MECHANICAL GENERAL SPECIFICATION

TMS1639

Revision Table

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Revision History

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DOCUMENT HISTORY

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TMS1437	Standard LV Electric Motor Technical Specification	3	01/03/2017	Superseded

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Table of Contents

1. SCOPE

This Specification outlines the minimum technical requirements for design, manufacture, installation, testing and commissioning of Urban Utilities mechanical infrastructure. This Specification is divided into three parts covering distinct topic areas:

- General Mechanical Design (Section 6)
- Motors, Pumps, Pipes, and Valves (Section 7)
- Mechanical Installation (Section 8)

This Specification is intended to complement any agreements between Urban Utilities and entities responsible for the delivery of required infrastructure, including but not limited to developers, delivery partners, and successful tenderers to bid.

This Specification is further intended to complement the information contained in other Urban Utilities technical specifications.

1.1 Application

Table 1-1 outlines the applicability of this specification to various areas of water and wastewater infrastructure.

Table 1-1 Applicability Table

ASSET AREA	APPLICABLE (YES/NO)
Water and Wastewater (Sewerage) Pipe Networks Including Recycled Water Systems (drinking & non-drinking water) excluding irrigation purposes	*Gravity Sewerage Code of Australia South East Queensland Service Providers Edition* and the *Water Supply Code of Australia South East Queensland Service Providers Edition*, collectively referred to as the *SEQ Design and Construction Code* is applicable. Reference web links www.seqcode.com.au and www.wsaa.asn.au Where SEQ Design and Construction Code is silent with regards to the requirements for a mechanical design or construction element then the relevant sections of this specification shall apply. This mechanical specification applies to above ground pipework. (generally found at facilities). Underground pipework is considered civil works and should reference TMS1435 or the *SEQ Design and Construction Code*.
Trunk Water Supply and Trunk Sewerage Services	The Urban Utilities *Trunk Water Code* and *Trunk Gravity Sewer Code* (under Development at time of writing) are applicable. Where these codes are silent with regards to the requirements for a mechanical design or construction element then the relevant sections of this specification shall apply.
Water and Sewage Treatment Plants; Water Pumping Station; Recycled effluent for irrigation purposes	This specification (TMS1639) is applicable.
Sewage Pumping Stations	*SEQ Design and Construction Code* Edition of *WSA-4* (i.e. the *SEQ Sewage Pumping Station Code*) is applicable. Where the *SEQ Sewage Pumping Station Code* is silent with regards to the requirements for a particular

ASSET AREA	APPLICABLE (YES/NO)
	mechanical design or construction element then the relevant sections of this specification shall apply.
Drinking water Reservoirs and Tanks	The *Drinking Water Reservoirs and Tanks Specification TMS1581* is applicable. Where *TMS1581* is silent with regards to the requirements for a design or construction element then the relevant sections of this specification shall apply.

2. PURPOSE

This Specification is intended to provide details and instructions on the minimum requirements for design, manufacture, installation, testing and commissioning of a mechanical installation on a facility that is intended to be owned, maintained and operated by Urban Utilities. This specification shall be used for all works that may include the creation, upgrading, overhaul, repair, decommissioning or demolition of any new or existing Urban Utilities assets.

This Specification seeks to ensure that new and upgraded mechanical facilities are designed and installed to be reliable, efficient, serviceable and as safe as is practicable.

Deviation from the requirements in this Standard Specification requires written agreement as per the deviation process detailed in PRO752. This process includes completion of a Standards Deviation Request Form and submission to Urban Utilities.

3. DEFINITIONS

Definitions of terms used in this document can be found in Table 3-1.

Table 3-1 Definitions

ITEM	DEFINITION/DESCRITPION
Accountable Party	Is the responsible person nominated within an Inspection and Test Plan (ITP) or verification document or procedure as responsible to certify completion of a task or step within the quality assurance process.
Consumables	Products or resource that is consumed by equipment and must be frequently replenished or replaced.
Contractor	The entity responsible for the delivery, or part thereof, of the required infrastructure including design, manufacture, supply, installation and/or demolition. This may include, but is not limited to, a developer or the successful tenderer to a bid.
Critical mechanical equipment	Critical mechanical equipment is any equipment whose failure will have serious safety, regulatory or production consequences
Certifying Engineer	The RPEQ engineer responsible for design of associated infrastructure.
Factory Acceptance Test	A process that evaluates the equipment during and after the manufacturing process by verifying that it is built and operating in accordance with the requirements of design specifications.
Hold Point	A pause in design or construction, at which point, work quality verification by the Accountable Party, is required before work can proceed.
Witness Point	An identified point in the design or construction work where the Accountable Party may review, witness, inspect the method or process of work
Maintenance Service Trucks	Service trucks typically used by Urban Utilities' maintenance staff for routine maintenance activities.
Operation and Maintenance Manual	Information pertaining to the operations and maintenance of the asset, provided in an electronic format compatible with Urban Utilities' asset management systems.
Project Documentation	Documentation that outlines the requirements of Urban Utilities infrastructure being established through a project. This documentation will form part of the agreement between Urban Utilities and the entity responsible for the development of the relevant infrastructure.
Manufacturer/Supplier/Vendor	Interchangeable terms within this document that refers to the responsible importer or manufacturer or supplier of a machine or component of a machine or system.

4. ACRONYMS AND ABBREVIATIONS

Abbreviations used in this document can be found in Table 4-1.

Table 4-1 Abbreviations

ABBREVIATION	DESCRIPTION
AS	Australian Standard
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
BS	British Standard
BSP	British Standard Pipe
BSPT	British Standard Pipe Thread
DC	Direct Current
DFT	Dry Film Thickness
DICL	Ductile Iron Cement Lined
DN	Nominal Diameter
EFW	Electric Fusion Welding
EPDM	Ethylene Propylene Diene Monomer
FP	Fatigue Purpose
FRP	Fibre-Reinforced Plastic
GP	General Purpose
GRP	Glass Reinforced Plastic
IEC	International Electrotechnical Commission
ISO	International Organisation for Standardisation
ITP	Inspection and Test Plan
MAOP	Maximum Allowable Operating Pressure
NB	Nominal Bore
NZS	New Zealand Standard
O&M	Operations and Maintenance
PCB	Printed Circuit Boards
PE	Polyethylene
PLC	Programmable Logic Controllers
PN	Nominal Pressure
PTFE	Polytetrafluoroethylene
PVC	Polyvinyl Chloride
RAS	Return Activated Sludge

ABBREVIATION	DESCRIPTION
RH	Right Hand
RTD	Resistance Temperature Detector
SCADA	Supervisory Control and Data Acquisition
DRL	Data Requirements List (CHE486)
SEQ	South East Queensland
SiC	Silicon Carbide
SIL	Safety Integrity Levels
SMLS	Seamless
SP	Structural Purpose
SS	Stainless Steel
STP	Sewage Treatment Plant
TEM	Template
TMS	Technical Specification
UHMWPE	Ultra-High-Molecular-Weight Polyethylene
UV	Ultraviolet
VSD	Variable Speed Drives
WAS	Waste Activated Sludge
WHS	Work Health and Safety
WSA or WSAA	Water Services Association (of Australia)

5. STANDARDS, CODES AND REGULATIONS

All design, equipment and workmanship shall conform to the most recent requirements of the relevant statutory Local, State and Commonwealth authorities and current applicable Australian Standards. Alternatively, where no Australian Standard exists, work shall conform to the most current and applicable International Standard.

The below sections, including tables Table 5-1,Table 5-2, Table 5-3 and Table 5-4, list the standards, codes and regulations identified as most relevant to mechanical works. This list does not include all documents and accordingly the responsible Certifying Engineer, Contractor or other relevant entity shall undertake their own investigations to identify and ensure compliance with all relevant standards, codes and regulations.

5.1 Acts and Regulations

Table 5-1 Acts and Regulations

LEGISLATION	DESCRIPTION
Work Health and Safety Act 2011	Provides a framework to ensure the health and safety of workers and workplaces.
Work Health and Safety Regulation 2011	Prescribes specific requirements for hazards and risks to ensure the health and safety of workers and workplaces.
Work Health and Safety Codes of Practice 2011	A practical guide to ensure the health and safety of workers and workplaces.
Professional Engineers Act Qld 2002	The act serves to protect the public by ensuring professional engineering services are provided by a registered professional engineer in a professional and competent way.
Professional Engineers Regulation 2019	Prescribes specific requirements relating to the Professional Engineers Act 2002.
Environmental Protection Act 1994	Lists obligations and duties to prevent environmental harm, nuisances, and contamination along with setting the enforcement tools that can be used when offences or acts of non-compliance are identified.
National Construction Code 2019	A performance-based code that provides a minimum level required for safety, health, amenity, accessibility, and sustainability in relation to certain buildings.
SEQ Design and Construction Code	Provides a consolidation of design and construction standards for retail water supply and sewerage infrastructure for South-East Queensland.

5.2 Australian Standards

Table 5-2 Australian Standards

STANDARD	TITLE
AS 1055	Acoustics - Description and measurement of environmental noise
AS 1111	ISO metric hexagon bolts and screws
AS 1112	ISO metric hexagon nuts
AS 1216	Class labels for dangerous goods

STANDARD	TITLE
AS 1237	Flat metal washers – for general engineering purposes
AS 1318	Use of colour for the marking of physical hazards and the identification of certain equipment in industry
AS 1319	Safety signs for the occupational environment
AS 1345	Identification of the contents of pipes, conduits and ducts
AS 1418	Cranes, hoists and winches
AS 1530.1	Methods for fire tests on building materials, components and structures. Part 1: Combustibility test for materials
AS 1554	Structural steel welding
AS 1579	Arc-welded steel pipes and fittings for water and wastewater
AS 1657	Fixed platforms, walkways, stairways and ladders – design, construction and installation
AS 1742	Manual of uniform traffic control devices
AS 1906	Retroreflective materials and devices for road traffic control purposes
AS 2312	Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings
AS 2508	Safe storage and handling information card
AS 2528	Bolts, studbolts and nuts for flanges and other high and low temperature applications
AS 2550	Cranes, hoists and winches – safe use
AS 2700	Colour standards for general purposes
AS 2784	Endless wedge belt and V-belt drives
AS 2890	Parking facilities
AS 2927	The storage and handling of liquefied chlorine gas
AS 3780	The storage and handling of Corrosive Substances
AS 3845	Road safety barrier system
AS 4024	Safety of machinery
AS 4037	Pressure equipment – examination and testing
AS 4041	Pressure piping
AS 4100	Steel structures
AS 4254	Ductwork for air-handling systems in buildings
AS 4795	Butterfly valves for waterworks purposes
AS 4991	Lifting devices
AS 6401	Knife-gate valves for waterworks purposes
AS/NZS 1214	Hot-dip galvanised coatings on threaded fasteners
AS/NZS 2638	Gate valves for waterworks purposes

STANDARD	TITLE
AS/NZS 2648	Underground marking tape
AS/NZS 3000	Electrical installations
AS/NZS 3500.2	Plumbing and Drainage
AS/NZS 4020	Testing of products for use in contact with drinking water
AS/NZS 4024	Safety of Machinery
AS/NZS 4087	Metallic flanges for waterworks purposes
AS/NZS 4680	Hot-dipped galvanised (zinc) coatings on fabricated ferrous articles
AS/NZS 61439	Low voltage switchgear and control gear assemblies
AS IEC 61882	Hazard and operability studies (HAZOP studies) – application guide
AS/NZS IEC 61672	Electroacoustics – sound level meters
AS/NZS IEC 61882	Hazard and operability studies
AS ISO 5801	Industrial fans – Performance testing using standardised airways
AS ISO 9906	Hydraulic performance acceptance tests for rotodynamic pumps

