficiency Point (BEP)

The flow rate at which the pumps exhibit a maximum efficiency (the gradient of the efficiency-flow curve is zero), for a particular impeller diameter and speed.

1.4.4 Corporation

The Water Corporation of Western Australia.

1.4.5 Corrosive Water

Water or effluent with significantly corrosive properties defined in table 2.1

1.4.6 Hydrostatic Test Pressure

The pressure to which the pump casing is required to be tested during production.

1.4.7 Highly Corrosive Water

Seawater or Brine with highly corrosive properties defined in table 2.1

1.4.8 Manufacturer

An entity, or combination of entities, that is responsible for selection, processing and control of Product constituent materials or compounds and for the processing equipment that collectively result in the manufactured product.

1.4.9 Maximum Allowable Working Pressure (MAWP)

The maximum working pressure, including surge, at which the pump is designed to operate.

1.4.10 Maximum Operating Pressure (MOP)

The maximum pressure to which the pump casing will be subject during its operating life. Generally determined as the *Maximum Suction Pressure*, plus the head generated by the (*ultimate duty* impeller and speed) pump under zero flow conditions.

1.4.11 Maximum Suction Pressure

The maximum pressure to which the suction of the pump will ever be subject, during its service life.

1.4.12 Nominal Size

An alphanumeric designation of size for components of a pipework system, which is used for reference purposes. It comprises the letters DN followed by a dimensionless whole number which is indirectly related to the physical size, in millimetres, of the bore or outside diameter of the end connections.

1.4.13 Notation

Statements expressed by use of the word ‘shall’ are mandatory or ‘normative’ requirements of the Specification. Statements expressed by use of the words ‘should’ or ‘may’ are ‘informative’ but not mandatory and are provided only for information and guidance. Notes in Specification text are informative. Notes that form part of Specification Tables are normative. An Appendix to the Specification that is designated ‘normative’ contains mandatory requirements. An Appendix that is designated ‘informative’ is provided for information and guidance only. The term ‘specified’ includes

requirements of the Specification and requirements stated or referenced in other project documentation.

1.4.14 NPSH

Definitions in relation to NPSH, NPSHA, NPSH3 and NPSH Datum Plane are as provided in ISO9906- 2012.
The definition of the term NPSHR has been expanded further by Clause 3.2.2 of this Specification to include a minimum value of NPSHR relative to NPSH3.

1.4.15 Officer

A duly authorised representative or appointed agent of the Corporation.

1.4.16 Preferred Operating Range (POR)

The range of flow, nominated by the manufacturer and expressed as % BEP, within which the pump is designed to operate on a continuous basis without reduction in reliability; and within which the relevant Vibration requirements in section 3.4.3 of this specification will be met.

1.4.17 Pressure Class (PN)

The *Pressure Class* refers to the pressure rating of the flanges integral to the pump casing only, which must be equal or greater than the *Maximum Allowable Working Pressure* to which the casing has been designed.

(The following definition is taken directly from AS 4087.)

A classification of pressure by PN number, based on the allowable operating pressure (AOP) expressed in Megapascals (PN = 10 x AOP).

1.4.18 Product

A single unit or multiple units of manufactured end product or an assembly of manufactured component products, materials or equipment. This Specification and accompanying *Purchasing Schedule* define the nature and details of Product to be supplied.

1.4.19 Product Appraisal

A formal process whereby Product, including product design, is subjected to systematic engineering assessment to determine Product fitness for prescribed end uses and to evaluate the extent of Product and production systems conformity with nominated standards and specifications. Product Appraisal includes verification of the extent of compliance in accordance with the requirements of a relevant 'Technical Compliance Schedule' Appendix.

1.4.20 Product Assessor

An organization, Officer or other person who, having demonstrated specialist product knowledge and competence acceptable to the Corporation, is nominated by the Corporation, subjects Product to Product Appraisal and issues one or more Product Verification Reports.

1.4.21 Product Warranty

A formal express undertaking by a Supplier or Manufacturer that Product is:

- In conformity with the nominated product specification and referenced standards;
- Fit for the nominated Product end use or application;
- Designed for sustained operation at the nominated service performance levels for the specified design life;
- Adequately packaged for intended transportation, handling and storage conditions;
- Supported by English language installation, operating and servicing instructions;

- Adequately supported by Supplier capacity to provide technical Product support.

NOTE: Where required, a Product Warranty should indemnify the Corporation against claims made or losses suffered as a result of breach of the Warranty by means of Public and Products Liability Insurances as specified in the undertaking.

1.4.22 Pump

The term pump (or pumps) referred to in this Specification shall mean an axially-split casing centrifugal pump (or pumps).

1.4.23 Pumpset

A pumpset generally comprises of one pump and one prime mover (typically an electric motor), mounted on a common baseplate, and includes a power transmission coupling between the pump and the prime mover, and other ancillary equipment mounted directly onto the pump, prime mover and baseplate.

In particular applications, two pumps mounted in series driven by a common prime mover (e.g. suction booster arrangement) or a single pump drive by two prime movers (e.g. diesel engine and electric motor) may be considered a single pumpset.

NOTE: The term 'driver', for the purposes of this specification, shall be synonymous with the term 'prime mover'.

1.4.24 Purchasing Schedule

A Corporation purchase order, tender, schedule of prices, bill of quantities, or specification that details the nature, quantity and other characteristics of Product to be supplied, purchased or installed.

NOTE: The *Purchasing Schedule* of this Specification in part will include Table 11.1 Schedule of Project Specific Requirements and Table 11.2 Water Properties.

1.4.25 Quality System

A management system that establishes, documents, implements and maintains organizational structures, resources, responsibilities, processes and procedures for the manufacture of Product and provision of Product related services in accordance with the requirements of AS/NZS ISO 9001.

1.4.26 Standard Water

Water or effluent with mildly corrosive properties defined in table 2.1

1.4.27 Standby Service

An application where the installed pump may not operate for extended periods (>4 weeks) but remains available for operation.

1.4.28 Strategic Product

An essential product whose performance is critical in eliminating risk to the safe and effective provision of water services, which are functions of the Corporation under the Water Corporation Act as licensed under the Water Services Coordination Act.

NOTES:

1. Strategic product is most commonly an element of permanent Corporation infrastructure. Ancillary operational and safety equipment, not intended to form part of this infrastructure, may be considered strategic by virtue of enhanced operational performance or personnel safety.
2. Plumbing products (end-of-line water service fittings DN 32 or smaller) used in strategic services may, by virtue of statutory and regulatory requirements, be considered strategic in Corporation applications.

1.4.29 Supplier

An entity or combination of entities that is responsible for the supply of Product.

NOTE: A Supplier may be a Product manufacturer, owner, producer, distributor or vendor or an agent, tenderer or contractor for supply of Product or Product related service.

1.4.30 Testing

The determination of Product characteristics by inspection and by the application of specified test procedures.

1.4.31 Ultimate (Duty, Impeller, Speed)

The maximum duty, impeller size and speed at which a pump will be required to operate in its service life.

1.4.32 WSAA

The Water Services Association of Australia of which the Water Corporation is a corporate member.

1.5 Designation of Size

This Specification generally covers pump discharge flange sizes to DN 900, pressure classes to PN 40 and flow capacities to 3,000 L/s.

2 Materials and Components

2.1 General

The materials and components used in the manufacture of the pumps shall be selected based on the properties of water being pumped. Those properties which are known and which relate to corrosion are provided in the *Water Properties* section of the *Purchasing Schedule.*

The following classification of waters shall apply for the purpose of specifying minimum corrosion resistance of materials:

Table 2.1 Classification of Water Corrosivity

Classification	Description	PH	Chlorides mg/L	Alkalinity mg/L	Free Chlorine mg/L	Average Temp. C
Standard waters:	Water or Effluent	6-9	<500	>20	>5	<25
Corrosive waters:	Water or Effluent	5-9	>500 <3000	<20	>2	-
Highly corrosive waters	Saline Water, Seawater or Brine	5-9	>3000	<20	>1	-

Note: The free chlorine levels decrease with higher chloride levels as these act synergistically to increase the corrosive properties of the water.

It is the responsibility of the Designer / Design Manager to gather all available water quality information from the corporation and complete table 11.2 of the *Purchasing Schedule*.

2.2 Contamination of Drinking Water

Materials for construction of components and coatings in contact with drinking water shall be certified, by an authorized certification laboratory, as complying with the requirements for such materials, to one or more of the following standards or authorities:

- Australia - AS/NZS 4020
- UK – BS 6920:2000 and the Water Regulations Advisory Scheme (WRAS)
- USA - ANSI/NSF 61 – Drinking Water System Components
- France - ACS (Attestation de conformité sanitaire).

2.3 Materials of Construction

Each pump shall be constructed from materials which have equal or superior mechanical, wear and corrosion resistance properties to the materials detailed in Table 2.2 below. The materials selected shall be suitable for the *Water Properties* stated in Table 11.2 of Appendix A. The stated material properties represent the **basic or minimum** requirements, and materials of equivalent or superior quality may be acceptable. The manufacturer shall provide documentary evidence of material properties (e.g. PREN, hardness) to clearly demonstrate compliance with relevant requirements.