5.3 Industry Codes & Publications

Table 5-3 WSAA Codes and Publications

STANDARD	TITLE
WSA 130	ISO End Suction Centrifugal Pumps
WSA 131	ISO End Suction Centrifugal Motor Pumps
WSA PS – 200	Ductile Iron Pipes (CIOD) for Pressure Applications - Water Supply and Sewerage
WSA PS – 201	Ductile Iron Fittings (CIOD) for Pressure and Non-Pressure Applications - Water Supply and Sewerage
WSA PS – 202	Ductile Iron Fittings (CIOD) for Pressure and Non-Pressure Applications - Water Supply and Sewerage
WSA PS – 202S	Ductile Iron Pipes and Fittings (ISO Sized) for Pressure and Non-Pressure Applications – Sewerage
WSA PS – 203	Steel Pipes for Pressure and Non-Pressure Applications - Water Supply and Sewerage
WSA PS – 204	Steel Fittings for Pressure and Non-Pressure Applications - Water Supply and Sewerage
WSA PS – 205	Filament Wound Glass Reinforced Plastics (FW-GRP) Pipes and Fittings for Pressure Applications – Water Supply
WSA PS – 205S	Filament Wound Glass Reinforced Plastics (FW-GRP) Pipes and Fittings for Pressure Applications – Sewerage
WSA PS – 207	Polyethylene (PE) Pipes for Pressure Applications – Water Supply and Sewerage
WSA PS – 208	Plastics Moulded Fittings for Pressure Applications with PE Pipe – Water Supply and Sewerage
WSA PS – 211	Polyvinylchloride, Unplasticised (PVC-U) Pressure Pipes for Pressure Applications - Water Supply and Sewerage

STANDARD	TITLE
WSA PS - 230	Polyvinylchloride, Unplasticised (PVC-U) Pipes and Fittings for Non-Pressure Applications – Sewerage and Drainage
WSA PS - 237	Centrifugally Cast Glass Reinforced Plastics (CC-GRP) Pipes and Fittings (ISO Sized) for Pressure and Non-Pressure Applications – Water Supply
WSA PS – 237S	Centrifugally Cast Glass Reinforced Plastics (CC-GRP) Pipes and Fittings (ISO Sized) for Pressure and Non-Pressure Applications - Sewerage
WSA PS - 242	Polyethylene (PE), Plain Wall, Pipes and Fittings for Non-Pressure Applications - Sewerage
WSA PS – 260	Gate Valves, Resilient Seated for Pressure Applications – Water Supply and Sewerage
WSA PS – 261	Gate Valves, Metal Seated for Pressure Applications – Water Supply and Sewerage
WSA PS – 263	Butterfly Valves for Pressure Applications – Water Supply
WSA PS – 264	4 Non-Return (Reflux) Valves for Pressure Applications – Water Supply and Sewerage
WSA PS – 266	Knife Gate Valves for Pressure Applications - Water Supply and Sewerage
WSA PS – 269	Extension Spindles for Valves (Other than Gate Valves)
WSA PS – 274	Ball Valves for Pressure Applications – Water Supply
WSA PS – 278	Gate Valves, Resilient Seated, with Integral Polyethylene (PE) Ends for Pressure Applications – Water Supply and Sewerage
WSA PS – 280	Reflux Valves - Sewerage
WSA PS – 281	Gate Valves, Resilient Seated, with Restrained Flexible Joints for Polyethylene Pipe in Pressure Applications – Water Supply and Sewerage
WSA PS - 283	Resilient Seated Gate Valves for Under-pressure Line Stopping - Drinking Water and Non-Drinking Water Supply
WSA 101	Industry standard for submersible pumps for sewage pumping stations
WSA 109	Flanged gaskets and O-rings
WSA 130	ISO End Suction Centrifugal Pumps
WSA 131	ISO End Suction Centrifugal Motor Pumps
WSA 201	Manual for Selection and Application of Protective Coatings
IPAM	Infrastructure Products and Materials (IPAM) list or 'SEQ Accepted Mechanical Products and Material List', refer http://www.seqcode.com.au/products/.

Table 5-4 Other Codes and Publications

STANDARD	TITLE
AGMA	American Gear Manufacturers Association Standards
ANSI/HI 9.6.3	Rotodynamic (Centrifugal and Vertical) Pumps – Guideline for Allowable Operating Region
ANSI/HI 9.6.4	Rotodynamic Pumps for Vibration Measurement and Allowable Values
ANSI/HI 11.6	Rotodynamic Submersible Pumps: For Hydraulic Performance, Hydrostatic Pressure, Mechanical and Electrical Acceptance Tests

STANDARD	TITLE
ASME B16.9	Factory-Made Wrought Buttwelding Fittings
ASME B16.11	Forged Fittings, Socket-Welding and Threaded
ASME B36.19M	Stainless Steel Pipe
ASTM A182M	Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
ASTM A240M	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications
ASTM A312	Standard Specification for Seamless, Welded and Heavily cold Worked Austenitic Stainless Steel Pipes
ASTM A380	Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
ASTM A403	Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM D1785	Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
AWWA C517	Resilient-Seated Cast-Iron Eccentric Plug Valves
EN 593	Industrial valves - Metallic butterfly valves for general purposes
EN12266	Industrial valves. Testing of metallic valves Pressure tests, test procedures and acceptance criteria
ISO 9223	Corrosion of Metals and Alloys

5.4 Urban Utilities Standards

Various Urban Utilities technical specifications, procedures and templates standard may relate to mechanical works. Those identified as relevant are documented in Table 5-5.

Table 5-5 Urban Utilities Standards

STANDARD	DESCRIPTION
CHE486	Deliverables Requirements List (DRL)
STD145	Noise Environmental Standard
STD146	Air, Dust and Odour Environmental Standard
PRO84	Urban Utilities Risk Management Procedure
PRO307	Engineering Drawing and Document Management Guideline for Capital Project Delivery
PRO379	Energy Lock Out Tag Out Procedure
PRO395	Urban Utilities Addendum to SEQ Code Asset Information Requirements
PRO662	Safety in Design Procedure
TMS76	Urban Utilities Corrosion Protection Supplement to the WSA 201 - Manual for Selection and Application of Protective Coatings

STANDARD	DESCRIPTION
TEM641	Delivery Partner Project Scope of Works - Part B Standard General Specifications
TMS1732	Electrical and Instrumentation General Specification
TMS1733	Control Systems General Specification
TMS1731	Civil and Structural General Specification
TMS1647	Equipment Tag Naming Technical Specification
TMS1654	Project Document Numbering & Naming Requirements

6. GENERAL MECHANICAL DESIGN

6.1 General requirements

Specific constraints, limitations, capacities and performance requirements for machinery installations shall typically either be stated in the Project Documentation or shall be able to be determined by the Certifying Engineer from information provided in the Project Documentation. Nevertheless, unless specifically stated otherwise in the Project Documentation, the Certifying Engineer must check and confirm all condition, and sizing and dimensional information for mechanical equipment. The values and the source of design criteria information must be noted in the design report, as per DRL.

6.1.1 Design Responsibility

At all times the designer remains responsible for ensuring infrastructure designed is fit for purpose and safe to construct, operate, maintain, and demolish. In doing so the designer must exercise appropriate due diligence to identify and manage hazards so far as is reasonably practicable.

Personnel engaged for engineering design services shall be accredited, suitably experienced, competent and skilled in the field of work in which they are engaged. Design works not performed to a prescriptive standard shall be completed by or under the direct supervision of RPEQ Engineer.

6.1.2 Temporary Design

Temporary Works designs shall cover all new elements necessary for construction but intended for removal prior to final handover. Temporary Works design documentation shall be RPEQ certified and accepted by Urban Utilities' Representative before commencing installation works associated with the design.

Designs shall clearly indicate the method by which temporary designs will be used in construction.

6.2 Operating conditions and Design life

Unless specified otherwise in the Project Documentation, new equipment shall be designed for minimum design life duration as stated below for the intended environment and duty. New equipment shall also be suitable for normal continuous operation with only scheduled maintenance as specified by the component manufacturer.

Table 6-1 Design Life

COMPONENT	MINIMUM DESIGN LIFE
Network Water and Wastewater pumping facility and piping	Design life in SEQ Code takes precedence
Stainless Steel Process Tanks	30 years
Stainless Steel Process Pipe	30 years
Carbon Steel Process Pipe, HDG or Painted	25 years

COMPONENT	MINIMUM DESIGN LIFE
Pipe Supports General (Metallic)	25 years
FRP/GRP/PE/PVC (Non-metallic) Process Tanks	25 years
FRP/GRP/PE/PVC Process Pipe	25 years
General Mechanical Equipment, including equipment enclosure, pumps and blowers	25 years
Process ductwork	25 years
Solids Handling and Slurry Pumps	15 years
Chemical Dosing Pumps and Equipment	10 years
Instrument Air Compressors	15 years
Diffused Aeration Diffusers	7 years
Surface Mounted Aerators	30 years
Penstocks, and Stop-Boards	50 years
Penstock Lift Mechanisms	25 years
UV Equipment	25 years
Platforms, walkways, stairways, and handrailing used for process applications such as accessing tanks, pipes and process plant and mechanical equipment	25 years
Lifting Equipment (indoors) refer structural building design life.	50 years
Lifting Equipment (outdoors)	25 years
Conveyors	25years

Where brownfield site upgrades are required, Urban Utilities seeks to realise any benefit that may be achieved by retaining and repurposing existing equipment and infrastructure, provided that such equipment is capable of being cost-effectively reconditioned and integrated within the upgraded facility or process trains. Such structures, equipment and services that are to be re-used or integrated into the site upgrade, may have already undergone a visual inspection with consideration for age, wear, as well as review of maintenance and failure records and feedback from site personnel during the preparation of project requirements Documentation. However, some areas or equipment such as submerged structures and plant may not have been inspected prior to development of all project requirements within the project scope. In such cases, the exact scope of work and the selected design solution and construction methods may need to be revised and re-evaluated at appropriate stages during the project delivery, subject to any requirements of the Project Documentation.

6.3 Design Investigations

The Certifying Engineer must determine the veracity and criticality of information supplied from Urban Utilities records about existing assets, early in the design phase of the project, to de-risk the work program on site as much as possible, where existing asset information may have a critical effect on design or the site work program.

Also refer to Section 3.5 of TEM641, where relevant to the project scope of work.

6.4 Design Documentation

Unless required otherwise in the Project Documentation, design drawings and equipment specification documents must be provided according to the project Deliverables Requirements List (DRL). Refer to CHE486 (DRL) for the types of documentation which may be required.

6.5 Service Requirements

Unless required otherwise in the Project Documentation, mechanical plant must be designed, selected and installed on the basis that processes operate continuously, and that individual plant may be set to operate continuously for indefinite periods.

Maintenance, service and parts replacement interval periods must be provided to Urban Utilities within design deliverable documents as early as possible within the design development phase of the project.

Any new mechanical equipment that is intended be supplied, must be capable of being serviced by competent service providers. Any requirement that equipment can only be serviced by the supplier shall be made known to Urban Utilities, at the time of offer, with all details included in the design deliverable documents.

Parts that are subject to wear and the need to be adjusted or replaced shall be readily accessible and simple to replace with the machine in place, as far as practicable.

Routine operator and maintenance tasks which include inspection, cleaning, lubrication changes and replenishment must be capable of being safely carried out from either the ground, or permanent access platforms.

Access to removable inspection panels, lubrication injection points, sensor covers and the like, must not be obstructed by pipe, handrail or support structure items, unless these elements are also designed and made to be readily and safely removed for such activities.

6.6 Commonality of Equipment

The designers shall use common/interchangeable equipment within a process facility with the same function and capacity requirement as much as is practicable to reduce the number of spares that will be needed and to make machinery items interchangeable wherever possible. A list of preferred mechanical products and materials for Network is available within the 'SEQ Products and Material Lists' (http://www.seqcode.com.au/products/), also known as the Infrastructure Products and Materials (IPAM) lists.

6.7 Availability of Spare Parts

Unless stated otherwise in the project requirements documentation, the availability of spare parts information including, but not limited to normal stock availability, the location where spare parts are held and the expected lead time for delivery to Urban Utilities maintenance service providers, must be provided on the relevant equipment data sheets which must be completed and included in the design deliverable documents.

6.8 Special Tools

Where special tools for assembly are required, a complete set of special tools must be, supplied with on the equipment item assembly at delivery.

6.9 Equipment Data for Design and System Integration

Mechanical equipment manufacturers and suppliers shall provide complete data sheets containing details of all the necessary design parameters, to enable integration into the process train as well as design of all necessary supporting equipment and services that are needed for the construction, operation and maintenance of the supplied machinery. Such supporting service sub-systems may include but may not be limited to:

- Provision for flushing and drainage,
- Wash water,
- Cooling and ventilation system,
- Compressed air supply,
- Power,
- Communications

6.10 Quality Assurance Records

Mechanical equipment and facilities provided to Urban Utilities shall be designed and manufactured, installed, integrated, tested and commissioned under an appropriate quality management system. Unless stated otherwise in the Project Documentation, quality assurance records shall be supplied as per the project DRL, refer to (CHE486).

6.11 Quality Assurance Plan

Quality assurance plans are a series of documents that plan and record the quality assurance activities that will ensure and verify the defined quality outcome that must be achieved for a significant fabricated structure or manufactured item.

Quality assurance plans shall show the type, sequence and number of testing, inspection and measurement activities and events to occur in each relevant stage of the manufacturing process, as well as how the pass or rejection criteria are determined.

Documents to be included in the quality assurance plan, depending on type and complexity of the manufacture may include:

- Procurement records, referencing relevant drawings and datasheets
- Material Certification - certificate of conformity to confirm source of raw materials
- Welding – documents appropriate reference procedures, qualification and certification records
- Protective coating requirements – reference coating specifications
- Assembly – reference dimensional checks and functionality checks
- Non-destructive testing methods
- Factory Acceptance Test – reference applicable separate Factory Acceptance Test documentation
- Certification Documentation (Materials, component parts, and component sub-assemblies, Certification of Conformity showing compliance to the equipment data sheets).

Unless stated otherwise in the project requirements the quality assurance plan shall also include Witness Points listed in Table 6-2 Witness Points.

Table 6-2 Witness Points

WITNESS POINT	CLARIFICATION
Drawings, Data Sheets and Technical Info	Approval of technical data and drawings prior to placement of orders
Dimensional and Assembly Check	Tack welded assembly with dimensional check. Prior to release for welding plus dimensional confirmation post welded fitted assembly
Welding and NDT Inspection	Post welding inspection with NDT requirements
Release to Corrosion Protection	Post grinding, fettling, weld splatter removal and cleaning, prior to corrosion protection
Corrosion Protection	Corrosion protection shall incorporate independent ITP with separate Hold and Witness Points, based on the type of corrosion protection system to be applied
Factory Acceptance Testing	The Project Documentation shall indicate type of Factory Testing as well as acceptable or target performance criteria required for Sub-contractor, Manufacturer and Vendor Supplied Systems and Equipment.
Final Release and Documentation Review	All documentation is complete, and product is ready for dispatch

Unless stated otherwise in the Project Documentation, design information must be provided for all third party procured systems and equipment in accordance with requirements outlined in this section.

6.11.1.1 Shop Drawings

Detailed drawings must be provided for all vendor and sub-contractor supplied mechanical systems and equipment items with the following minimum details:

- Principal dimensions
- Weld and construction details
- Materials of construction
- Corrosion protection system

Imported equipment shall be from reputable suppliers with local representation. ISO 9001 certification shall be required for vendors of imported equipment.

Where components are of a bespoke design, that is specifically developed for the work under contract, the equipment drawings provided must contain sufficient detail to enable Urban Utilities to have the component or item re-manufactured.

6.11.1.2 Datasheets

Completed technical data sheets shall be provided to Urban Utilities for key mechanical systems and plant equipment (in native Excel format). Standard Urban Utilities Datasheets shall be used where available for the following equipment:

- Penstock / Stopboard
- Micro-strainer inlet strainer
- Inlet screens
- Screenings washer/compactor
- Grit Removal Equipment (channel type and paddle type)
- Surface Aerator
- Blower
- Centrifuge
- Centrifugal Pump
- Conveyor
- Chemical Dosing Trains
- Liquid Chemical Storage Systems
- Compressed Air System
- Sludge Screen

Where Urban Utilities does not have a standard datasheet for an equipment item, a specific project related datasheet shall be created during the early stages of the project and used as part of the Issue for Tender documentation. Bespoke data sheets that are developed for work under contract shall specify at a minimum the following criteria, as applicable:

- Manufacturer
- Place of manufacturing
- Model number
- Data Sheet Sections
- Project Reference Information
- Environmental operating conditions
- Equipment performance data and operating range
- Process Requirement Information
- Function Information
- Design parameters and design information
- Type and configuration information
- Process configuration Information
- Ancillary service requirements (service water demand, compressed air demand, potable water demand, ventilation etc.)
- Electrical data (kW, voltage, frequency, phase, current, etc.)
- IP rating
- Materials of construction
- Manufacture Information
- Recommended Spares

6.11.1.3 Material Certification

Unless stated otherwise in the Project Documentation, Mill Test Reports must be provided for metals other than wrought mild steel sections.

6.11.1.4 Equipment Certification

Certified documentation shall be provided to Urban Utilities within a compiled QC pack to ensure the following:

- Equipment compliance with relevant standards and codes
- Quality assurance
- Ensure safety in design
- Final functionality of the equipment and/or system achieves the intended purpose

Accepted Certification may be in the form of certificates (issued by equipment suppliers, registering authority or authorising authority) or RPEQ certified drawings.

The following list of items are provided as a typical guide of mechanical items requiring certification. This list is not considered extensive but rather as a guide and the relevant standards apply to all supplied equipment. Note building certifications are not referenced in this mechanical specification as they are considered civil works not mechanical works. Similarly electrical certification documentation is also not listed as it is considered electrical works not mechanical works.

- Equipment Material certification
- Trade certification
- Engineering certification
- Welding certification
- Manufacturing certification
- Drawing Certification (RPEQ signoff)
- Pressure vessel certification
- Fall restraint equipment certification
- Lifting equipment / crane certification
- Plumbing certification

6.12 Welding

Welding of steels shall be carried out strictly in accordance with the requirements of AS 1554, or approved equivalent international standard for items fabricated overseas unless specifically stated otherwise on drawings and/or Project Documentation.

Welding symbols on drawings shall be in accordance with the requirements of AS1101.3. Welding of pipes and pipe fittings shall be in accordance with the requirements of Section 5 of AS 4041 and AS 4458.

Welding of stainless steel shall be in accordance with the requirements of AS 1554.6. -All carbon steel and stainless-steel welding shall be carried out conforming to either GP (General Purpose) or SP (Structural Purpose) categories as defined in Section 1.6 of AS 1554.1, or FP (Fatigue Purpose) as defined in AS 1554.5. Weld categories shall generally apply to the mechanical works applications listed in Table 6-3 Weld Category Application below.

Table 6-3 Weld Category Application

CATEGORY	DESCRIPTION
GP	Minor brackets carrying light fittings, electrical cable trays, etc.
SP	All structural connections for walkways, support frames and machine frames, including all bracing and cleat connections
FP	To be avoided by design, so far as is practicable.

The removal of slag and weld spatter shall be part of the welding process.

6.12.1 Welding Supervision

Welding for category GP, SP and FP shall be carried out by suitably qualified welders with welding qualifications and approved weld procedures in accordance with the requirements of AS 1554.1. Where applicable, all welders shall work under the supervision of a welding supervisor as defined in Section 4.12.1 of AS 1554.1.

6.12.2 Preheating

Where required, preheating and inter-run temperature control shall be performed in accordance with the requirements of AS 1554.1, Clause 5.3.

6.12.3 Procedure and Performance Qualifications for Welding

All welders shall be certified and / or qualified in accordance with the requirements of the relevant part of AS 1554. Copies of all welder qualifications and certificates shall be issued upon request to Urban Utilities representative before commencing work on site.

For all weld categories, the fabricator shall have available welding procedures and procedure qualification records to submit if requested to the Urban Utilities representative for approval.

6.12.4 Welding Consumables

Refer to Section 2.3 of AS 1554.1.

Batch certificate records shall be included in the weld qualification records.

6.12.5 Non-Destructive Testing

All non-destructive testing shall be carried out by suitably qualified and accredited technicians for carrying out the examination method employed satisfying the requirements of:

- Section 7.4 of AS/NZS 1554.1 for structural steel
- Section 7.4.2 of AS/NZS 1554.6 for stainless steel
- Section 7.4.2 of AS 1665 for aluminium

Test Technicians shall be accredited by the Australian Institute of Non-destructive Testing (AINDT).

6.12.6 Weld Repairs

For all SP and FP weld categories for steel and weld category B for aluminium structures, where it is necessary to repair welds that have failed the inspection criteria, Urban Utilities shall be advised in writing and a repair welding procedure shall be prepared and provided to the Urban Utilities representative for acceptance before commencing repair work. Weld repair work shall be carried out in accordance with the requirements of:

- Section 5.8 of AS/NZS 1554.1 for structural steel
- Section 5.16 of AS/NZS 1554.6 for stainless steel and
- Section 6.2 of AS 1665 for aluminium structures.

6.12.7 Weld Finish for Stainless Steel

Stainless steel fabricated parts shall undergo a mechanical and chemical clean, followed by passivation in accordance with the requirements of Section 6.2.3 of AS 1554.6.

Unless stated otherwise in the project requirements Documentation, post weld pickling and passivation processes must achieve a minimum of “Surface condition II” as defined in Section 6.2.3 of AS 1554.6 shall be included for all stainless steel fabricated equipment and shall be conducted in accordance with the requirements of ASTM A380.

6.12.8 Welding Assurance

Welding records demonstrating compliance to the required standards and shall be filed and available for inspection by Urban Utilities. The documentation will typically include the following where applicable:

- Inspection & Test Plan (ITP)
- Qualified welding procedure specifications
- Procedure Qualification Record
- Welder Qualification Records
- Mechanical non-destructive test results
- Welding supervisor qualifications
- Welding inspector qualifications

6.12.9 Assembly

Final assembly of parts and equipment shall be visually inspected prior to conducting dimensional checks, followed by functional testing, with results recorded on the ITP record document. Where specified in the project requirements Documentation, Urban Utilities shall be provided reasonable notice so that Urban Utilities’ representative can be present to witness ITP inspection, testing and completion activities.

Any tools, equipment or services required to check final factory assembly shall be supplied by the manufacturer. This shall include, but not limited to the following:

- DFT equipment
- Torque wrenches
- Measuring and levelling equipment

- Lubrication charges
- Supply power

6.13 Safety in Design

The Safety in Design processes shall be incorporated into the design in order to reconcile safe design with full facility life cycle and function. The design process shall be a structured process aimed at discovering and documenting all potential safety risks associated with the Works in accordance with the requirements of relevant acts, regulations, Australian standards and industry codes of practice.

The design shall identify, document and address all safety risks early in the design process. Refer to PRO662 *Safety in Design Procedure* for details regarding the implementation of Safety in Design and Project Risk Assessments.

6.13.1 Machine Safety

Machine safety principles as per AS/NZS 4024 shall be applied to machines or packages / assemblies of machines designed to work as a singular unit (e.g. belt filter press, step screens, settling tank bridges etc.). "Machine" in this context is defined as an assembly, fitted with a drive system consisting of linked parts or components, at least one of which moves, and which are joined together for a specific application (e.g. a pump and coupled motor or a fan, but not a gas-fired boiler, an electric heater, a tank or a pipe system).