Table 2.2 - Materials of Construction

Pump Component	Standard Waters	Corrosive Waters	Highly Corrosive Waters[1]
Casing:	Grey iron to AS 1830, grade ISO 185/JL/250	Stainless steel / Duplex stainless steel PREN =>24	Super duplex stainless steel PREN =>40
Impeller:	Stainless steel / Duplex stainless steel PREN =>24	Duplex stainless steel PREN =>35	Super duplex stainless steel PREN =>40
Shaft (Dry Shaft Design)	Stainless steel PREN =>13	Stainless steel PREN =>24	Super duplex stainless steel PREN =>40
Shaft (Wet Shaft Design):	Stainless steel / Duplex stainless steel PREN =>24	Duplex stainless steel PREN =>30	Super duplex stainless steel PREN =>40
Shaft Sleeves:	Stainless steel / Duplex stainless steel PREN =>24	Duplex stainless steel PREN =>30	Super duplex stainless steel PREN =>40
Shaft keys:	Stainless steel to EN 10088-3 grade 1.4057	Duplex stainless steel to EN 10088-3 grade 1.4462	Manufacturer select
Impeller wear ring (Refer Cl 2.4 and Cl 3.3.3):	Manufacturer Select[1]	Manufacturer Select[1]	Manufacturer select[1]
Casing wear ring Refer Note (2) and clause 2.4:	Manufacturer select[2]	Manufacturer select[2]	Manufacturer select[2]
Bearing Housings, Seal Housings:	Grey iron to AS 1830, grade ISO 185/JL/250	Stainless steel PREN => 24	Super duplex stainless steel PREN =>40
Mechanical Seal:			
Seal Plate	Stainless steel / duplex stainless steel PREN =>24	Stainless steel / duplex stainless steel PREN =>24	Super duplex stainless steel PREN =>40
Spring(s)	Hastelloy C	Hastelloy C	Hastelloy C
Rotating face(s)	Solid carbon	Solid carbon	Solid carbon
Stationary face(s)	Silicon carbide	Silicon carbide	Silicon carbide
Studs, pins, bolts, nuts – internal	Stainless steel PREN =>24	Stainless steel PREN =>24	Stainless Steel PREN =>40

Pump Component	Standard Waters	Corrosive Waters	Highly Corrosive Waters(1)
Studs, pins, bolts, nuts – external	Manufacturer Select	Manufacturer Select	Super-duplex Stainless steel PREN =>40
Plugs (drain, vent)	Stainless Steel PREN =>24	Stainless Steel PREN =>24	Super-duplex Stainless steel PREN =>40
Seal flushing and drain piping	Stainless Steel PREN =>24	Stainless Steel PREN =>24	Super-duplex Stainless steel PREN =>40
Cyclone separator	Stainless Steel PREN =>24	Stainless Steel PREN =>24	Stainless steel to ASTM A 743 grade CF 8M
O-Ring seals	Synthetic Elastomer – EPDM or NBR	Synthetic Elastomer – EPDM or NBR	Synthetic Elastomer – EPDM or NBR

Notes: (1) Wetted components for Highly Corrosive Waters may require additional specification (e.g. surface finish, heat treatment processes) over and above material PREN. These should be researched, agreed and specified in the Parent Document.

(2) Where impeller wear rings are required (refer Cl. 3.3.3) - materials shall have equal or superior corrosion and abrasion resistance to that of the impeller, and shall be non-galling with the casing wear ring.

(3) Casing wear ring materials shall be of equal or superior corrosion resistance to, and be non-galling with, the impeller wear ring. The material shall also have a high degree of abrasion resistance and be electrochemically compatible with both the casing and impeller wear ring. Refer also Cl. 2.4.

(4) The Manufacturer is encouraged to offer non-metallic wear ring materials (eg. Engineering plastic, ceramic etc.) where they offer a wear or efficiency benefit and the Manufacturer is able to demonstrate previous superior performance of those materials.

(5) Whilst the Manufacturer may offer materials for 'Standard Waters' with a minimum standard as indicated above, in many circumstances a higher standard (eg. CF8M, Duplex SS etc.). casing may be beneficial in reducing maintenance and hence offer a lower whole of life cost. On this basis the Manufacturer is encouraged to make an alternate offer based on superior casing material.

2.4 Abrasive Service – Wear Ring and Bush Materials

Where *Abrasive Service* is specified in the *Purchasing Schedule*, materials for wear rings and bushes shall be selected by the manufacturer for *Abrasive Service* conditions. Material selection and design shall ensure:

- The tolerance of these parts to the presence of sand during start-up, run-down and normal operation - without seizure of the rotating element
- A high level of abrasion resistance and long service life
- Corrosion resistance appropriate to the specified *Water Properties*.

2.5 Material Certification

Material certificates shall be provided for the pump Casing, Impeller, Shaft, Wear Rings and Sleeves to the requirements of EN 10204 and the following:

- Production Pumps (< 500 kW motor size) - Certificate Type 2-2 (batch)
- Engineered Pumps (=>500 kW motor size) - Certificate Type 3.1 (specific item)

2.6 Stainless Steel

2.6.1 Welding, Heat Treatment and Passivation

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

2.6.2 Graphite Compounds

Graphite greases, graphite packing and graphite compounds shall not be used in contact with stainless steel. Protective or decorative coatings shall not be applied to stainless steel when exposed to moist or corrosive environments.

2.6.3 Galling

Components and fasteners that may be susceptible to galling shall embody mitigating features such as:

Selection of stainless steel grades with at least 50 HB hardness difference e.g. grade 431 stainless steel bolts (285 HB) fitted with grade 316 stainless steel nuts (217 HB);

Use of nickel food grade anti-seize lubricant (grease) when fitting stainless steel fasteners;

Provision of surfaces that do not promote galling e.g. rolled threaded stainless steel fasteners in lieu of machined threads;

Selection of close tolerance bolts and nuts;

Eliminating contaminants (grit) during fitting and operation of susceptible components;

Adopting material design loads which are below those that would produce galling.

2.7 Dezincification-resistant Materials

Copper alloy materials shall be dezincification-resistant and shall comply with AS 2345.

2.8 Non-metallic Materials

Non-metallic materials used in the components of the Product shall be fit for the intended purpose and shall exhibit dimensional stability when exposed to weather, sunlight and where relevant after extended periods of immersion.

2.9 Immersed Components

All continuously immersed components shall be manufactured from corrosion-resistant materials except for cast iron pump casings and seal housings, which shall be coated in accordance with the Coating section of this Specification. Materials for components in contact with each other shall be selected so as to minimise galvanic corrosion.

2.10 Elastomeric Materials

Elastomeric materials shall be made of material that is not adversely affected by the fluid, temperature or environmental conditions to which the material will be subjected in service.

3 Design and Manufacture

3.1 General

The pump shall be of the single or two-stage centrifugal type and configured for either horizontal or vertical orientation as stated in the *Purchasing Schedule*.

The pump casing shall be axially-split along the shaft centre-line to allow removal of the casing cover and the rotating element complete with bearings and mechanical seals without breaking the suction and discharge pipework connections;, and without the need to disturb the driver.

Similarly, preference is for the pump design to allow removal of bearing housings with the pump in-situ and without splitting the casing halves, to facilitate renewal of bearings and mechanical seals. The design criteria of the pumps shall be based on a minimum life expectancy of 25 years.

3.2 Performance

3.2.1 Pump Selection

Pumps shall meet the duty requirements and where applicable, maximum and minimum system curves required operating envelope, contained in the *Purchasing Schedule*.

In general pumps shall be selected so that:

- the Primary Guarantee Duty Point is at, or close to, the Best Efficiency Capacity of the pumps;
- any Secondary Duty Points are met with the same impeller diameter as the Primary Guarantee Point.
- no continuous operating duty point lies outside the *Preferred Operating Range* for the operating speed.
- no intermittent operating duty point lies outside the *Allowable Operating Range* for the operating speed.

3.2.2 NPSH

NPSHA is stated in the *Purchasing Schedule*.

Pumps shall be selected to have an NPSHR equal to or less than the system NPSHA under all steady state operating conditions. NPSHR shall include appropriate margin (S) over NPSH3 as required to ensure the long term satisfactory operation of the pump and longevity of the impeller.

The **NPSH margin (S)** shall be the greater of the values determined as follows:

1. One (1) metre head for operation within *POR*, 1.5m for frequent operation outside *POR*
2. As recommended by the Manufacturer in Appendix D.
3. The difference between NPSH3 and the product of NPSH3 at BEC and the corresponding NPSH Margin Factor required in Fig 3-1.

$$S = \text{NPSH3 at } Q_{BEP} \times (\text{Margin Factor} - 1)$$

Notes applying to NPSH margin (S) determination:

1. The margin determined above is applicable for standard service waters and the specified impeller materials. For seawater applications, multiply the margin factor by 1.15.
2. Figure 3-1 requires a higher NPSH Margin Factor and therefore higher NPSHR for pumps operating frequently outside of the *Preferred Operating Range*.
3. For flow rates less than BEP, the minimum NPSHR shall be that calculated for BEP. For flow rates greater than BEP, the minimum NPSHR shall be the NPSH3 for that flow, plus the NPSH margin (S) (refer fig 3-2).

Fig 3-1 **NPSH Margin Factor**

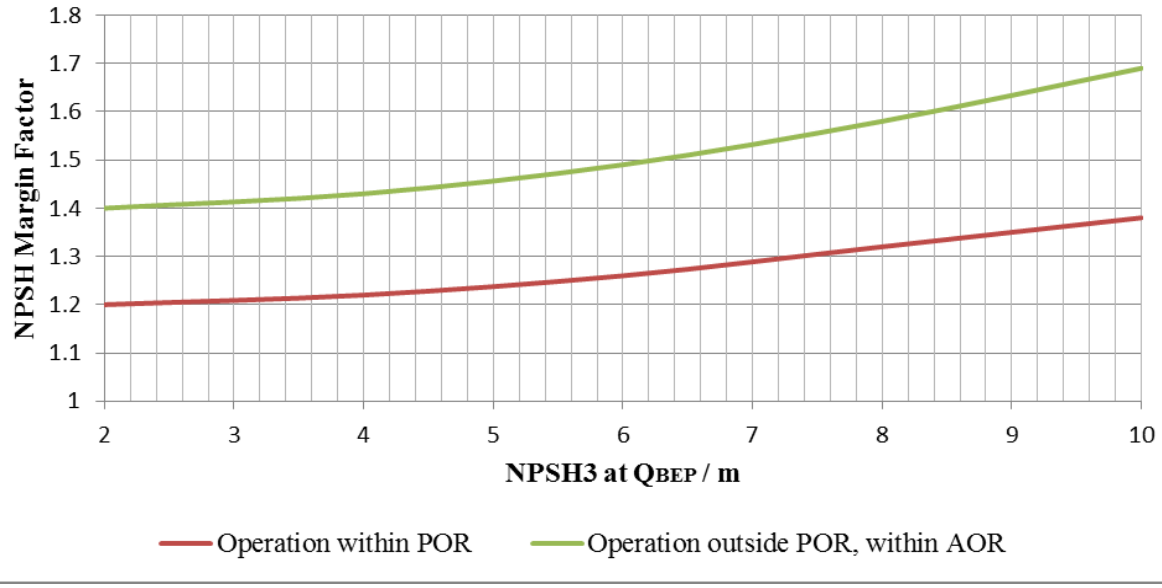
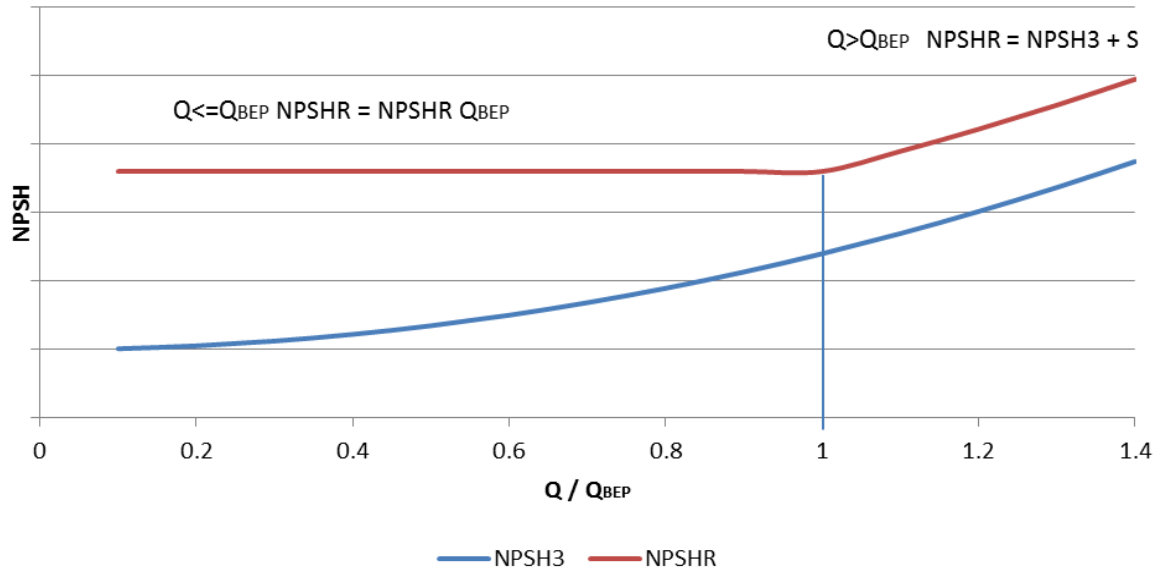


Fig 3-2 **NPSHR vs Flow**



3.2.3 Performance Curves

As part of the selection process the Manufacturer shall provide the following pump performance curves and related information:

- Head-flow, efficiency and absorbed power curves for the pumps fitted with the impeller diameter and speed to meet the Primary Guarantee Point and any the Secondary Point(s). Pump head-flow characteristic curve or curves shall be superimposed onto the minimum and maximum system resistance curves or operating envelope.
- Head-flow, efficiency and absorbed power curves for the maximum diameter impeller able to be fitted to the pump.
- NPSH3 & NPSHR curves for the duty and maximum diameter impellers.

NOTES:

1. The flow axis shall be in L/s with major divisions of 5, 10, 20, 50 or 100 and minor divisions of 1, 2, 5, 10 or 20
2. The head axis shall be in metres of water with major divisions of 10, 20 or 50 and minor division of 1, 2, 5 or 10
3. The efficiency axis shall be in percentage or decimal points, the major divisions shall be 10% or 0.1 with minor divisions either 1, 2 or 5 (or decimal equivalent as appropriate).
4. Alternate divisions and divisions for other axes (Power, NPSH etc.) shall be displayed with regular intervals which are readily interpolated by eye to determine an approximate value at any given flow within the displayed range.

3.2.4 Driver Selection

Drivers for axially-split casing pumps utilized by the Corporation are almost exclusively electric induction motors, either wound rotor or squirrel cage design which are normally supplied separately. Detailed motor specifications do not form part of this specification.

The driver selection is normally conducted by others in accordance with the Corporation's design standards and relevant electrical type specifications issued separately to this Specification. Where the scope of supply is for the complete pumpset, the motor specification will be included as part of the bid package.

3.2.5 Direction of Rotation and Flow

The direction of rotation of the pump shaft (when viewed from the driver), and driver location in relation to the pump (when viewed in the direction of flow towards the suction flange), shall be specified in the *Purchasing Schedule*. The options to be specified (for horizontal installations) are:

- Anticlockwise – Driver on right side
- Clockwise – Driver on left side

3.3 Pump Design

3.3.1 Maximum Allowable Working Pressure and Hydrostatic Test Pressure

Pumps shall be designed, manufactured, and provided with 'name plate' details to indicate, the *Maximum Allowable Working Pressure* (MAWP) and the *Hydrostatic Test Pressure*.

The M*aximum Suction Pressure* of the application under start-up conditions shall be stated in the *Purchasing Schedule*. The manufacturer shall determine the *Maximum Operating Pressure* (MOP) as the sum of *Maximum Suction Pressure* plus the zero flow ('shut-off') head of the pump with *ultimate duty* impeller and speed. The pump shall be selected so that the MAWP is greater than the MOP.

Pump Flanges shall be selected from the next available Pressure Class and shall be capable of sealing against mating flanges which are designed to either AS4087 or EN 1092.

The pump casing, including suction branch and all flanges, shall also be designed and manufactured to withstand the *Hydrostatic Test Pressure*, when tested in accordance with Clause 5.5.1. The Hydrostatic Test Pressure shall be the greater of: 1.3 times MAWP or 1.5 times MOP.

Hydrostatic Test Pressure	=>	1.3 x MAWP	OR
	=>	1.5 x MOP	(whichever produces highest value)

3.3.2 Casing

Casings shall be designed and manufactured to provide hydraulically smooth volute flow passage(s).

Casings shall be designed to withstand static and dynamic forces transmitted from the installed suction and discharge pipework. The Manufacturer shall provide details of reaction forces and moments (nozzle loads) that the casing is designed to carry at the suction and discharge flange connections.
Casings should be designed to balance radial thrusts. In particular, single stage pumps shall generally be of the double-volute casing style with a 180^0 wrap angle.

Single-stage, single volute pumps are not preferred but may be considered for acceptance provided that:

- All continuous and intermittent duty flows are within the *Preferred Operating Range*.
- The duty head is less than 70m
- The discharge flange size is not greater than 200mm

Casings for two-stage pumps shall be of the multiple volute type (ring casing type pumps are not covered by this Specification).

Casings shall incorporate mating registration tongues and grooves at the seal housing or shall have as a minimum two dowel pins for accurate location of casing halves. The overall design of register fits and bearing housings shall be such that the rotating element is self-aligning during assembly.

Casings shall each incorporate a footplate for horizontal orientation or pump support stool for vertical orientation. The footplate or pump support stool shall incorporate holding down bolt holes.

Casing suction and discharge ports shall be flanged in accordance with either AS 4087, EN 1092-1 or EN 1092-2, The Corporation may nominate a preferred standard in the *Purchasing Schedule*. The flange standard, class and the casing Maximum Allowable Working Pressure, shall be indicated by the manufacturer during tender.

Each pump casing shall be provided with the following tapping points:

Pressure: One 15mm nominal BSP tapping point for pressure gauge connection, located on or adjacent to both the suction and discharge flanges on the horizontal centre line, fitted with stainless steel barrel nipples and ball valves.

Drains:	20mm nominal BSP tapping points, located on the casing suction and delivery low points, fitted with a stainless steel plugs.
Vent:	A 20mm nominal BSP tapping point on the casing high points(s), fitted with a stainless steel nipple(s) and valve(s).
Seal Leakage:	20mm nominal BSP tapping points for bearing housing seal-leakage drains.
Seal Flushing:	10mm nominal BSP tapping points for seal flushing water. Stainless steel pipe shall be used for seal flushing. Refer Clause 3.3.9 for seal flushing requirements.

Tapping point sizes are indicative and may be varied to manufacturer's standards. NPT threaded connections may be proposed and where accepted, shall be indicated on General Arrangement drawings.

Bosses shall be provided for all tapping points in the pump casing.

Casings shall be fitted with studs, bolts or cap screws for securing the casing cover and bearing housings. Removable casing halves shall be fitted with forcing screws to facilitate dismantling. Eyebolts, cast holes, or lugs shall be provided, rated for lifting of the complete pump. Eyebolts shall comply with AS 2317.

3.3.2.1 Casing Dimensional Tolerances

All pumps of the same make / model ordered in one lot or where pumps are being ordered as a spare or like for like replacement for existing units, then such units shall be dimensionally interchangeable. The following dimensions, shall be within the tolerances specified below:

- Flange-face to flange-face
- Flange-face to shaft-centerline
- Flange centerline height
- Shaft centerline height
- Footplate bolt-hole locations relative to each of the above.

The specified tolerance for grey iron casings shall be in accordance with ISO 8062-3 tolerance grades DCTG-13, GCTG-5 and RMAG-F.
The specified tolerance grade for stainless steel casings shall be in accordance with tolerance grades DCTG-13, GCTG-6 and RMAG-G.
The overall pump-set design shall ensure that pumps can be interchanged without the requirement for modification of pipework, baseplates or accessories.

Notes: Where pumps are being purchased as a spare or 'like-for-like' replacement of existing units, then this shall be indicated and existing pump serial numbers provided in the purchasing schedule.

3.3.3 Impeller(s)

The impeller(s) shall be:

- Precision cast, accurately machined, with the waterways dressed to a smooth finish.
- Secured to the shaft in a manner that prevents circumferential and axial movement throughout the operating life.
- Dynamically balanced.
- Fitted with replaceable wear rings, mechanically secured to the impeller

3.3.4 Shaft

The shaft shall be:

- Of ample size and stiffness to transmit the full driven output without wear ring contact.
- Of the 'dry' design, with O-ring seals between all wetted sleeves and impeller, and with all locating threads positioned outside of the wetted area - OR
- Of the 'wet' design, manufactured from a more corrosion resistant material (refer Table 2.1).
- Manufactured in one piece, machined throughout its entire length with a high degree of finish at the bearing surfaces.

3.3.5 Shaft Sleeves

Shaft sleeves shall be provided where wear of the shaft would otherwise occur and where required for impeller location.

Where provided, shaft sleeves shall be renewable in the event of damage and for 'dry-shaft' designs, form a continuous water-tight sleeve extending beyond the seal housing.

3.3.6 Rotating Assembly Dynamics

The first lateral critical speed of the rotating assembly shall be calculated for the maximum diameter impeller without consideration of any support from the casing or impeller wear rings. The first lateral critical speed shall be greater than 120% of the maximum pump speed.

The total dynamic shaft deflection, at ultimate duty speed with the ultimate duty impeller shall be such that contact between the impeller wear-ring and casing wear-ring does not occur between zero flow and the upper flow limit of the *Allowable Operating Range*.

3.3.7 Wear Rings and Bushes

Pumps shall incorporate replaceable casing and impeller wear rings, neck bushes, diaphragm bushes and inter-stage bushes as appropriate for the pump type. Casing wear-rings, diaphragm bushes and inter-stage bushes shall incorporate mating registration tongues or grooves and anti-rotation pins.

The manufacturer shall indicate the radial clearance (with manufacturing tolerances) of the wear-rings in the tender response.