When selecting machines or assemblies of machines for use at Urban Utilities facilities, documentation must be available showing compliance with the relevant portions AS/NZS 4024 or its harmonised international equivalents as listed in AS/NZS 4024:1100 (note that many of these are also listed as part of Machinery Directive 2006/42/EC). Machine compliance to AS/NZS 4024 shall be confirmed as early in the equipment selection process as possible. Documentation shall explicitly name the standard(s) applied and may take one or more of the following forms:

- Documentation as per AS/NZS 4024.1201 summarising the risk assessment procedure followed, the results achieved, and the safety measures applied
- Declaration of conformity
- Third party certifications
- Test certificates

A machine safety risk assessment as per AS/NZS 4024:1201 (in addition to the requirements of PRO662 Safety in Design) shall be carried out for machines or packages / assemblies of machines being supplied where no documented compliance with AS/NZS 4024 or a harmonised international equivalent can be provided.
Specific requirements for complementary safety measures to enhance the safety of machines beyond AS/NZS 4024 mandatory requirements are outlined in the following sections.
Urban Utilities requires machine safety be incorporated into designs in accordance with the requirements of the following general approach:

i) machines or systems should have an inherently safe design, such that they do not cause harm under any conditions, including as a result of:
   - their physical shape
   - by the magnitude of active forces
   - by transferring or accumulating and releasing potential kinetic, chemical, sound pressure or electro-magnetic energy

ii) If the machine or system is not inherently safe, the Certifying Engineer must warrant that the necessary layers of protection for risk control are provided. Such layers of protection should follow the hierarchy of controls and may include the following:
- safeguarding to provide physical barriers.
- secondary protective measures, including sensitive protective equipment, interlocks, double action switches, lockable switches, two hand control devices, or other control system protective measures.

iii) Information for safe use must be provided by the Certifying Engineer, having regards to human factors. Such information for use may include but may not be limited to the following:
- Details of residual risk that is not able to be eliminated by inherently safe design or secondary protections.
- Scenarios that may lead to the defeat or failure of secondary protections.
- Prohibition or warning signs and labels placed where they will be seen by persons who interact with the machine or system for all limits of use.
- Training for operators and maintainers to include information about how to detect and prevent the potential interactions with the machine or system from potentially becoming harmful.
- Provision of training material to facilitate retraining for operators and maintainers.

6.13.1.1 Safety Instrumented Systems

Owing to their complexity and difficulty of integration with Urban Utilities' systems, the use of Safety Instrumented Systems (SIS) shall be avoided if the required safety performance can be achieved without their use. Where use of SIS is unavoidable (e.g. proprietary vendor control systems), the SIS shall comply with TMS1651 Machine Safety.

6.13.1.2 Guards

All moving shafts, couplings, flywheels, belt drives and hot surfaces shall be fully guarded in conformance with the relevant Queensland Work Health and Safety Act, Regulation and Codes of Practice and Australian Standards (including AS 4024). Guards and protective barriers shall be provided to eliminate the risk of body parts getting into any crush or pinch points on machines or in contact with hot surfaces.

Grease points and operational check points shall be accessible with guards in place. The minimum requirement for fixing and attachment guards and barriers is for them to be reusable many times. Attaching guards or removable barriers with rivets or self-drilling screws is not acceptable. Where new fixings are added to existing machinery, such fixings must not create stress concentration points to stressed elements of the machine or structure.

Where machinery is fitted with removable covers to facilitate frequent access for adjustment or close inspection, such covers must be fitted with permanent warning signs and where deemed necessary through the specified risk assessment, shall also be fitted with at least one of these legislated control measures (per WHS Regulation): an interlock, the use of a tool to remove the guard, or presence-sensing detection.

Where frequent inspection of moving parts is required, but manual access to the parts is not required while the machine is operating, the cover shall be transparent to allow inspection without removal of the cover.

Where guard panels are incorporated into walkway handrails, the resultant assembly shall be fully conforming to AS1657. Mesh guards that are intended to allow operators to see moving machinery parts shall be painted matt black to minimise reflected light and make it easier for operators to see through the mesh.

6.13.1.3 Warning Signs, Sirens and Strobes

Safety and warning signs shall comply with the requirements of AS 1318, AS 1319, AS 2508, AS 1216 and AS 3780 as applicable and shall be installed adjacent to equipment that may start automatically, and where other potential hazards including chemical hazards may occur.

Outdoor signs shall be suitable for prolonged exposure to UV and weather conditions, without any significant deterioration over the design life of the machine.

Unless specified otherwise in the Project Documentation, all automatically operated moving machinery must be fitted with a flashing light and siren to operate a minimum of 30 seconds prior to starting with the light remaining on for least 2 minutes after the machine has started or until the machine has stopped.

6.13.1.4 Safety Interlocks

Necessary safety interlock devices shall be provided to prevent the system from operating or to stop the system if upstream or downstream parts of the process train are not in; or do not remain in a suitable or available condition.

6.13.1.5 Fail Safe

Critical input signals and interlocking devices shall be in the logical ‘on’ or ‘1’ state for normal operation or run permissive resultant function.

When power sources are de-energised or fail, machine motion must stop. Process plant and devices must move to a safe state. Refer to Section 3.5.6 *Programming for Failsafe Control* in TMS1733.

6.13.1.6 System Protection Devices

Mechanical systems, conveyors, pumps and pressurised equipment in particular shall be protected from damage through binding, bearing collapse, blockage or other process-related stoppages.

Means of protection may include:

- Over pressure, under pressure and over temperature switches
- Under and Over Pressure relieving devices
- Torque limiters
- Mechanical or electrical shear pins
- A combination of the above

Proprietary mechanical equipment shall be provided with all necessary protection devices for the intended operating conditions.

Protection devices shall be adjustable within the safe operating capacity of the equipment and/or system.

Effective torque limiting devices shall be fitted to the following equipment:

- Mechanical Screens
- Conveyors
- Final Settling Tank (FST) Drives
- Centrifuges

Also refer to:

- Section 7.1 LV Motors requirements for thermal overload protections.
- Section 3.5 PLC Programming of TMS1733.

Where under and over-pressure protection requirements may include a pressure relief valve, the relief valve shall be in accordance with the requirements of AS 1271. The inlet or exhaust shall be located so as not to create a hazard or nuisance. The relief valve shall maintain a positive seat with no partial passing until the relevant pressure excursion event has commenced. The relief valve set point shall be selected as a final protection for the pump and / or system from mechanical damage. Primary protection of the system shall be provided by the normal system controls, backed up by high or low pressure switches.

6.13.1.7 Protection from Vehicles

Corner guards, wheel stops, protective barriers or bollards and warning signs shall be provided to protect structures, equipment and personnel that are vulnerable to harm from moving vehicular traffic. Such protective devices shall comply with relevant Australian Standards, including but not necessarily limited to AS 1319, AS 1742, AS 1906, AS 2890 and AS 3845.

Unless specified otherwise, all bollards shall be at least 140mm diameter x 1200mm high above finished surface level and painted yellow in accordance with the requirements of AS 1319, with a min. 50mm wide reflective top band.

A minimum 1100 mm clearance shall be provided between the protected structure or equipment and the bollard.

6.14 Labelling and Nameplates

A nameplate/data plate manufactured from stainless steel grade 316 shall be installed to the body, where they are easy to see, on all motor driven machines and process equipment (including those without electrical motors), by means of stainless-steel grade 316 screws (or rivets). Data Plates shall be stamped, laser etched or engraved with all relevant data as listed below.

6.14.1 Equipment Generic Data (Applicable to all equipment)

a) Manufacturer's name;
b) Model Number or Manufacturers Code

c) Year of Manufacture
d) Serial Number
e) Total Weight (if required)

6.14.2 Equipment Specific Data

In addition to Equipment Generic Data, all Equipment Data Plates shall include specific performance data, operating capacity and other key criteria useful for site staff. The below table provides a guideline of the typical data plate attributes for typical treatment plant equipment for reference purposes.

DATA TO BE INCLUDED	APPLICABLE TO:
Performance duty capacity	All process equipment
Electrical Data (Voltage, Frequency, Full Load Current, Power Factor	All equipment with an electrical drive
Weather IP Rating	All electrical Equipment
Body Material Designation	All Equipment
Operating / Output Speed	Pumps, Gearboxes, Actuators, Mixers
Gear ratio	Gearboxes
Propeller Pitch	Mixers, Fans
Impeller Size / Type	Pumps
Direction of Rotation	Pumps, Gearboxes, Mixers, Surface Aerators
Direction of flow indication	Penstocks, Stop Boards
Nominal Size or Aperture dimensions (width x height)	Penstocks, Stop Boards, Tilting Weirs

The location of the equipment nameplate shall consider the location and orientation of the equipment to enable access and readability of the nameplate when commissioned.

6.14.3 Valve Specific Data

- Valve Type
- Nominal Size (DN)
- Pressure Class (PN)
- Australian Standard Design
- Process Connection (Flange Spec, Class, BSP)
- Direction of Flow (indication to be on valve body)
- Open and close arrows when applicable (on spindle)

6.14.4 Plant Tags (Labels)

Plant tagging shall be supplied separately to the equipment nameplates at the end of the project to enable time to nominate the Ellipse Plant Code ID number. The plant tag shall be

stainless steel 316 tag of nominal size 80mm long x 15mm high x 1mm thick stainless 316 steel plate. Text height shall be 10mm.

Refer to applicable AS/NZS Valve Code for guidance on valve nameplate size and lettering details. Designers shall seek approval from Urban Utilities in the event the physical dimensions specified for the applicable nameplate are not practical (such as for small bore valves).

Plant Tags shall be permanently fixed to, or adjacent to, the plant using screws, pop rivets or tied using corrosion resistant wire as appropriate to the plant item.

6.14.5 Motor Specific Data

Electrical motors shall be provided with a nameplate meeting the requirements of AS 60034. In addition to those requirements, the following information shall be displayed when applicable:

- Motor mounting style as defined by Code II in AS 60034.7
- Motor weight in kg
- Winding connection type (i.e. star or delta)
- Type and manufacture of temperature sensing devices installed (e.g. Pt100)
- Type and size of bearings installed in the motor (including grease type)
- Anti-condensation heater power draw in VA
- Additional parameters for motor duty types S2-S10 (i.e. not continuous) as per AS 60034.1
- Ex markings for motors installed in Hazardous Areas to AS 60079 (refer to TMS1732 *Electrical & Instrumentation General Specification* for details), including conditions (e.g. suitability for use with a VSD)
- Operating limits for use with VSDs, including speed, power, torque, voltage and current
- Bearing grease type (for motors ≥75kW)

Part or all the above information may be provided on a separate nameplate if space is restricted on the manufacturer's standard nameplate.

Unidirectional motors shall indicate direction of rotation with an arrow at the non-drive end of the motor frame. Arrows shall be stamped or made from 316SS and riveted to the frame. Painted or adhesive direction labels are not accepted.

Refer to TMS1632 *Electrical & Instrumentation General Specification* for detailed requirements related to electrical safety and warning labels.

6.15 Access Platforms, walkways, stairways and ladders

Wherever possible, equipment shall be located to provide safe, convenient and unobstructed access for operation and maintenance with the machine in place, as well as future removal and replacement. The machinery installation design shall consider how future maintenance, removal, replacement and demolition activities can be carried out while adjacent and associated plant are able to continue to operate if necessary.