3.3.8 Bearings, Housings and Temperature / Vibration Monitoring

3.3.8.1 General

Pumps mounted in the shaft horizontal orientation shall be provided with rolling element outboard bearings.

Pumps mounted in the shaft vertical orientation shall be provided with an upper combined axial thrust / radial outboard bearing and lower radial bearing. Lower radial bearings of the hydrodynamic (bush) type shall incorporate a flush from the pump discharge / volute via a cyclone separator or from an external supply, a rolling element bearing for the lower bearing is not preferred.

Two-stage pumps may incorporate inter-stage hydrodynamic (bush) bearings. Inter-stage bushes shall be manufactured from materials which are non-galling and suitable for the water quality, including abrasive service where applicable.

3.3.8.2 Rolling Element Bearings – General

Rolling element (ball or roller type) bearings shall be designed to accommodate maximum axial and radial loads over the full operating curve; and selected for a minimum L10 design life of 100,000 hours calculated according to ISO 281:2007 when run anywhere within the *Allowable Operating Range*. Bearing life calculations shall assume worst case axial load due to manufacturing asymmetry.

Ball bearing retainers shall be of one piece steel construction. Bearings shall conform to ISO standard metric dimensions.

Rolling element bearings shall be grease lubricated and shall be supplied packed with the quantity and grade of grease recommended by the bearing manufacturer (oil lubricated rolling element bearings are not contemplated by this Specification, but may be considered for acceptance by the Corporation for particular applications).

3.3.8.3 Rolling Element Bearings – Provision for Temperature Monitoring

Rolling Element Bearings shall be provided with Resistance Temperature Detectors, (RTDs) to enable monitoring of bearing temperatures. The resistance thermometer elements shall:

- Be three wire platinum element types with 6 mm OD stainless steel sheath and Grade B accuracy in accordance with BSEN 60751;
- Have a resistance of 100 ohms (i.e. require a PT 100 RTD);
- Be wired, via electrical conduits, to a terminal box fixed to the baseplate.

3.3.8.4 Rolling Element Bearing – Provision for Vibration Monitoring

Pumps with a driver rated => 250kW shall have a non-directional vibration sensing transducer supplied and fitted to each Rolling Element Bearing housing. Vibration transducers shall be:

- Suitable for continuous monitoring according to ISO 10816
- Incorporate a robust IP68 stainless steel housing with an M12 threaded connection
- 24V 2 wire loop powered 4-20 mA, with a measurement range of at least 0-10 mm/s (rms), but not exceeding 0-25mm/s (rms)
- Provided with a connector and wiring routed via electrical conduits to a terminal box (common with vibration cable termination) fixed to the baseplate.

3.3.8.5 Outboard Bearing Housings

Bearing housings for pumps shall be flanged for bolt connection to both the upper and lower casing halves. The housings shall either be dowelled or located by co-axial groove or register fit, to facilitate easy removal and accurate alignment during re-assembly.

Bearings shall be protected from water ingress from mechanical seal leakage by a seal locking ring acting as a water thrower or in its absence a purpose designed water thrower.

Bearing housings for rolling element bearing shall be fitted with grease nipples in accessible locations or where specified in the *Purchasing Schedule* with single point automatic gas lubricators. Provision shall be made to release excess grease from bearing housings to prevent over-greasing (i.e. pressure relief valve). Lubricant retaining and dust excluding seals shall be provided on all bearing housings. Sealed for life bearings may be offered as an alternative for consideration by the Corporation.

3.3.8.6 Hydrodynamic (Journal/ Bush) Bearings

Bush type bearings shall be utilized as the lower bearing in single or multi-stage pumps in shaft vertical orientation, and may be utilized as inter-stage bearings for multi-stage pumps.

Bush bearings may be of the fluted or parallel bore type. Lubrication shall be provided by either the pumped water (if clean water) via external pipework from the volute periphery, or from an external water supply. Cyclone separators shall be provided for applications using pumped water.

Bush bearing materials may be bronze or synthetic. Synthetic materials shall have non-expanding properties and shall be designed to have 100,000 hour service life.

3.3.9 Mechanical Seals

Pumps shall be fitted with balanced cartridge mechanical seals, unless otherwise specified in the *Purchasing Schedule*.

Mechanical seals shall be retained by a flange with provision for the flushing water connection in accordance with API Plan 11 for potable water applications or via Cyclone Separators (API Plan 31) for *Abrasive Service* applications.

Seal flushing and drain pipework shall be supplied by the Manufacturer and shall include isolating and throttling valves.

3.3.10 Fasteners, Dowels and Casing Half Sealing

The pump shall be supplied with all fasteners, washers and gaskets. Fastener threads shall comply with AS 1275 and bolts and studs shall be sized so that excessive threads do not protrude past the nut after assembly. Bolts and nuts shall comply with AS 1111.1 (ISO 4016) and AS 1112.3 (ISO 4034) or AS1110.1 (ISO 4014) and AS1112.1 (ISO 4032).

Stainless steel fasteners shall either be designed to prevent galling or treated with anti-galling compounds prior to assembly.

Dowels shall be provided between components requiring accurate location during assembly.

Casing half assembly may be sealed with compressed fibre or fluid type gasket; relevant product technical information shall be provided.

3.4 Manufacture

3.4.1 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, nut and washer. Mating machined and balanced assemblies shall be match-marked.

3.4.2 Balance of Rotating Elements

Balancing shall be in accordance with ISO 1940/1, relevant certificates shall be supplied.

Rotating elements shall be statically and dynamically balanced as a complete assembly to achieve the minimum balance quality grade ‘G’ appropriate for the pump maximum rotational speed (n) as follows:-

n <=	1000 rpm	Grade G6.3
n >	1000 rpm	Grade G2.5

The manufacturer may select a more stringent grade - where required to satisfy the vibration limits specified below.

3.4.3 Vibration

Vibration limits of pumps shall comply with ISO 10816-7:2009 and the following paragraphs - prior to factory release. The maximum vibration velocity limit for new pumps (Zone A) shall not exceed the values shown in Table A1 for category II pumps.

Vibration values determined during factory testing shall not exceed the values in the rows for the “Factory acceptance test - Allowable operating range” and “Factory acceptance test - Preferred operating range” when operating at any flow rate within the respective operating range - up to the maximum required duty flow.

Vibration values for all acceptance tests in the P*referred Operating Range,* when filtered for rotational and vane-pass frequencies, shall be < = 3mm/s (r.m.s.) in accordance with Table A1.

3.4.4 Castings

Casting structure shall be homogeneous with uniform grain, and free from blowholes, porosity, shrinkage, cracks and other defects detrimental to the casting integrity. Castings shall be properly cleaned and fettled with all lumps, fins and rough areas smoothed. No repairs shall be permitted on structural defects however minor defects in steel castings may be repaired providing approval is obtained from *the Officer* in accordance with Section 10.3.2.

3.5 Ancillary Equipment

3.5.1 Flexible Coupling

Pumps shall be coupled to their driver or drive-shaft via a dynamically balanced flexible coupling.

Flexible couplings shall comprise two separate halves, the driven half mounted onto the pump shaft with parallel bore and parallel key. The parallel key shall be stepped down to the diameter of the pump shaft where it extends beyond the coupling.

If the supply of the driver or drive shaft is required under the *Purchasing Schedule*, the coupling driven half shall be mounted onto the driver/ drive shaft by means of a parallel key.

Where the motor is not available, the Manufacturer shall supply the coupling driven half loose for each pump set. The coupling driven halves shall be parallel bored with keyway, to the dimensions and tolerances provided by *the Officer*, and supplied to *the Officer* to be passed on to the motor contractor.

Each flexible coupling shall:

- Utilize an elastomeric flexible element(s) to transmit the torque from the driver to the pump, a pin and bush type coupling is generally preferred.
- Be capable of transmitting 150% of the full starting torque of the driver and a minimum of 200% of the maximum absorbed power of the pump.
- Incorporate facility for hydraulic removal for bore sizes 95mm and greater.

Where specified in the *Purchasing Schedule*, couplings shall be of the 'spacer' type. 'Spacer' type couplings shall incorporate means to restrain the spacer in the event of failure of the flexible element and provide electrical isolation between the driver and driven shafts.

'Spacer' couplings should be considered for all pumps where there will be a clear maintenance benefit. Typically this would be in providing greater space for maneuvering the pump / motor on or off the baseplate during maintenance. It is not generally the practice for the Corporation, but it may also facilitate in-situ replacement of drive end bearing and seal. The decision to include 'spacer' couplings should also consider the impact on pump building footprint (ie. normally a spacer coupling will increase the overall length of a pump set and therefore increase the building footprint).

3.5.2 Baseplate and Coupling Guard

Each pump shall be mounted on a baseplate fabricated from cold-rolled steel sections.

Pumps mounted in the horizontal shaft orientation that are direct coupled to their respective driver, shall have a common baseplate with the driver.

Pumps mounted in the vertical shaft orientation shall have a baseplate (support stool) which is independent to the driver and easily separable from the pump for maintenance purposes. The driver support frame shall meet the same general specifications as for the pump baseplate. (In the case of small electric motor driver, the motor may be supported by the pump via a motor adaptor to the same general specifications as for the pump casing).

Baseplates shall:

- Be designed for concrete/grout filling of all sections to provide structural stability and prevent the pooling of water. Where concrete filling of a section is not practicable, the baseplate section shall be self-draining (e.g. incorporate bevels at joint areas) to prevent pooling.

- Be fully seal welded to prevent moisture ingress into joints in accordance with Water Corporation Technical Specification WS-1.
- Prepared and coated to the requirements of Section 4.
- Incorporate individual mounting pads for the pump and driver mounting feet. Mounting pads shall be accurately machined to ensure a precise horizontal plane, and to levels that allow shims to be used on the driver feet for accurately achieving shaft alignment.
- For horizontal shaft orientation pumps, incorporate jacking screws to assist in aligning the driver both laterally and longitudinally for alignment with the pump.
- Incorporate foundation mounting pads to allow jacking and alignment of the baseplate during installation, and facility to allow mortar grouting under the mounting pads.
- Allow for sufficient movement of the pump, prior to alignment, to compensate for suction pipe shrinkage during final pipework weld connections.

A guard shall be fitted to each pumpset to protect personnel from exposed rotating shafts and the flexible coupling. The guard shall be:

- Of robust steel construction.
- Removable to facilitate servicing of the flexible coupling.
- Fabricated from cold-rolled steel plate, heavy hot-dip galvanized after fabrication and trial fitting.

A fabrication drawing of the baseplate and a General Arrangement drawing of baseplate, motor, pump and accessories, shall be provided to *the Officer* for review within 30 days of contract award.