ACCESS PROVISION	DESIGN REQUIREMENT
General access pathways to, through and past zones - minimum clear width.	New facilities: The clear width of all general access routes and evacuation routes shall not be less than 1,000 mm, Urban utilities may approve deviation based on brownfield limitations; where this practically cannot be achieved, for an absolute minimum width of 600 mm for short distances.
Access around plant and equipment	Access must be sufficient to allow maintenance work to be carried out safely. The clear width of access around plant and equipment shall be 800 mm minimum, Urban utilities may approve deviation based on brownfield limitations; where this practically cannot be achieved, for an absolute minimum width of 600 mm for short distances.
Level walkways	(0^o to 3^o from horizontal in direction of travel) as per AS 1657, preferred selection. Single steps between horizontal walkways are not allowed, as they may cause a trip or stumble. Warning signs and at least one handrail is required for each level change between horizontal walkways. Maximum slope perpendicular to the direction of travel shall be 3^o.
Sloping walkways	(3^o to 10^o from horizontal in direction of travel) as per AS 1657 preferred range. Single steps on sloping walkways are not allowed, as they may cause a trip or stumble. Warning signs and at least one handrail is required for each level change between sloping walkways. Maximum slope perpendicular to the direction of travel shall be 3^o.
Stairs	(30^o to 38^o from horizontal) as per AS1657 preferred range only.
Handrails, gates, safety rails,	Shall be based on Webforge MonowillsTM System or Urban Utilities accepted equivalent.
Inclined Step-type ladders	Generally not suitable for Urban Utilities sites and may only be used where no other access solution is practicable. Consultation with workers is mandatory and must be documented in the design report. No ladder may be preferable where the need to access the elevated zone is infrequent and where elevated access can be provided by the use of a mobile, elevated work platform.
Inclined rung-type ladders	As per inclined step-type ladders above.
Single stile rung-type ladders	Not allowed on Urban Utilities' sites
Individual -rung ladders (step irons)	Not allowed on Urban Utilities' sites
Floor protrusion and trip hazards	Hinges, handles, latched and the like that may be necessary where through floor access hatches are provided, but must be of a recessed or counter sunk design, such that they finish flush with the floor surface. *Note:- this is a (zero mm) safer requirement than the maximum, 5mm protrusion or level discrepancy that is indicated in AS 1657.*
Confined Space Access Considerations	Mechanical equipment installations shall be designed so that machines or maintainable sub-assemblies can be removed without

ACCESS PROVISION	DESIGN REQUIREMENT
	the need to enter a confined space. Designs requiring confined space entry may only be used subject to Urban Utilities written approval and only in those areas requiring infrequent access and where confined space entry is considered unavoidable.
Safety Below Platforms or Landings	Refer to Sections 4.5 and 4.6 of AS 1657. If access to places beneath any platform is not excluded, then protections must be provided.
Corrosion Environment and material selection considerations	Access platforms, walkways, stairways and ladders for mildly corrosive environmental conditions and manufactured from carbon steel shall have minimum corrosion protection of HDG 600 in accordance with the requirements of section 6.19.2. Extreme corrosion environments around the following process elements shall have sub-floor structural elements and platform decking made from appropriate materials such as GRP, Stainless 316 or marine grade aluminium: - Primary treatment area (inlet works, screening plant, grit separation), - Primary Settling tanks, - Primary sludge thickening plant, - Biosolids separation (dewatering plant), - Areas adjacent to the marine environment - Any area where an extreme corrosion micro-environment maybe created. Hot-dip galvanised steel, coated steel and aluminium shall not be selected for immersed applications. Corrosion resistant materials such as grade 316 stainless steel or FRP shall be selected for ladders to pits and for platforms, walkways, stairways and ladders in immersed applications. Fixings shall also be manufactured from corrosive resistant materials in such environments.
Where not specifically stated otherwise in this specification or in the Project Documentation, conformance with the requirements of AS1657 applies to access structures and requirements	

6.16 Lifting Facilities

Urban Utilities prefers to use Maintenance Service Trucks, fitted with jib cranes for all lifting requirements. However, in the event that Service Trucks do not have sufficient access for work, fixed or moveable lifting gear shall be provided.

Urban Utilities' Service Truck vehicle specifications are as follows:

- Typically ISUZU NPR400 Medium
- Wheel Base: 3.365m
- Overall Length: 5.985m
- Rear Overhang: 1.510m
- Rear Track: 2.115m
- Front Track: 2.115m

- Height: 2.500m
- Cab Height: 2.270m
- Body Width: 2.250m
- Turning Radius: 6.300m

The Jib crane is located at the rear of the truck

Where specified in the Project Documentation, suitable permanent lifting facilities, such as jib cranes, monorail cranes, gantry cranes must be provided. Where permanent lifting equipment is not specified and access by the maintenance service trucks is not practical, the design shall make allowance for suitable mobile lifting equipment such as A-Frames or engine type hoists. When incorporating use of A-frame roller hoists, adequate aisle space and floor designs shall be allowed for the safe removal of equipment via trolleys or otherwise.

6.16.1 Mechanically Assisted Lifting Frames

Where the design intent is that mobile A-frames or engine hoists shall be utilised to facilitate maintenance work on mechanical equipment. The designs of aisles around equipment and between plinths shall allow safe maintenance lifting clearances. Floors shall be designed to suit point loads from mobile lifting equipment and handling trolleys.

Mobile lifting equipment shall be in accordance with the requirements of the relevant AS standards including AS 1418 and industry codes.

6.16.2 Jib Cranes

Where specified as part of the scope of work, equipment such as submersible mixers, stop boards, penstocks, gates, submersible pumps etc. shall be provided with a means of mechanically assisted lifting.

Where the equipment is light enough to allow a small light weight davit to be used, the installation of multiple permanent davit bases and supply of a removable davit lifting mechanism can be offered in lieu of installing multiple permanent installed jib cranes (davits) . Where the size of the davit crane is too great to be removable, permanent cranes shall be installed at all locations where appropriate.

Each jib crane must include a boom hoist, or winch, associated lifting chain or wire rope, hook and all necessary fixings. The jib crane may be post or wall mounted. Where davit bases are installed in walkways, base plates shall finish flush with walkway levels so as not to create a tripping hazard.

The reach and slew of the boom must provide for lifting of the load from its installed position and lowering the load to a designated platform or floor area.

6.16.3 Overhead Travelling Cranes

Overhead travelling gantry cranes shall be supplied and installed complete with beams, rails, bridge, trolley, hoist, catenary system, service platform and access ladder and shall be designed, manufactured, factory tested, delivered, installed, site tested, commissioned, certified in accordance with the requirements of the relevant parts of AS 1418.

Crane Group Classification shall be C1 and Crane Mechanism Classification shall be M2, all in accordance with the requirements of AS 1418 Part 1 and AS 5246.1.

All long travel rails shall be fixed true and secure to the support beams or support structure. Allowance shall be made for linear expansion in the rail fixing brackets. Mechanical end stops shall be fitted to each end of the rails and be removable. The height of each end stop shall be suited to the crane carriage bumper. Electrically operated cranes shall be fitted with adjustable limit switches to limit crane travel before reaching end stops.

Any lubrication points shall be easily accessible for site operators using standard equipment, to be specified in the Project Documentation.

All service platforms and access structures shall comply with AS 1657 and AS 1418.

The operating envelope of the crane system must enable the safe lifting of all installed mechanical and electrical equipment.

6.16.4 Crane Hoists

All cranes shall be provided with either a wire rope or chain hoist.

The hoist shall have sufficient vertical head room to lift the equipment free of all possible obstructions from the installed position and place it within the designated loading or service area or onto transport.

The hoist brake shall be fail-safe under power failure conditions. The brake mechanism shall be suitably protected from rain or water spray and dust ingress.

The hoist steel wire rope shall be in accordance with the requirements of AS 3569. Hoist lifting chains shall be in accordance with the requirements of AS 2321. Where exposed to sewage or aggressive environments, the wire rope or chain shall be manufactured from stainless steel and comply with AS 4797 if supplied as chain.

The hoist rope shall be manufactured in one continuous length, without any joints. Particular attention must be paid to anchorage to the drum, upon which the rope shall be wound tightly without any kinks.

A rope and pressure ring shall be provided to ensure the rope lays correctly and actuates the upper and lower limit switches to prevent overwinding of the drum.

For manually operated hoists and trolleys, the hand chains shall be suspended below the crane beam or boom to 500mm above floor level.

All gears and sprockets shall be fully guarded. The hook shall be drop forged steel. It shall have a safety catch and be supported by a thrust ball or roller bearing to allow it to swivel in any direction.

All external parts of the hoists and trolleys shall be coated in accordance with the requirements of WSA 201 and TMS76. The hoist and equipment shall be suitable for continuous exposure to the weather and direct sunlight.

6.16.5 Electric Hoists

All electrically operated hoists shall be controlled by a pendant control station. The control station shall also include trolley and gantry or boom travel controls, as applicable. The station shall house all the required push buttons to provide the required two speed control in each direction.

The pendant shall control all motors and the master cut-out contactor. Push buttons shall be provided to control the following operations, as appropriate:

- Raise
- Raise – creep
- Lower
- Lower – creep
- Transverse forward and back
- Transverse forward and back – creep
- Longitudinal forward and back
- Longitudinal forward and back – creep
- On
- Off – master cut-out

6.16.6 Crane Electrical Requirements

Except where the specification requires a higher standard, all work shall be carried out in accordance with the requirements of the latest edition of AS/NZS 3000, AS/NZS 3008.1 and TMS1732.

All crane supply must be 415V, 3 phase, 50Hz.

Electrically operated cranes shall include sliding contact power feed systems and collectors (a catenary power feed system or travelling cables) and travel limit switches.

The catenary system shall be of robust design, and shall be supplied with all rails, trolleys, clamps and accessories to provide a complete and safe installation.

The catenary system shall be located so as to be easily accessible for maintenance using standard equipment, to be specified in the Project Documentation. The system shall be installed level, true and correctly aligned with the travel of the crane and shall be of adequate length to allow operation of the crane over the full range of travel.

A 3-phase isolating switch shall be installed adjacent to the cranes access platform, or as agreed with Urban Utilities. The isolator shall be correctly labelled.

All overhead travelling cranes shall include a cycle logger for mechanical maintenance and inspections.

A certificate of compliance of Electrical Work (CCEW) and all associated documentation shall be completed as per requirements set out in TMS1732.

6.16.7 Limit Switches

Limit switches shall be heavy duty industrial type and shall be installed on the crane to limit the hoisting, long and cross travels. Any additional motion limiting devices, where required, shall be provided to obviate physical damage to the crane or an object, or structure within the crane area.

Working limit switches shall be provided for the hoisting motions, cross travel and long travel. When operated these switches shall cause the power supply to the motor it controls to be interrupted and the brake to be applied. Note this must not prevent reversal of motion. The limit switches shall be self-resetting when the motion returns to the non-limited section of its range.

A final limit switch shall be provided for limiting the hoisting motion. When operated this switch shall cause the power supply to the motor to be interrupted and the brake to be applied. The final limit switch shall be of whole current series type and must prevent reversal of motion until it has been manually reset. The means to manually reset the final limit switch shall not be readily accessible to the crane operator.

6.16.8 Lighting

Where specified in scope of work lighting meeting applicable Australian Standards shall be provided for illumination of the hook and load. All light fittings if installed on the crane structure shall have anti-vibration mountings.

Illumination shall be suitable for maintenance work and shall be to TMS1732 and AS 1670.

6.16.9 Crane Installation and Testing

The crane shall be installed and tested under the crane manufacturer's supervision. Each crane, along with all its associated equipment shall be load tested and certified to its safe working load in accordance with the requirements of AS 1418. The beams and trolleys shall be tested for their range of travel. All certificates of compliance and commissioning documentation shall form part of the cranes Operation and Maintenance Manual.

6.17 Bolts and Fasteners

All mechanical equipment supplied, shall be furnished with suitable fasteners, tightened to the torques specified by their manufacturer and, where necessary, secured from becoming loose. Tack welding is not an acceptable anti-loosening system.

All metric bolts, screws and nuts shall comply with AS 1110, AS 1111 and AS 1112.

Thread must comply with AS 1275.

All unified bolts and nuts shall comply with AS 2465 with threads complying with AS 3635.

Flat metal washers shall be fitted under each bolt head and nut and shall be of same grade as the bolt set. Washers shall be in accordance with the requirements of AS 1237.

Bolt lengths shall be selected such that after fully torquing the bolt, a minimum of two full bolt threads are exposed and protrude the nut. No more than 12mm may be exposed above nuts. Bolts may not be cut before or after installation.

Lock nuts, where used, shall be fully metallic construction. nylon-insert lock nuts shall not be used.

High strength phenolic insulating washers and insulating bolt stem sleeves, together with non-hygroscopic insulating gaskets or pads shall be fitted to all bolted joints where dissimilar metals are fixed together and where connections between steel with cathodic protection and steel without cathodic protection are assembled.

The Certifying Engineer must determine whether bolt holes require boring and oversize or higher strength, reduced diameter bolts to accommodate protective coatings and insulating sleeves.

In all cases, bolts and machine screws shall have appropriate markings or certificates supplied to clearly indicate the grade of material.