4 Protective Coatings

4.1 General

The external and internal surfaces of pumps and appurtenant fittings shall be prepared and coated in accordance with the relevant clauses below. Prior to coating all sharp edges, burrs, slag and other sharp surface irregularities shall be removed. Surfaces to be coated, which will become inaccessible after assembly or erection, shall be cleaned and coated before becoming inaccessible.

4.2 Pump Internal Coating

All accessible internal surfaces of cast iron pumps shall be coated using a minimum of two coats of a material compatible, two component, high performance ceramic filled epoxy coating system, fully compliant with Clause 2.2 and specifically designed for the following:-

- Permanent immersion in water with the properties specified in Appendix A
- Providing a high degree of corrosion and erosion protection in extreme fluid flow conditions
- Improving the efficiency of Fluid Handling Systems
- Non-conductive and testable using a high voltage brush

Coatings deemed to comply with the above include *Belzona 1341 Super Metal Glide* and *Chesterton ARC S2.* The manufacturer may propose alternate coatings. Potable water compliance certificates, material safety data sheets and technical specifications shall be submitted to *The Officer* prior to coating application.

Surface preparation and coating application shall be in accordance with the coating manufacturer's recommendations. The following sections of Water Corporation Specification F3- High Build Ceramic Filled Epoxy Coating on New and Existing Pumps, shall be applicable:

- Coating Applicator / Personnel Qualification

- Inspection and Testing of Coating (except as modified by clause 5.5.2 of SPS515)
- Repair of a Defective Coating and Retesting
- Recording and Reporting
- Contractor's Responsibility

In the absence of coating manufacturer surface preparation / application recommendations, the following specifications shall be followed:

- Surfaces to be coated shall be prepared to the requirements of *The Corporation's* Specification *A1 - Surface Preparation for the Application of Protective Coatings on Steel or Cast Iron.*
- The coating application and quality verification process shall comply with the requirements of Specification *F3 - High Build Ceramic Filled Epoxy Coating on New and Existing Pumps.*

NOTE:

1. Coatings are not required for corrosion protection on stainless steel pumps. However, stainless steel pump casings may be coated or preferably polished where required to achieve optimum efficiency (refer Section 5.7)
2. Prior approval for coatings other than those listed above should be sought from The Corporation in order to prevent delays during the tender process.

4.3 Pump External Coating

The external surface of cast iron pumps shall be prepared for coating in accordance with AS 1627.2 followed by coating in accordance with the Manufacturer's standard coating system to a finish colour of AS 2700 G21 Jade. The total dry film thickness shall be 250 microns minimum. External coatings are not required on stainless steel pumps.

4.4 Baseplate

Baseplates shall be hot dip galvanised to the requirements of either AS/NZS 4680 or ISO 1461, prior to machining of mounting pads. The machined faces shall be protected from atmospheric corrosion by application of a suitable temporary inhibiting coating (eg. Lanotec Type A grease).

4.5 Coupling Guard

The coupling guard shall be hot dip galvanized in accordance with AS/NZS 4680 prior to finishing in in bright yellow paint 'PMS 136C, 115U', AS 2700 Y15 Sunflower or 'RAL 1026 – Luminous Yellow'.

5 Testing

5.1 General

Product shall be tested in accordance with the test requirements of this Specification. Testing shall be deemed acceptable when test outcomes have been formally verified by a Certification Body or witnessed by a testing Officer. Product for which a test requirement has not been met shall be classified as non-compliant Product.

NOTES:

1. Testing should be carried out by an organisation accredited by NATA or in accordance with AS/ISO/IEC 17025.
2. A testing Officer should normally be an Officer who has specialist knowledge of or training in product or materials testing appropriate to the Product characteristics to be tested.

5.2 Notification of Testing

The Corporation shall be notified in writing of each formal test proposal at least seven (14) days prior to the preparation of Product for testing except where a specified test has been the subject of a current valid Certificate issued by a Certification Body. This notification is required to enable the Corporation to make all necessary arrangements including appointment of a testing Officer in a timely manner.

5.3 Access to the Place of Manufacture

The testing Officer shall be afforded access, at all reasonable times, to all places of manufacture of Product or Product components and shall be authorised to arrange or undertake such testing at the place of manufacture, as the Corporation deems appropriate for the testing regime specified.

5.4 Place of Manufacture other than WA

Where any Product or Product component is being manufactured other than in Western Australia the Corporation may appoint a local inspecting Officer to undertake inspections and witnessed testing as required. The testing Officer shall be provided with all due authority and permits required to carry out testing at the place of manufacture.

NOTE: The cost of witnessed testing arranged by the Corporation will be borne by the Corporation unless otherwise negotiated.

5.5 Quality Verification Tests

5.5.1 Hydrostatic Tests (bare casing and assembled pump)

Each pump casing shall be subjected to a hydrostatic test to the requirements of ANSI/HI 14.6.2011 - Appendix B and Clause 3.3.1. The test shall be performed prior to the application of internal surface coatings and may be undertaken on the assembled pump or the bare casing. No artificial structural support or restraint shall be provided to the casing during the test.

Hydrostatic testing of the assembled and coated pumps shall be undertaken, to the same requirements stated above (or as limited by the pressure rating of the mechanical seal), after the completion of performance testing. Free rotation of the assembled pump shall be confirmed during this test.

5.5.2 Coating Test

The indicated coating tests are applicable to the internal coating only, tests on the external coating shall be in accordance with the manufacturers' standard.

- Coating continuity shall be tested using spark testing in accordance with AS 3894.1. Alternatively, high voltage continuity testing may be undertaken in accordance with recognised international standards appropriate for the substrate and coating type (eg. NACE SP0188-2006, AST D5162-08 etc), the standard and procedure shall be agreed with *The Officer* prior to testing. Acceptance criteria for repair of holidays shall be no worse than 3 defects per 100,000 mm^2, above this the pump internals shall be re-coated. Acceptance criteria for final coating shall be zero holidays.

- Coating adhesion shall be tested in accordance AS 1580 Method 408.5 and AS 3894.9 Method C.
- Coating thickness shall be tested in accordance with AS 3894.3.

5.5.3 Quality Assurance Plan

A Quality Assurance Plan providing details of all inspections and tests to be undertaken, as well as records to be maintained and submitted - to ensure the technical requirements of this specification are complied with; shall be submitted to *The Officer* within 30 days of contract award.

5.6 Performance Proving Tests

5.6.1 General

Each pump shall be tested by the Manufacturer to prove that the performance is as per the schedule of performance guarantees in Section 14.

Unless otherwise stated in the *Purchasing Schedule* or later notified by *the Officer*, the Performance Proving Tests shall be witnessed by the Testing Officer.

The Performance Proving Tests shall be carried out in accordance with ISO 9906 - 2012, except as otherwise stated in this Specification.

The Manufacturer shall carry out performance testing of the pumps utilizing the drivers stated in the *Purchasing Schedule*, or one of the following in order of preference:

- The driver to be installed with its respective pump.
- A driver to be installed with one of several pumps of the same service.
- A driver of the same type, nominal speed and direction of rotation as will be installed with the respective pump, where the test motor is supplied by the Manufacturer.

5.6.2 Test Set-up

The pumps shall be tested at the speed stated by the Manufacturer to achieve the Guaranteed Duty Points (i.e. reduced speed testing is not acceptable, notwithstanding the provisions of ISO 9906).

The method of determining the pump power absorbed shall be nominated by the Manufacturer and agreed with The Corporation prior to testing being undertaken. The preferred method is to use a torque coupling and shaft speed measurement.

The pumps shall be tested on a purpose designed test loop, whereby adjustment of pump suction and discharge conditions can be controlled to within the required level of accuracy to meet ISO 9906 test conditions.

Particular note is to be taken to ensure NPSH to the pumps under test is the same as that which the pumps will be subjected when operating on site.

All instrumentation used for testing shall be certified by the National Association of Testing Authorities Australia (NATA), or an approved equivalent body in an overseas country, as complying with the required measurement tolerance for that instrumentation as stipulated in ISO 9906.

The pumps / pumpsets shall be rigidly fixed to foundations for the duration of the tests (i.e. testing under ‘relaxed’ conditions shall not be accepted).

Details of proposed test arrangements, demonstrating compliance with all test requirements, shall be provided to *The Officer* within 30 days of contract award.

5.6.3 Scope of Tests

Tests shall include test curves generated for the following:

- Determination of the head-flow characteristic, extending from shut-off (zero flow) to at least 120% of the Primary Guarantee Duty Point, or 120% of the Best Efficiency Point, whichever the greater. At least ten (10) points along the characteristic curve shall be taken.
- Where the tests are to be undertaken for variable speed pumps, the head-flow characteristic shall also be determined for the maximum and minimum intended operating speeds.
- Determination of the power absorbed by the pump, and the pump efficiency calculated, for each of the above-stated test points.
- Determination of the NPSH3 characteristic curve, extending from 50% of the Best Efficiency Point to at least 120% of the Primary Guarantee Duty Point, or 120% of the Best Efficiency Point, whichever the greater. At least five (5) points along the characteristic curve shall be taken.

NOTE: The NPSH test method shall be the constant flow method. For the purpose of this Specification a drop of 3% in total differential head from the no loss of head, shall determine the NPSH3 value at each test flow. The number of readings taken shall be as necessary to determine the shape of the individual 'horsetail' curves.

5.6.4 Drive Train Components

Where the *Purchasing Schedule* so requires, the pumps shall be tested by the Manufacturer as a complete pumpset (i.e. with electric induction motor driver) together with the variable-voltage variable-frequency speed control equipment (VVVF drive) to be installed on site for the pumps.

Where the *Purchasing Schedule* also requires, the power supply transformer to be installed on site to feed the VVVF drive shall also be used in the tests.

The Manufacturer shall bear responsibility of the handling, set-up, accommodation, management, removal and dispatch of the speed control equipment within the delivery schedule. If the equipment is provided free-issue by the Corporation to the Manufacturer for the purposes of the tests, the Corporation will provide a suitably trained technician to operate and maintain the Corporation's equipment.

The Manufacturer shall provide suitable power measurement equipment to determine the electrical power absorbed by the motor(s) (i.e. not rely on measurement of power supply to the VVVF drive). Alternatively, the Manufacturer may determine pump absorbed power by measurement of pump shaft torque.

NOTE: String testing of pump, motor and drives involves logistical risk, significant time and cost. It should only be specified where there is realistic concern that drive train components may not function as intended when installed on site. In most cases separate electric string tests and pump tests will be sufficient.