6.17.1 Stainless Steel Fasteners

Stainless steel bolts, nuts, screws, studs and washers shall be used in the following conditions:

- Submerged or buried under ground
- Cast-in or grouted into concrete structures, including that of anchor bolts
- In contact with raw sewage, sludge or treated effluent
- Exposure to corrosive environments such as sewage gas and salt loaded atmosphere
- Used for connecting stainless steel materials
- Used for connecting dissimilar metals
- Used in dismantling joints and pipe couplings

Stainless steel fasteners, shall be minimum grade A4-70, 316 stainless steel. All fasteners shall carry markings of the manufacturing source (manufacturer's identification symbol) for product traceability.

All stainless-steel fasteners shall be prevented from seizure or galling to allow for future dismantling. The following measures shall be implemented:

- Bolt and nut threads must be rolled or buffed smooth before installation
- The threads shall be thoroughly coated with non-corrosive anti-seize compound prior to assembly
- Nuts shall be hand tightened at low speed to reduce heat generated by friction
- Nuts must be tightened using a torque wrench to the recommended torque pressure, to avoid over tightening

If bolted joints are in contact with potable water, the anti-seize compound must comply with AS 4020.

6.17.2 Non-Stainless-Steel Fasteners

All structural fasteners shall, as a minimum, shall be high strength steel bolts for structural engineering class 8.8, with steel nuts class 8 and associated hardened and tempered steel washers, all complying with AS 1252 and AS 2465.

All threads shall be ISO metric course pitch series. Bolting categories shall be 8.8/TB (tensioning) as per AS 4100.

All grade 4.6 bolts and nuts shall be hot dipped galvanised in accordance with the requirements of AS 1214 and washers in accordance with the requirements of AS 4680.

Electro galvanising, nickel, cadmium, chrome or any other plating processes are not accepted on Urban Utilities' facilities.

All fasteners shall have markings of the manufacturing source (manufacturer's identification symbol) for product traceability.

6.17.3 Anchors and fixings

Ramset, Chemset injection 801 adhesive, maxima spin capsules, or similar high strength, high duty chemical anchor epoxy stud adhesive shall be used according to manufacturer's design ratings and design loads. Grade 316 stainless steel bolts (A4.7) (as a minimum) shall be used for all anchor bolts embedded in concrete. Selection and sizing of chemical anchor studs is considered part of the structural engineering design. Details shall be shown on the structural detail drawings. Design calculations for bolted connection shall be supplied for review upon request by Urban Utilities.

Mechanical anchors are not allowed unless written approval is provided by Urban Utilities or specified in the Project Documentation.

All exposed threads on purpose protruding rods, such as jacking bolts, that require the thread to adjust or level equipment shall be laced with Denso tape, or similar approved.

6.17.4 Light weight Fasteners

Where the application is required for fixing small light weight piping, conduits, cable ladder or small fixtures into existing aluminium or steel structures, a purpose designed fastener such as the Hilti S-BT-GR or S-BT-MR fixing system designed for C5 highly Corrosive environments would be considered suitable. Use of these small mechanical anchors is subject to approval of the application.

6.18 Materials

6.18.1 General

Evidence shall be provided to Urban Utilities that materials for mechanical equipment components have been selected appropriate to service conditions, loadings, duty, stresses, application and cycles to achieve the required service life of the mechanical equipment, free from corrosion, cracking and various types of wear or material failure.

All steelwork subject to immersion, splash or spray shall be stainless steel Grade 316 as a minimum;

All new metal walkways and all handrails in Class C5 – Industrial environment to AS 4312 (including gates) shall be marine grade aluminium.

Structural steel requirements shall be in accordance with the requirements of the Urban Utilities TMS1731 *Civil and Structural General Specification*. Material Certificates shall be provided to demonstrate that the material meets the appropriate Australian Standard. If material is to an international standard, then the certification requirements shall be agreed in writing with Urban Utilities prior to procurement or manufacture, otherwise the material and/or equipment shall not be accepted. Urban Utilities will generally acknowledge common

British, European and North American standards as being acceptable, however, other standards may not be accepted by Urban Utilities.

Elastomer and polymer products shall be protected from damage that may be caused by exposure to UV, dust, humidity biological agents and other airborne contaminants. Such precautions may include but may not be limited to storage within a building or temporary shelter and if necessary, maintenance and resealing, of protective packaging.

For all critical machine parts, materials shall be traceable via a suitable quality system in English language. Urban Utilities may reject materials if the materials in question cannot be traced back to a source or be shown to comply with a suitable quality system.

6.18.2 Products in contact with Drinking Water

Any products utilised that comes into contact with drinking water that is subsequently delivered to the Urban Utilities water network must comply with the relevant requirements of AS/NZS 4020, demonstrated in the form of a test report provided by a certification body or Accredited Testing Laboratory, in accordance with AS/NZS 4020. This includes coatings applied to the inside of piping delivering drinking water, seals on equipment in contact with drinking water etc.

6.18.3 Corrosive Environment

Corrosive environments occur where chemicals with a deleterious effect on materials are present. These include, but are not limited to:

- Areas within 2km of the sea shore (saltwater)
- High salinity, high groundwater environments (saltwater)
- Sewage treatment plants (H_2S gas)
- Sewage pump station wet wells (H_2S gas)
- Corrosive chemical storage and dosing areas (various chemicals)
- be in a splash zone or tidal zone of sewage, mixed liquor or final effluent.
- High humidity, poorly ventilated rooms, chambers, dry wells etc.

When installing materials or equipment in a corrosive environment, consideration shall be given to the environment and which contaminants are present as well as their severity. Mitigation methods (e.g. selection of materials, coatings, ventilation, air filtering etc.) shall be employed to enable equipment to withstand any corrosive agents identified in the environment for the duration of the equipment's design life.

6.18.4 Dissimilar Metals

Galvanic corrosion will occur in dissimilar metals when in close contact if the anodic potential is too great. Close contact can also include connected via a liquid, being submerged or outdoors with pooling of rainwater. The performance of an assembly of dissimilar metals includes other factors. eg conductivity of electroyte, the proportion of time that the electrolyte is present, and the relative surface area of the metal components in the system. These factors must be considered by the Certifying Engineer to ensure the equipment reaches its design life.

Where the anodic potential is greater than 150mV for Saturated Calomel Electrodes, suitable insulating separation shall be installed between the materials. Refer to industry reference data for Potential (mV) versus saturated calomel electrode for various metal/alloy.

For example, when connecting aluminium handrail to Steel structures, the parts shall be separated using phenolic sleeved washers and packers.

Refer to Section 6.18.4 regarding requirements when bolting together dissimilar metals.

Where it is not practicable to isolate the flow of electrons in metal assemblies, alternative or additional protection is required.

6.18.5 Exposure Categories

Exposure categories for atmospheric corrosivity for metallic items shall be in accordance with the requirements of AS 2312 and ISO 9223. In addition, the following minimum categories shall be used for Urban Utilities sites:

- Sewage Treatment Plant Outdoors – C5 – Industrial
- Sewer wet well Headspace – C5 – Extreme
- Non-odorous Indoors – C2 Mild
- Indoor Airconditioned – C1
- Humid / Corrosive Indoors – C5 – Industrial

Protective coatings durability ratings shall be in accordance with the requirements of AS 2312.1 and AS 2312.2. Concrete exposure classifications can be obtained from AS 5100.5, AS 3735 and AS 3600

Protective coatings applied to plain carbon steel structures shall not be considered as suitable separating material for galvanic corrosion.

Any stainless-steel pipe or fitting which is to be supported on galvanised brackets and pipe supports shall be isolated without possibility of contamination of dissimilar metals. Galvanised steel support brackets shall include a UHMWPE strip mechanically fixed to the support bracket and PE tube fitted over the “U” bolt to prevent interruption of the Chromate layer of the stainless steel by iron oxide from the plain carbon steel support brackets.

6.19 Corrosion Protection and Coatings

6.19.1 General

This section provides guidance on the applicable corrosion environment classification, enabling the designer to confirm that the recommended corrosion protection system proposed is in accordance with the requirements of WSA 201. Further TMS76 - *Urban Utilities Supplement to WSA 201* provides approved application products conforming to WSA 201 to achieve the necessary corrosion protection.

Unless stated otherwise in the Project Documentation, the site Corrosivity shall be classified as per table 5.1 of WSA 201. The Corrosivity of the Sewage Treatment Plant environment shall be classified as Extreme, equal to Category C5-I Atmospheric Industrial Zone (Very High) as defined by AS/NZS 2312.1:2014.

The environment for steelwork subject to immersion shall be designated as Sewage immersion for non-atmospheric environments (Table C1 AS/NZS 2312). However, for new steelwork, stainless steel grade 316 should be used where the part is subjected to immersion, sprays or splash.

All fabricated plain carbon steelwork and iron parts and exposed metal pipework surfaces shall be coated, except for the following:

a) Machined surfaces, which shall be protected during blasting and painting. These surfaces shall be treated with protective film after painting is complete to prevent corrosion prior to being assembled.
b) Plated and galvanised surfaces unless specified otherwise;
c) Grease fittings, hose fittings, valve stems, gauges and similar;
d) Concealed galvanised or metal sprayed surfaces;
e) Stainless steel surfaces;
f) aluminium surfaces;
g) Drive chains and sprockets; and
h) Nameplates (including manufacturer's nameplates and data plates), which shall be protected during blasting and painting, and cleaned and buffed to leave wordings clearly legible.

Urban Utilities shall be notified regarding any proprietary mechanical equipment that requires manufacturer specific coatings which do not align with the coating systems detailed in WSA 201, TMS 76 or this Specification. This may include equipment such as motors, bearing blocks, gear housings, etc. The performance and durability of any manufacturer specific coating system shall be equal to or greater than those offered in WSA 201.

Details of any manufacturer specific coatings shall be provided to Urban Utilities for approval before any equipment is ordered or coated.

Final equipment colours shall be in accordance with those specified in WSA 201 and TMS 76.

6.19.2 Hot-Dip Galvanizing

Hot-dipped galvanized (HDG) coatings on steel materials shall comply with the requirements of AS/NZS 4680. The applied minimum hot dipped galvanizing coating mass shall be 600g/m² (HDG 600). When assessing HDG as a suitable coating system, the environmental corrosivity classification and required design life shall be considered. The composition of the zinc in the galvanizing bath shall not be less than 98%.

All articles to be galvanized shall be handled in such a manner as to avoid distortion and mechanical damage. Where welding or flame cutting of galvanized components is used during installation, the coating shall be reinstated in accordance with the requirements of AS/NZS 4680 Appendix E.

Galvanized steel surfaces that require coatings shall be prepared in accordance with the requirements of AS/NZS 2312.2 Clause 7.5.3

6.19.3 Cathodic Protection

Refer to TMS1595 for cathodic protection requirements, where applicable, for steel tanks and pipes or for submerged or buried structures.

6.19.4 Handling of Finished Parts

Painted metalwork must be handled with care to prevent damage to the coating. It shall not be handled until the paint system has fully cured, according to the manufacturer's recommendations, or a minimum of 7 days.

To prevent damage to the paint:

a) Slings used for handling the painted steelwork shall be covered with a soft material to prevent damage to the paint; and
b) Supports in contact with painted steelwork during transport or storage and temporary supports during erection shall be coated with soft material.

All finished products shall be thoroughly inspected for damage to painted surfaces prior to installation. Any damaged paint must be repaired to restore the full protective barrier to the specified thickness. The colour of the protective coating repair shall match the colour of the part being repaired.

6.20 Insulation

This specification shall provide the requirements for insulation of mechanical equipment and fittings.

Thermal insulation of pipework, ductwork and plant equipment shall in in accordance with the requirements of AS 4426, Classification *Medium Temperature*.

Insulation will be required on pipes or ducts or specific process equipment as follows:

- To prevent injury, burns or damage to personnel or plant equipment;
- As required by the process for thermal efficiency purposes;
- To manage heat loads within a building;
- To retain heat within a pipe or duct system;
- As specified by Urban Utilities in the Project Documentation.

Pipework and ducts shall be insulated (lagged) after inspection and hydraulic testing.

Details of the selected insulation type and shell materials shall be provided to Urban Utilities for review on request. External / outdoor insulation shall be suitable for UV exposure.

The requirements for insulation of buildings or other civil related structures shall be detailed in the Urban Utilities Standard Civil Specification.