5.6.5 Tolerances on Test Results

Pumps shall meet the pump test acceptance grade tolerances in accordance with Table 8 of ISO 9906:2012 for the duty points stated in the *Purchasing Schedule* and as follows:

Guarantee Duty Point:	Acceptance Grade 1E
	τ_Q +/-5%, τ_H +/-3%, τ_P +4%, τ_η =>0%
Secondary Duty Point(s):	Acceptance Grade 1B
	τ_Q +/-5%, τ_H +/-3%, τ_P +4%, τ_η -3%

NOTE: Less stringent tolerances may be proposed for Secondary Duty Points, however this must be accepted and agreed prior to contract award.

5.6.6 Noise Testing

Where required by The Corporation (for site acoustic design considerations) and as indicted in the purchasing schedule, sound power level testing shall be undertaken. Testing shall (within the practical limitations of the test-bay environment), comply with the procedures contained in AS 1055, AS 1081, and AS/NZS 1269.

5.6.7 Vibration Testing

Each pump shall be tested for vibration severity performance. Pump vibration test values shall comply with Section 3.4.3 of this Specification.

5.6.8 Pump Test Report

5.6.8.1 General

For the purpose of acceptance, the Manufacturer shall provide a Pump Test Report, in electronic form, comprising:

- A Performance Test Report in accordance with ISO 9906 Annex F.
- A Coating inspection and High Voltage Spark Test certificate.
- A Vibration Test Report.
- A noise Test Report (where applicable)

The Pump Test Report shall certify that the Product has complied with the specified test requirements. Copies of all Test Reports shall be supplied to *The Officer* for acceptance.

5.6.8.2 Acceptance

Product shall not be dispatched from the Manufacturer's works until acceptance of the Pump Test Report by *The Officer*, or the appointed testing and inspecting authority. Acceptance will be conditional on the Product complying with the test requirements and guaranteed performance.

Three copies, in both electronic and printed form, of each approved Pump Test Report containing the test documentation for each pump, shall be provided to *The Officer*.

5.7 Contract Price Adjustments – Efficiency and Delivery

Where pumps are to be procured through the Water Corporation contracts branch, clauses 5.7.1 to 5.7.6 are to be copies into the special conditions of contract. LD / Bonus Rates and Contract Price Adjustment Limits at items (5.7.2 to 5.7.5 of Table 11.1) shall also be copied into the special conditions of contract. Any cross references in these sections shall be corrected in the special conditions of contract.

Regardless, these instructions shall be deleted from this specification prior to it being issued for tender.

5.7.1 General

The contract price may be adjusted as described in the following Clauses, for:

Liquidated Damages - Late Delivery - if delivery is not completed by the agreed date

Liquidated Damages - Low Efficiency - if the guaranteed efficiency (η_G) at the primary guarantee duty is not met

Performance Bonus - High Efficiency - if the guaranteed efficiency (η_G) at the primary guarantee duty is exceeded

The requirement for contract price adjustment shall be indicated in *Appendix A: Project Specific Requirements*. Where the provision is included, the contract price adjustment will be calculated as the

sum of all applicable Liquidated Damages and / or Performance Bonus, as described in the following clauses, up to the limit defined in *Appendix A: Project Specific Requirements*.

Notes:

1. The decision as to which provisions for contract price adjustment will be applicable to a particular order shall be made in consultation between the Designer and The Corporation Design Manager.
2. The decision with regards to applicability of contract price adjustment for efficiency deviation shall be informed by calculating the net present value (NPV) of 1% efficiency deviation taken over the asset life using evaluation spreadsheet Aqua #19333383. Copy will be supplied on request to The Corporation Design Manager.
3. Liquidated damages must be based on genuine financial loss to The Corporation. It is the Designer's responsibility to undertake and provide calculations to support any claim, in the event of a dispute.

5.7.2 Liquidated Damages - Late Delivery

In the event that delivery of the pump(s) to The Corporation is not completed by the contractually agreed date, the supplier shall pay liquidated damages to The Corporation. Liquidated damages will be calculated as a percentage reduction of the contract amount for each full week of delay. The applicable percentage of contract amount reduction per week, applicable for each full week late delivery, is defined in *Appendix A: Project Specific Requirements.*

5.7.3 Liquidated Damages – Low Efficiency

In the event that the efficiency recorded on the final factory test is lower than the efficiency guaranteed in Appendix D, for the Primary Duty Point only, the Supplier shall pay liquidated damages to The Corporation. Liquidated damages will be calculated as a percentage reduction of the contract amount for each one percentage (1%) below the guaranteed efficiency, for each pump, at the guaranteed duty point. The amount shall be calculated in increments of one tenth of a percentage point (0.1%) low efficiency on a pro-rata basis. The applicable percentage of contract amount reduction, per 1% below guaranteed efficiency, is defined in *Appendix A: Project Specific Requirements.*

5.7.4 Performance Bonus - High Efficiency

In the event that the efficiency recorded on the final factory test is higher than the efficiency guaranteed in Appendix D, for the Primary Duty Point only, the Supplier shall receive a performance bonus from The Corporation. The performance bonus will be calculated as a percentage increase of the contract amount for each percentage point (1%) above the guaranteed efficiency, for each pump, at the guaranteed duty point. The amount shall be calculated in increments of one tenth of a percentage point (0.1%) high efficiency on a pro-rata basis. The applicable percentage of contract amount increase, per 1% above guaranteed efficiency, is defined in *Appendix A: Project Specific Requirements.*

5.7.5 Contract Price Adjustment Limit

The overall contract price adjustment, increase or decrease, as described in the preceding clauses, shall be limited so as to not exceed a percentage of the overall contract price. The applicable contract price adjustment limit is defined in *Appendix A: Project Specific Requirements.*

Notes

1. The standard amounts for most contracts, which are generally accepted by the pump supply industry and are therefore unlikely to cause delay to contract award are:

Liquidated Damages Late Delivery	1% contract price reduction per week of delay
Liquidated Damages Low Efficiency	2% contract price reduction per 1% below η_G
Performance Bonus High Efficiency	2% contract price increase per 1% above η_G
Contract Price Adjustment Limit	15% reduction to 10% increase

2. Where the cost of low efficiency is high (which may be the case for large pumps operating long hours), higher efficiency related values should be considered.
3. Contract Price Adjustments – Example Calculation

The following example calculation considers an order for 4 pumps which arrive 3 weeks after the agreed delivery date. 3 of the 4 pumps exceed guaranteed efficiency by 0.5%, the other is below guaranteed efficiency by 0.8%. The specified LD for late delivery is 1% per week and for high or low efficiency is 2% of contract amount per 1% above or below η_G:

Liquidated damages late delivery	=	3 weeks x 1%	=	-3%
Liquidated damages low efficiency	=	1 x 0.8 x 2%	=	-1.6%
Performance bonus high efficiency	=	3 x 0.5 x 2%	=	+3%
Overall contract price adjustment	=	-3%-1.6%+3%	=	-1.6%

5.7.6 Right to Reject – Excessively Low Efficiency

The Corporation reserves the right to reject any pump-set where the efficiency, at the primary guarantee duty (Appendix D), recorded for an individual pump on final factory test is below the guaranteed efficiency by greater than three percentage points (3%).

6 Marking and Packaging

6.1 Marking

6.1.1 Body Markings

Each Pump shall have the following information clearly marked by casting on the body, or displayed by stamping or engraving on a corrosion resistant plate which shall be permanently secured using corrosion resistant fasteners:

(a) Manufacturer's name.

(b) Model/Type.

(c) Suction and outlet connection size - DN.

(d) Serial number.

(e) Duty flow, L/s

(f) Duty head, m.

(g) Speed rev/min.

(h) Impeller diameter.

(i) Seal make and model.

(j) NPSH3 at duty point.

(k) Duty power required (kW).

(l) Year of manufacture.

The pump casing hydrostatic test pressure and serial number shall be stamped on the casings. The direction of rotation of the pump shall be clearly indicated by an arrow cast on the castings.

Cast lettering shall be as large as practicable.

6.2 Packaging

6.2.1 General

Following acceptance by *The Officer*, Product shall be packaged with appropriate protection, which shall prevent damage or defects as a result of handling, storage or transportation. Flexible packaging material shall have a minimum expected life in outside storage conditions of 12 months from the date of delivery.

6.2.2 Identification Tag

Wherever requested in the Purchasing Schedule each Product item shall be identified using a weatherproof marking pen on a corrosion resistant metal identification tag securely wired to the Product in a conspicuous position using a galvanized tie wire with the following information:

(a) Contract number.

(b) Purchase order number.

6.2.3 Marking of Packaging

Where requested in the Purchasing Schedule, the Product shall be identified by marking on the outside of any protective packaging the same information as shown on the identification tag.

7 Manuals

7.1 Format and Language

Each pump shall be supplied complete with appropriate installation, operation and maintenance instructions or manuals, in clear diagrammatic and text format, in English

7.2 Content

The manuals shall contain all the relevant information required to commission and maintain the Product in operational service, including the following:

(a) Details of Product features.

(b) Operational adjustments.

(c) Lifting instructions for the pump and for the skid mounted pump and driver assembly.

(d) Installation and commissioning instructions.

(e) Preventative maintenance requirements and intervals.

(f) Testing procedures.

(g) Trouble shooting guidelines.

(h) A list of parts and associated exploded views or sectional diagrams and part numbers.

(i) A list of recommended spare parts with part numbers.

(j) A copy of all Product Certification.

8 Spare Parts and Special Tools

8.1 General

All spare parts shall be interchangeable for a manufacturer's Product of the same size and model.

Spare parts and servicing facilities for the product shall be readily available in Western Australia.

8.2 Spare Parts

Where required in the Purchasing Schedule the following spare parts shall be supplied, suitably packaged for long-term storage:

- A set of oversize (reduced ID) casing wear rings **OR** (refer Clause 3.3.3)
- A 'matched pair' set of impeller and casing wear rings.
- A set of mechanical seals[2].
- A set of O-rings
- A set of bearings[2].
- A set of all sleeves, bushes and wear components on the rotating element.

NOTES:

1. 'Set' shall mean the number of items required for the particular pump
2. Unless otherwise stated (where bearings, mechanical seals are ready available locally they may be deleted)

8.3 Special Tools

Any special tools required for service and maintenance of the Product shall be supplied.