6.21 Ventilation

6.21.1 General

All new ventilation or odour extraction systems, and upgrades to any existing systems shall include the design, supply, installation, testing and commissioning for Buildings and Process equipment as specified. The design criteria for relevant air changes per hour to achieve the required corrosion protection shall be as per the project specification. Where the required air changes for the plant is not specified the following shall apply:

STRUCTURE TO VENTILATED	MINIMUM REQUIRED AIR CHANGES PER HOUR
Inlet Works (under covers)	30 AC/h
Primary settling tanks and channels	12 AC/h
Dewatering / sludge handling rooms	30 – 50 AC/h
Dewatering / sludge handling covered equipment (conveyors)	30 to 60 AC/h (based on empty volume)

Designers shall consider the likely percentage of openings and size of gaps of the structure being covered to design a suitable suction velocity and negative pressure under the covers to prevent the release of odorous and corrosive gases. The suction velocity shall also consider the required mixing with fresh air to displace harmful gases from structures and entrain them into the extraction ducting.

Process aeration systems and pipework are not considered ventilation and therefore not referenced is this section.

6.21.2 Ventilation Fans

Fans shall be 3 phase, 415V, industrial quality, axial or centrifugal type, constructed from grade316 stainless steel. The fans shall be selected to achieve the lowest practicable absorbed power at the nominated operating conditions. A grade 316 stainless steel safety guard shall be provided on unducted fan entry collars. Alternative corrosion resistance and structurally adequate materials of construction maybe considered subject to acceptance by Urban Utilities. All fan installations shall include redundancy at least one standby fan unit.

Fan motors shall comply with Urban Utilities General Electrical Specification TMS1732.

Fan performance test curves with the operating point clearly indicated thereon, shall be provided for each of the fans and shall be incorporated in the Operation and Maintenance Manual. The performance curves shall be based on tests carried out in accordance with the requirements of AS 2936.

Computational Fluid Dynamics (CFD) shall only be required for ventilation systems if noted within the Project Documentation, or where the design engineer requires confirmation of the airflow within a room with obstacles where dead zones may arise.

6.21.3 Installation

Fans and accessories shall be arranged to allow service access for maintenance and removal, and for replacement of assemblies and component parts, without disturbance of other items of plant.

Flexible connections shall be provided to prevent transmission of vibration to ductwork. Where necessary, expansion pieces between fans and flexible connections shall be provided.

6.21.4 Ductwork

Plant room Ventilation Ductwork is required for wet and humid rooms such as Belt Filter Press rooms to reduce the corrosion environment potential by extracting the harmful gases. Similarly, to reduce the corrosion potential in covered tanks and structures odour extraction systems use ventilation ducts to vent away the corrosive gases. Such plant ventilation ducts

shall be constructed from grade 316 stainless steel, fibreglass, PVC or other suitable corrosion resistant material. PVC pipe ducts shall only be used up to 300 mm diameter where H_2S gas is present. All other flow control equipment within the duct such as fans or dampers shall be constructed from corrosion resistant material.

All non-plant room building ventilation for air-conditioning ductwork (e.g. for electrical switchrooms, offices), including fittings, hangers, supports and insulation shall be supplied in accordance with the requirements of AS 4254.1, AS 4254.2 and the National Construction Code (NCC).

The design of ductwork shall ensure suitable air velocities to reduce noise and shall be in accordance with the requirements of AS 2107.

Flexible connectors must be installed at the inlet and outlet of fans and in the duct runs where required for expansion, contraction and movement. Expansion joints shall be designed to accept thermal expansion requirements.

6.22 Noise

6.22.1 General

The design of plant, equipment and its associated noise damping systems must achieve the following objectives:

1. Control and minimise occupational noise exposure that could lead to temporary or permanent hearing loss
2. Minimise the likelihood that nearby residents and industrial premises are offended or disturbed by operating plant and equipment

Management of noise shall be in accordance with the requirements of AS 1269, AS 1217, AS 1081 and AS 3663 and shall be tested for compliance upon completion of commissioning of equipment.

Urban Utilities preference is to supply equipment that does not require the use of hearing protection for operation and maintenance, being inherently safe for staff. Section 6.22.2 provides guidance on how to achieve this inherently safe noise environment.

Section 6.22.5 describes the regulatory noise compliance requirements, where the inherently safe low noise levels prescribed in Section 6.22.3cannot be achieved.

6.22.2 Measurement Method

Where verification of sound emission performance of any item of machinery or combined machinery installation, is a requirement within the Project Documentation, the sound pressure level shall be measured with a precision sound level meter conforming to the requirements of the latest versions of AS1259, or AS IEC 61672. All details of the sound level measurement test procedures and operating conditions shall be provided prior to conducting sound emission performance tests.

Where sound emission performance values are provided for individual items of machinery, the values provided shall be given for measurements taken at 1 metre from the machine surface.

6.22.3 Safe Sound Performance

The sound pressure emission from new plant shall be as low as is reasonably practicable. Sound emission levels from machinery shall be given due weighting when selecting plant and

machinery options. Where the selected plant, machinery or complete operating system will produce sound pressure intensity that is sufficient to cause harm or nuisance, design must also consider the inclusion of sound attenuating components such as dampers, and sound attenuating barriers and enclosures, use of sound absorbing components within the building fabric where practicable.

Unless stated otherwise in the Project Documentation, , the inherently safe sound pressure level at a distance of 1.0m from the noise source in Urban Utilities work site is deemed to be:

- 70dB(A) for any single piece of plant in service under any operating condition.
- 75dB(A) for a complete system with all duty units in service under any operating condition

6.22.4 Environmental Noise Nuisance

The following environmental noise requirements must be complied with for protection of the well-being and amenity of individuals and the community in any nearby residential areas.

- Requirements of STD145 Environmental Noise Standard
- Local Government development requirements

6.22.5 Occupational Noise

The following occupational health and safety exposure limits for noise that must be complied with are noted:

1. $L_{Aeq,\,8\text{-}h}$ Contribution shall not exceed 85 dB(A) determined in accordance with the requirements of AS/NZS 1269.1; and

2. $L_{C,peak}$ shall not exceed 140 dB(C) determined in accordance with the requirements of AS/NZS 1269.1

The overall approach taken with regard to the potentially harmful effects of exposure to sound emission from machinery should follow the approach taken for machinery safety outlined in section 6.13.1 for all applications where it is assessed that it is not practicable for a machinery installation or process systems to meet the inherently safe sound performance discussed above in section 6.22.3.

6.22.6 Sound Proofing Enclosures and Devices

Noise levels must be contained to the specified level by appropriate equipment design or with an acoustic enclosure.

Where fitted, acoustic enclosures shall form an integral part of the equipment and shall address the following requirements:

- not adversely affect the safety, function or normal operation of equipment
- allow for induction and exhaust of cooling air to the equipment within the enclosure
- be constructed so that it can be easily removed for maintenance purposes
- provision for lifting handles for 2 people, or mechanical lifting points
- detailed instructions on how to safely remove and handle the enclosure panels

- have latches to keep the enclosure closed when it is over the equipment,
- have hinged access doors or panels to provide easy access for routine inspection and maintenance activities, if required
- be constructed of non-combustible materials.

6.23 Vibration

Vibration levels of industrial machines, other than rotodynamic pumping units, must comply with ISO 10816 and AS 2625.

Vibration severity of industrial machines not covered by ISO 10816 must not exceed the maximum levels specified by the equipment manufacturer.

Where specified in Project Documentation, critical mechanical equipment shall be provided with permanently mounted vibration monitoring devices. Alternatively, quick disconnect vibration sensor mounting points may be specified where periodic collection of bearing condition monitoring data is able to provide sufficient condition monitoring data. Sensor mounting must be in accordance with the requirements of Section 6.2 of API 670. Also refer to Section 6.27 for requirements of bearing monitoring devices.

6.24 Balancing and Alignment

All appropriate rotating equipment shall be dynamically balanced by the manufacturer, prior to leaving the factory.

Alignment of shafts on rotating equipment shall be checked for concentricity and re-aligned if necessary, under the guidance of the equipment supplier. This shall be applicable after delivery, and installation of equipment where physical trauma to equipment during transport or installation may have resulted in misalignment of shafts.

6.25 Machine mounts

For machines with separate foot mount motors, the machine and motors units shall be mounted on a common rigid base frame. The base frame shall be fabricated steel, fully welded and adequately braced to resist maximum operating motor torque and maintain accurate vertical alignment of the driven machine and the motor. The minimum protective coating requirement for steel skids, machine frames and mounting bases is hot dipped galvanizing to a minimum of 600g/m^2. Machines which are installed within a protected building environment, not exposed to moist conditions, may include coated steel skids in accordance with the requirements of TMS 76 Table 5.6.

Landing surfaces on base frames shall be machined to receive the driven machine and the motor to facilitate accurate driven machine and driver alignment. Packing shims shall be 316SS. Jacking plates and screws shall be provided on the base frame to facilitate horizontal alignment of the driven machine and the motor.

Machinery skids, frames and mounting bases shall be securely and rigidly bolted to the machinery area floor slab. A raised concrete plinth will be required under the machinery skid, frame or mounting base to take up level differences or if the machinery area floor is outdoors or is in an area that is likely to be wet or require frequent washing down. Design and construction

of support plinths shall be in accordance with the requirements of TMS1731. The support plinth shall be elevated at least 100 mm above the natural surface level.

The installation of mechanical machinery shall be done in accordance with the manufacturer's installation guidelines and recommendations.

Rotating machinery likely to be a source of vibration such as positive displacement blowers and pumps or reciprocating machinery shall have flexible connections between the pipework as well as vibration isolation mounts to prevent vibration being propagated through pipes and the building structure.

6.26 Drives & couplings

6.26.1 Couplings

Pumps and equipment (except submersible mixers and pumps) shall be fitted with flexible couplings (or vee-belt or wedge or toothed belt drives). Flexible couplings shall be of the cone-ring or flexible element type, rated to suit the torque output under all loading conditions.

Equipment with direct inline power transmissions, such as flexible couplings, shall not be altered for belt or chain drive unless the equipment manufacturer confirms, in writing, that the drive end bearing has been designed to accept the additional radial loads.

Care shall be taken in checking alignment of driving and driven shafts. The motor and driven equipment shall be in alignment from all aspects.

6.26.2 Vee Belts, Wedge Belts and Toothed Belts Drives

Vee-belt and wedge-belt drives shall be of metric parameters, narrow profile and in compliance with DIN 7753 / ISO 4184.

All belt drives shall be designed and selected for continuous operation under maximum operating temperatures for heavy duty industrial machines. Belt selection shall take into account motor rated power, speed and number of starts per day. Belts shall be standard commercial items readily available locally and normally kept in stock such as Aramid (Kevlar, Nomex Twaron) Tensile Cord and Chloroprene Compound. Pulleys and sprockets shall be keyed onto the shafts and held in place using a taper type locking bush.

The belt manufacturer's recommendations for installation and alignment shall be strictly adhered to when fitting belt drives.

6.26.3 Chain Drives

Chains shall be standard bushed roller chains comprising steel links hardened steel pins and roller bushes. Chains shall comply with ISO 606, DIN 8187/8188 and ANSI B29.1.

Sprockets shall be of steel with flame hardened teeth, with hardness not less than 360 Brinell.

Access covers for inspection and lubrication of the chains and sprockets shall be provided in an easily accessible location.

Open air chain driven arrangements shall only be used pending agreement in writing with Urban Utilities.

6.26.4 Gearboxes

Gears and gearboxes shall comply with AS 2938 and the American Gear Manufacturers Association (AGMA) Standards.

Each gearbox shall be designed to operate continuously at maximum duty with a minimum service factor based on maximum operating torque. In addition, each gearbox shall be designed to withstand starting torques of up to 250% of the full load running torque of the driving motor.

Gear housings shall be in two-piece constructions with a top cover for ease of inspection and maintenance.

The direction of rotation of input and output shaft must be permanently marked on the housing. Removable gasketed inspection covers shall be provided to permit inspection of the gears without dismantling of the gear reducer. Lifting lugs shall be provided to facilitate safe lifting of the gearbox.