9 Transportation, Handling and Storage

9.1 General

Transportation, handling and storage facilities shall be designed to prevent Product damage or defects and to maintain Product free of deleterious matter. Product shall not be dropped off elevated vehicle platforms or sites. Mechanical handling equipment shall be in accordance with AS 2550.1, AS 2550.3, AS 2550.5 and AS 2550.11 and shall be appropriate to the loads to be lifted. Manual handling shall be in accordance with the National Standard for Manual Handling and the National Code of Practice for Manual Handling, published by National Occupational Health and Safety Commission, Australia. Product restraint during transportation shall be in accordance with Load Restraint Guide—Guidelines for Safe Carriage of Loads on Road Vehicles, published jointly by the Federal Office of Road Safety and the National Road Transport Commission, Australia.

NOTE: Where wire ropes or chains are used for loading and unloading, they should not come into direct contact with Product. Lifting elements in direct contact with Product should be of a non-abrasive design e.g. elastomeric or fabric webbing straps. During transportation, Product restraints should be checked for tension at regular intervals of travel and should not be released until the transporting vehicle is resting in a secure stable disposition on level ground.

9.2 Preservation of Product in Storage

Product shall be stored in original Product packaging in accordance with the published requirements of the manufacturer, prior to installation. Sensitive component materials shall be protected from extended exposure to direct sunlight and high temperatures e.g. elastomeric components shall be stored in accordance with the general principles of AS 1646. Designated Product storage areas shall be of sufficient size to accommodate Product deliveries and shall be flat, reasonably level and free of combustible vegetation, sharp stones or projections that could cause Product damage or defects.

10 Quality Assurance

10.1 Certification

10.1.1 Certification of Product

Wherever this Specification requires compliance with nominated Product and test Standards, conformance shall be certified by means of a Certification Scheme, conducted by a Certification Body. Each Certificate shall expressly attest compliance of all Product items with the nominated Standards. Wherever specified, Certificates shall be submitted to the Officer nominated for this purpose. Product shall be marked in accordance with the requirements of the Certification Body.

NOTE: Compliance of Product including related accessories and services with nominated Standards and specified requirements may be verified by means of a Product Verification Report provided by a Product Assessor. The Product Verification Report should identify all relevant Certificates of Product compliance, duly issued in accordance with Certification Scheme rules.

10.1.2 Quality System

The processes for manufacture, testing, supply, transportation, handling, delivery and storage of Product to be supplied in accordance with this Specification shall form part of a documented Quality System. The System shall be certified by a Certification Body as complying with the requirements of AS/NZS ISO 9001 and shall provide for identification and traceability, control of production and delivery to the specified destination, customer verification and control of documents and records.

10.1.3 Product Re-verification

Product compliance with the Specification shall be subject to re-verification by a Product Assessor when, during the agreed Product supply period, there occurs any:

- substantive change in Product design, material formulation or performance
- Product failure to perform in operational service to the nominated performance specification.

Re-verification shall require the issue of a new or supplementary Product Verification Report. Product components and test outcomes that are not significantly affected by the Product change or failure may be excluded from the scope of re-verification, provided that these outcomes have already been reported in a current valid Product Verification Report that is acceptable to the Corporation.

Wherever the requirements of the Specification apply to a Product supply period in excess of three years, continuing acceptance of Product shall be subject to re-verification. The purpose of re-verification shall be to confirm the continuing compliance of Product quality and production control processes with the requirements of the Specification

10.2 Compliance and Acceptance

10.2.1 Means of Demonstrating Compliance

Compliance with this Specification shall be demonstrated by means of Product Appraisal and issue by a Product Assessor of a Product Verification Report that confirms compliance. Otherwise, Product shall be deemed non-compliant and ineligible for registration as Product authorized for use in Corporation infrastructure.

NOTES:

1. Where a project includes design work including Product design, Product Appraisal may form part of the project design review process and the Product Assessor may be a member of the project design review team.

2. A Product Verification Report should verify the extent of compliance with the Specification including all relevant ‘Technical Compliance Schedule’ Appendices and the currency of a Certificate where relevant to the Product.

10.2.2 Acceptance Criteria

For acceptance, Product shall be supplied as specified in the Purchasing Schedule.

Prior to the implementation of any arrangement to supply Product, the Supplier shall, in accordance with specified requirements:

- nominate applicable Product Warranty terms; and
- provide documentary verification in the form of a current valid Certificate or Product Verification Report as appropriate to the Product; and
- detail each element of Product that does not comply with the specified requirements together with the extent of non-compliance.

NOTE: Where the Specification includes Technical Compliance Schedules, the nature and extent of all non-compliances should be provided in accordance with the appropriate Schedules.

10.3 Non-compliant Product

10.3.1 General

Product whose design, workmanship or performance fails to conform to the specified requirements shall be clearly tagged and quarantined by the Supplier as non-compliant and shall be subject to rejection for return to and replacement by the Supplier.

Where the Specification includes a 'Technical Compliance Schedule', Product shall be deemed non-compliant except where a Supplier has demonstrated compliance in accordance with the requirements of the 'Technical Compliance Schedule' Appendices of the Specification.

10.3.2 Manufacturing Repairs (In-process)

Welding, the use of fillers and other repairs shall generally not be permissible on Product which is in the course of production. Repairs to custom-built Products such as axially-split pumps and large valves may be considered only if determined by the Corporation to be minor casting repair work in non-strategic locations. Accordingly, details of any defect which the Manufacturer considers can be repaired; together with details of proposed repair procedures shall be submitted in writing for determination by the Corporation.

The Manufacturer shall make provision in its production Quality System and in the appropriate ITP's for sufficient hold points whenever casting defects are encountered. Production work on non-compliant components shall cease and repair work shall not commence until the following details have been confirmed by the Corporation in writing:

(a) that repair of the non-compliant components in lieu of their replacement is acceptable; and

(b) that proposed repair procedures are acceptable; and

(c) that any proposal to vary the terms of the original Product Warranty as a consequence of the in-process repair is acceptable.

10.3.3 Product Warranty - General

The Supplier shall replace non-compliant Product with Product that conforms to the acceptance criteria or shall repair or rectify all faults in order to make Product complaint. Except as may otherwise be specified, the Product Warranty shall indemnify and keep indemnified the Corporation against all costs associated with repairing or making good non-compliant Product for a period no less than 24 months after Product delivery or 12 months after Product installation, whichever period elapses first.

10.3.4 Product Repair

All reasonable proposals for repair or remedy of defects will be considered, provided that each such proposal is accompanied by a methodology statement that accords with the performance objectives of this Specification, as determined by the Corporation. For acceptance, a proposal for repair or remedy of Product defects shall not void or otherwise diminish the provisions of the Product Warranty.

11 Appendix A: Project Specific Requirements (Purchasing Schedule)

11.1 General

Project specific information and requirements not included elsewhere in this Specification shall apply as specified in the following Clauses and shall be taken as forming part of the **Purchasing Schedule**.

11.2 Project Specification Requirements

This section should be updated to include project specific requirements which are relevant to the pump selection or scope of supply and not indicated elsewhere in the specification. This may include items such as site location, details of operating methodologies, pumping system, pump station arrangement, special liquidated damages provisions etc.

11.3 Specific Requirements

The following table details project specific requirements for the pumps to be procured.

Table 11.1 – Project Specific Requirements

Clause	Project Requirements	Item/ Option
-	Number of pumpsets required:	
2.1	Classification of Water Corrosivity	Standard / Corrosive / Highly Corrosive
2.1	Water Properties	Refer Table 11.2
2.4	Abrasive Service	Yes / No
2.5	Material Certification - Inspection Certificate Type	2-2 (Batch) / 3-1 (Specific Item)
3.1	Pump orientation:	Horizontal / Vertical
3.2.1	Primary Guarantee Duty Point (l/s, m):	
	Secondary Duty Point(1) (l/s, m):	
	Required Operating Envelope - curves provided	Yes / No
3.2.3	NPSHA(1) (m)	
3.2.6	Direction of Rotation (viewed from Driver)	Clockwise / Anticlockwise
3.3.1	Maximum Suction Pressure (m)	
3.3.2	Preferred Flange Standard:	AS 4087 / EN1092 / No Preference
3.3.2.1	Dimensions to Match Existing Unit	Yes / No
	Existing Pump Reference Serial No.	Specify / N/A
3.3.8.6	Automatic Gas Lubricators Required	Yes / No
3.3.9	Balanced Cartridge Mechanical Seals Required	Yes / No
3.5.1	Manufacturer to provide driver coupling half:	Yes / No
3.5.1	Coupling Type:	Standard / Spacer
5.6.1	Performance test witness:	Yes / No

Clause	Project Requirements	Item/ Option
5.6.1	Driver used for performance tests:	Specify
5.6.4	Test required with VVVF drive?	No / Specify
5.6.4	Test required with transformer?	No / Specify
5.7.2	LD Rate For Late Delivery (%/week)	No / Standard / Specify
5.7.3 5.7.4	Asset Life (years) (25 years is standard)	Specify
	NPV of 1% Efficiency Deviation ($/%) (includes costs for primary & secondary duties where applicable taken over the asset life)	No / Specify
	LD Rate For Low Efficiency Bonus Rate for High Efficiency (specific rates should be given as % contract price adjustment per percentage point pump efficiency deviation)	No / Standard / Specify No / Standard / Specify
5.7.5	Contract Price Adjustment Limits: Reduction (LD's low efficiency / late delivery) Increase (Bonus for high efficiency) (specific adjustment limits should be in %)	 No / Standard / Specify No / Standard / Specify
6.2.2	Identification tag required?	Yes / No
6.2.3	Marking of packaging required?	Yes / No
8.2	Spare Parts Required	No / Specify

Note (1) Where several operating duties are required a schedule of required duty flows and associated system characteristic curves shall be provided.
(2) It is *The Corporation's* Designer/Design Manager's responsibility to gather and complete all available information in tables 11.1 and 11.2.
(3) LD rate for low efficiency and Bonus rate for high efficiency would normally be the same.
(4) Refer to Clause 5.7.5 for standard LD / Bonus rates.
(5) As per Clause 5.7, if pumps are being procured through Water Corporation contracts branch, LD / Bonus Rates and Contract Price Adjustment Limits at items (5.7.2 to 5.7.5) shall be copied into the special conditions of contract. Regardless, this note shall be deleted prior to the specification being issued for tender.

11.4 Water Properties (Refer Clause 2.1)

Table 11.2 – Water Properties

Parameter	Description / Value
Classification of Corrosivity	Standard / Corrosive / Highly Corrosive
Abrasive Service (Definition 1.3.1)	Standard / Abrasive
Quantum of Abrasive Particles (where known)	g / kl
Water Type Description	Raw / Potable / Effluent / Seawater
Maximum Temperature (1)	
PH	
Chlorides	
Alkalinity	
Free Chlorine	
Temperature – Normal Operating	
Temperature – Maximum on Standby	
Total Dissolved Solids	
Carbonate Hardness	
Nitrate	
Nitrite	
Sulphate	

Note. (1) for pumps operating on standby, the maximum seasonal ambient temperature shall be used.

12 Appendix B: Technical Compliance Schedule (Normative)

12.1 Compliance Schedule

Suppliers shall demonstrate Product compliance with the Specification by completing Technical Compliance Schedule below on an item by item basis. For acceptance, the extent of scheduled technical item compliance shall be supported by verifiable documentary evidence. Each scheduled item nominates a Specification clause number with which the extent of Product compliance shall be demonstrated.

The Supplier shall denote compliance of an item by ticking the unshaded 'Yes' column appropriate to that item. Where Product does not comply with specified requirements, the Supplier shall tick the 'No' column and shall detail the reasons for non-conformance and any proposed alternatives in the 'Comments' column. The Supplier shall denote acceptance and understanding of a Specification clause by ticking the corresponding 'Noted' column wherever unshaded.

Failure to notify the Corporation of all non-compliant Product components, including the extent of non-compliance, may void an accepted offer to supply or may result in rectification of all non-compliant Product elements, at the Supplier's cost.

Table 12.1 – Technical Compliance Schedule

Axially-Split Centrifugal Pumps – Supplier Clause-by-Clause Response					
Clause	**Section**	**Noted**	**Compliance**		**Comments**
			Yes	**No**	
1.	**SCOPE AND GENERAL**				
1.1	Scope				
1.2	Evaluation of Bids				
1.3	Referenced Documents				
1.4	Definitions and Notation				
1.5	Designation of Size				
2.	**MATERIALS AND COMPONENTS**				
2.1	General				
2.2	Contamination of Drinking Water				
2.3	Materials of Construction				
2.4	Abrasive Service Materials				
2.5	Material Certification				
2.6.1	Welding, Heat Treatment and Passivation				
2.6.2	Graphite Compounds				
2.6.3	Galling				
2.7	Dezincification-resistant Materials				
2.8	Non-metallic Materials				
2.9	Immersed Components				
2.10	Elastomeric Materials				
3.	**DESIGN AND MANUFACTURE**				
3.1	General				
3.2	Performance				
3.2.1	Pump Selection				
3.2.2	NPSH				
3.2.3	Performance Curves				
3.2.4	Driver Selection				
3.3	Pump Design				
3.3.1	MAWP and Hydrostatic Test Pressure				
3.3.2	Casing				
3.3.3	Impellers				
3.3.4	Shafts				
3.3.5	Shaft Sleeves				
3.3.6	Rotating Assembly Dynamics				
3.3.7	Wear Rings and Bushes				
3.3.8	Bearings, Housings and Temperature/Vibration Monitoring				
3.3.8.1	General				

Axially-Split Centrifugal Pumps – Supplier Clause-by-Clause Response					
Clause	**Section**	**Noted**	**Compliance**		**Comments**
			Yes	**No**	
3.3.8.2	Rolling Element Bearings				
3.3.8.3	REB's – Provision for Temperature Monitoring				
3.3.8.4	REB's – Provision for Vibration Monitoring				
3.3.8.5	Outboard Bearing Housings				
3.3.8.6	Hydrodynamic (Journal/Bush) Bearings				
3.3.9	Mechanical Seals				
3.3.10	Fasteners, Dowels and Casing Half Sealing				
3.4	Manufacture				
3.4.1	Machining				
3.4.2	Balance of Rotating Elements				
3.4.3	Vibration				
3.4.4	Castings				
3.5	Ancillary Equipment				
3.5.1	Flexible Couplings				
3.5.2	Baseplates and Coupling Guards				
4.	**PROTECTIVE COATINGS**				
4.1	General				
4.2	Pump Internal Coating				
4.3	Pump External Coating				
4.4	Baseplate				
4.5	Coupling Guard				
5.	**TESTING**				
5.1	General				
5.2	Notification of Testing				
5.3	Access to the Place of Manufacture				
5.4	Place of Manufacture other than WA				
5.5	Quality Verification Tests				
5.5.1	Hydrostatic Tests				
5.5.2	Coating Test				
5.5.3	Quality Assurance Plan				
5.6	Performance Proving Tests				
5.6.1	General				
5.6.2	Test Set-up				
5.6.3	Scope of Tests				
5.6.4	Drive Train Components				
5.6.5	Tolerances on Test Results				
5.6.6	Noise Testing				
5.6.7	Vibration Testing				
5.6.8	Pump Test Report				
5.6.8.1	General				
5.6.8.2	Acceptance				
5.7	Contract Price Adjustments – Efficiency and Delivery				
5.7.1	General				
5.7.2	Liquidated Damages – Late Delivery				
5.7.3	Liquidated Damages – Low Efficiency				
5.7.4	Performance Bonus – High Efficiency				
5.7.5	Contract Price Adjustment				
5.7.6	Right to Reject – Excessively Low Efficiency				
6.	**MARKING AND PACKAGING**				
6.1	Marking				
6.1.1	Body Markings				
6.2	Packaging				
6.2.1	General				
6.2.2	Identification Tag				
6.2.3	Marking of Packaging				
7.	**MANUALS**				
7.1	Format and Language				
7.2	Content				
8.	**SPARE PARTS AND SPECIAL TOOLS**				
8.1	General				
8.2	Spare Parts				

Axially-Split Centrifugal Pumps – Supplier Clause-by-Clause Response					
Clause	**Section**	**Noted**	**Compliance**		**Comments**
			Yes	**No**	
8.3	Special Tools				
9.	**TRANSPORTATION, HANDLING AND STORAGE**				
9.1	General				
9.2	Preservation of Product in Storage				
10.	**QUALITY ASSURANCE**				
10.1	Certification				
10.1.1	Certification of Product				
10.1.2	Quality System				
10.1.3	Product Re-verification				
10.2	Compliance and Acceptance				
10.2.1	Means of Demonstrating Compliance				
10.2.2	Acceptance Criteria				
10.3	Non-compliant Product				
10.3.1	General				
10.3.2	Manufacturing Repairs (In-process)				
10.3.3	Product Warranty - General				
10.3.4	Product Repair				
11.	**PROJECT SPECIFIC REQUIREMENTS**				
11.1	General				
11.2	Project Specification Requirements				
11.3	Specific Requirements				
11.4	Water Properties				

Name of Supplier:

Signature: Date:

13 Appendix C - Technical Schedule – Supplier Data Sheet

Suppliers shall provide a Data Sheet with the following (minimum) technical information:

Table 13.1 - Technical Schedule

Item and Data Requirement	Supplier Data
Project / Supplier Details	
Project Reference Name	
Project Location	
Pump Identification Number(s)	
Supplier Contact Details	
Manufacturer Contact Details	
Quotation Reference/Item Numbers	
Pump Model / Hydraulic Type	
Pump - Casing / Configuration Details	
Horizontal/ Vertical	
Direction of Rotation (from Driver end)	CW / ACW
Driver location (viewed towards suction flange)	LHS / RHS
Casing Volute Design	Single / Dual
Number of stages:	Single Stage / Two Stage
Maximum Operating Pressure (Calculated)	/ bar
Maximum Allowable Working Pressure:	/ bar
Hydraulic Test Pressure (> 1.5xMOP, 1.3xMAWP)	/ bar
Casing Fasteners – stud / bolt / cap screw:	stud / bolt / cap screw
Casing Air Relief Valve – Standard & Size	
Casing Drain Valves – Qty/ Std / Size	
Pressure tappings (2) – Std / Size	
Suction Flange – Std / DN / PN	
Discharge Flange – Std / DN / PN:	
Major Components: - Material / Grade / Certificate Type	
Casing	
Bearing Housing	
Seal Housing	
Shaft	

Item and Data Requirement	Supplier Data
Shaft Protection Sleeves	
Impeller	
Impeller Wear Ring	
Casing Wear Ring	
Impeller & Shaft Design / Rotating Assembly Dynamics	
Impeller attachment - keyway & sleeves / shrink fit	
Number of vanes	
Hydraulically Balanced Double Suction / Unbalanced	
Diameter Fitted / mm	
Diameter - Max / Min / mm	
Diameter – Inlet Eye / mm	
Wear Ring Diametral Clearance - new / mm	
Wear Ring Diametral Clearance - max allowable worn / mm	
Maximum Allowable Speed / rpm	
Minimum Allowable Speed /rpm	
First Critical Speed / rpm	
Mass Moment of Inertia – WR2 (dry) / kgm^2	
Balance Grade - ISO1940 (Gr 6.3 or Gr 2.5)	
Nozzle Forces and Moments – Maximum Allowable (assumes horizontal in-line application)	
Fy (perpendicular to flange face)	
Fx (horizontal)	
Fx (vertical)	
My (axis perpendicular to flange face)	
Mx (horizontal axis)	
Mz (vertical axis)	
Coupling	
Make / model / Size	
Type - Standard / Spacer	

Item and Data Requirement	Supplier Data
Bearings	
DE - Type / lubrication	
DE – Make / model / size	
NDE - Type / lubrication	
NDE – Make / model / size	
Mechanical Seals	
Make / model	
Type	
Materials – stationary face / rotating face / casing	
Flushing Plan	
Baseplate	
Material	
Coating	
Dimensions / Dimensional Drawing Required	

Name of Supplier:

Signature: Date:

14 Appendix D – Schedule of Performance Guarantees

Suppliers shall guarantee pump/ pumpset performance by completing Schedule of performance guarantees below.

Table D1 – Schedule of Performance Guarantees

Item	Parameter	Unit	Primary Guarantee Duty Point	Secondary Duty Point 1		Secondary Duty Point 2	
				Required	Guaranteed	Required	Guaranteed
1	Flow rate, Q_G	L/s			(1)		(1)
2	Total dynamic head, H_G	m			(1)		(1)
3	Speed	rpm					
4	Efficiency (pump only)	%					
5	Absolute power (pump only)	kW					
6	Power losses (ancillaries)	kW					
7	Absolute power (including ancillaries)	kW					
8	Motor efficiency (if in scope of supply)	%					
9	Pumpset overall efficiency:	%					
10	Pumpset energy consumption	kWh/kL					
11	System NPSHA	m					
12	Pump NPSH3	m					
13	NPSH margin (S)	m					
14	NPSHR (= NPSH3 + S)	m					

Note (1) Secondary duty points offered will depend on pump and impeller hydraulic performance characteristics. Performance guarantees are therefore subject to agreement.

Name of Supplier:	
Signature:	Date:

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