The gears shall be splash lubricated from a sump. The bearings shall be either splash lubricated, or grease lubricated. Where grease lubricated bearings are fitted, seals shall be installed to retain the grease in the housing. Grease nipples and grease relief devices shall be fitted to housings containing grease-lubricated bearings.

The unit shall be provided with a sight glass or indicator to observe oil levels. All oil fill and drain lines shall be of sufficient size to permit efficient functioning and shall be located on the gear unit in a position, which is easily accessible from the floor. All oil and drain piping shall be provided so that a container may be placed under the drain discharge.

6.27 Bearings

Bearings shall be to ISO standard design dimensions of modern metric design and of ball and/or roller type with ample capacity for carrying all induced thrust and radial loads. All bearings shall be lubricated efficiently and be capable of long service without maintenance.

Ball and roller bearings shall have a bearing manufacturer's 'L10' life expectancy of at least 100,000 hours, for bearing loads encountered at design duty in accordance with AS 2729 and AS 3890. Bearings shall be in metric sizes complying with ISO 15 and ISO 1132.

Bearings shall be adequately cooled to accommodate operation of the equipment in worst case ambient temperature conditions of the installed location, under the highest loading conditions, without reduction in calculated load rating or rating life. This shall be achieved without special or additional cooling arrangements, such as water-cooled heat exchangers or similar.
All bearings shall be capable of maintaining their seal without degradation or decrease of seal capability, e.g. loss of seal element effectiveness due to higher than rated peripheral speed or due to axial shaft float. Seals shall protect against ingress of water and foreign matter and from egress of lubricant. Where locking collars are required to maintain seal element tension these shall be of grade 431 stainless steel. Locking screws shall be 'Loctited' at final adjustment.

Bearing system lubrication must be either splash oil, or with periodic grease replenishment. Sealed for life bearings shall not be used unless clear reasons for doing so are given and agreement is provided in writing from Urban Utilities.

It is the preference of Urban Utilities that drive shafts shall be simply supported on two bearings.

Care shall be taken to prevent damage to bearings (work hardening or 'brinelling') caused by vibration during transportation. Such precautions may include, but may not be limited to supporting shafts within packaging, ensuring that vibration is minimised during transport and final assembly of machinery on-site.

All bearings of critical mechanical equipment or machines larger than 500kW shall be fitted with accelerometers. Thrust bearings require monitoring in all three planes, while for other bearings the accelerometers shall cover the two radial planes. The accelerometers shall be used for continuous on-line vibration monitoring to provide vibration signals for spectral analysis and bearing failure prediction. Monitoring devices shall also provide warning and shut down when vibrations exceed pre-set maximum levels. The vibration monitoring system shall be designed in accordance with the requirements of API 670. All bearings of machines larger than 500kW shall be fitted with RTD temperature sensors wired to a monitoring, warning and shut down protection system.

Temperature detectors shall be 3-wire, 100-ohm resistance type PT100. All three wires from each temperature detector shall be wired back to the associated auxiliary terminal box on the motor.

6.28 Seals

Shaft seals shall be of packed gland type or mechanical cartridge type in accordance with the supplier's recommendation or Project Documentation.

The seal design shall facilitate easy routine maintenance, replacement and conversion to other seal designs.

Where mechanical seals are used, the face or primary ring shall be manufactured from tungsten carbide or silicon carbide as a minimum. The seals shall have a grade 316 stainless steel rotating spring. All wetted parts in mechanical seals exposed to wastewater or corrosive fluids shall be constructed from titanium and have PTFE and ceramic seal faces. Components shall be suitable for continuous operating in the process fluid defined in the Project Documentation.

Mechanical and packed gland seals shall be flushed with approved flushing medium where recommended by the seal manufacturer. Flushing requirements for shaft seals (pressure and flow demand), shall be in accordance with the manufacturers recommendations and shall be stated on the data sheet supplied with the equipment.

Submersible pumps and mixers shall be fitted with seal failure probes for early detection of primary seal failure.

6.29 Lubrication

All bearing housings shall be fitted with seals and shall be grease or oil lubricated. Grease nipples with captive screw caps shall be provided for all grease lubricated bearings and where practicable, capillary tubing shall be run from the bearings and grouped at a convenient accessible location. Bearing housings shall be fitted with pressure relief devices to prevent over pressure.

Oil lubricated bearings shall incorporate the following:

- An integral oil circulation system. The design of the circulation system and venting arrangement shall not allow escape of oil from the bearing.
- A large capacity adjustable constant level oil make-up system.
- An oil level indicator.
- A permanent marking of normal oil level on the bearing housing adjacent to the oil level indicator.

Where continuous grease or oil feeding is required, the capacity of the reservoir shall be sufficient for not less than 14 days continuous service, with indications in the form of meters or alarms.

All bearing blocks in wet areas shall be thoroughly hand packed with water resistant grease, with the grease injection point located diametrically opposed to the vent plug so that new grease being forced in from the top will reject any water that may have entered the bearing block.

Grease injection points and plugs shall be from 316, or higher grade stainless steel and shall be installed with PTFE tape or paste in the thread to facilitate periodic removal. Hex socket drive plugs shall not be acceptable, Hex head plugs only.

All grease injection points must be capable of being safely accessed from platform level. Achieving this requirement may require grease tubes to be extended to a suitable easily accessible location. Where grease lines are fitted, they shall not be attached to removable parts. Grease tubes must be suitably supported and protected. If saddles and “P” clips are used to support grease tubes, these must be manufactured from 316SS. Fasteners and fixings used to attach “P” clips and saddles must also be manufactured from 316SS and must not penetrate protective coatings on plain carbon steel parts and structures.

All gearboxes, and other equipment with oil bath type bearing frames and oil sumps shall have a means to easily check the oil level and top up or fill with the machine in place as well as, allow for lubricant to be drained and changed.

All equipment shall be supplied with complete information on lubrication requirements including a list of approved product manufacturers. Lubricants shall be selected to suit the site and operating conditions. All recommended oil and grease types shall be locally available. Specific oil and grease grades shall be specified in the Operation and Maintenance Manuals along with the required volumes and change-out interval.

Automatic or manual centralised lubrication systems shall be used where specified in the Project Documentation, or as required by equipment manufacturers and shall form part of the supply of the equipment.

Automatic lubrication system components shall be considered to include a minimum of:

- Pumping system and reservoir tank
- Pumping cabinet or enclosure
- Lubricant
- Filters
- All piping, fittings, clamps and anchors

- Pressure gauges, valves and end of line switches

Lubrication systems shall deliver appropriate lubrication to all bearings, labyrinth seals, pinions and gears to the manufacturers required dosage rates.

6.30 Air, Dust and Odour

The following environmental Air, Dust and Odour requirements must be complied with for protection of the well-being and amenity of individuals and the community.

- Requirements of STD146 Air, Dust and Odour Environmental Standard
- Local Government development requirements

7. MOTORS, PUMPS, PIPES AND VALVES

7.1 LV Motors

Refer to the relevant sections of TMS1732 *Electrical & Instrumentation General Specification* for detailed requirements regarding LV motor starters, the installation and testing of LV motors as well as special requirements for LV motors used in Hazardous Areas. Motor starting analysis shall be undertaken to determine voltage drop when starting large motors as per TEM336 *Power Systems Analysis Guidelines.*

The nameplate rating of motors shall be for continuous full load operation under the worst-case combination of service conditions for their applications.

The following requirements apply for LV Motors:

PARAMETER	REQUIREMENT
Motor Type	• Compliant to AS 60034 • Motors 0.37kW – 250kW shall be Totally Enclosed, Fan-Cooled (TEFC) squirrel cage rotor induction motors • Motor frame size and dimensions shall be as per AS 1359.30 • High efficiency motors to AS1359.5 or IE3 to IEC 60034-30-1 preferred • Motors shall be bidirectional
Duty	• Nameplate rating shall be for continuous full load operation under the worst-case combination of service conditions for their applications • Continuous duty (S1) to AS60034.1
Materials	• Motor body: High grade cast iron or steel • Fitments (incl fans, cowls, terminal boxes, shields): Steel • Bodies and fitments of motors in Hazardous Areas shall be of non-sparking materials • Bodies and fitments shall be treated with a corrosion resistant coating suitable for the environment. Coatings on bodies and fitments shall be the same
Cooling	Cooling method shall be TEFC • Fans shall be mounted at the non-drive end & blow to the drive end • Fixed speed fans may be used on VSD-driven motors if cooling is shown to be adequate at lower shaft speeds. Otherwise, independently controlled fans shall be used. • Alternative cooling to IC411 or IC511 as per AS 60034.6 accepted
Ingress Protection	• IP56 (min) for motor enclosure & bearing housing • IP66 for motor heater terminal boxes • IP56 (min) for other terminal boxes • IP2X for fan cowlings (horizontal mounting) • IP22 for fan cowlings (vertical mounting) • Rain covers required for flange or vertically mounted outdoor motors

PARAMETER	REQUIREMENT
Starter Compatibility	• Motor starting shall be via an OEM-approved motor starter arrangement • VSD-driven motors shall be compatible with the nominated VSD output without additional measures (e.g. vibration dampeners or VSD output-side dV/dt filters)
Brakes	• Suitable for operation on the LV supply • Fail-safe • Fitted with limit switches activated by brake release
Windings	Construction • Motors >150kW shall have form wound coil construction • Copper conductors shall be used on stator windings & terminal leads • Windings shall maintain rigidity during normal service conditions • Windings shall withstand dynamic forces from frequent restarts against full opposite residual voltage Insulation • Vacuum Pressure Epoxy Impregnation (VPI) preferred • Non-hygropsopic • Oil resistant • Resistant to flame propagation • Class F (155°C) insulation as per IEC 60085 • Motor temperature rise Class B (75°C) Leads • End-windings and leads treated to resist tracking & contamination • Leads insulated with heat resistant thermosetting insulation or similar Motor windings shall withstand impulse voltages as per IEC 60034-15, with the following stipulations: • Windings shall withstand $4U_n$ main voltage • Windings shall withstand $2U_n$ interturn voltage • Interturn wavefront rise time shall be 0.1µs unless a longer front time on the VSD output can be confirmed, in which case the actual wavefront shall determine test rise time
Starting Torque	• Starting torque at 100% rated voltage and any speed between standstill and the pull-out torque point, shall be ≥1.7 times full load torque • Where loads require high starting torque, larger motors are preferred to smaller motors specially designed for high starting torques • Motors shall be capable of DOL starting at 80% nominal voltage at the motor terminals under the worst operating conditions • Accelerating torque shall be ≥10% of full load torque across the curve

PARAMETER	REQUIREMENT
Running Power & Torque	• Torque characteristics shall be ≥10% higher than the driven load across the curve • Rotary lobe pump motors shall be rated for 120% of the power and torque requirement for the driven load • All other pump motors shall be rated at not less than 110% of the power and torque requirement for the driven load

Running Speed	• VSD-driven motor maximum speed shall be 105% of synchronous speed at 50Hz
	• Fixed speed motors shall be capable of:
	  ○ Continuous operation at 1.2 times rated speed without sustaining damage
	  ○ Continuous operation at any voltage/frequency in Zone A as per AS 60034.1

Re-start Performance	Motors shall be capable of recovering normal operation following: • Total loss of supply voltage for 0.2s • Sudden restoration to 60% nominal voltage for 3s • Sudden restoration to 80% nominal voltage Motors shall be capable of restarting under the following conditions: • DOL restart at 80% nominal voltage under the worst operating conditions and any phase angle • 3 successive starts from maximum ambient temperature • 2 successive starts from full load operating temperature ○ Cooldown time between sequences of successive starts shall be ≤15 minutes
Temperature Measurement	Temperature measurement shall be by 2-wire or 3-wire Pt100 RTDs: • Motors 37kW – 75kW shall have one RTD per phase winding • Motors >75kW require two (min) RTDs per phase winding • Vertically mounted motors ≥75kW require RTDs on the thrust bearings • Provision shall be made for a 3-wire system from the auxiliary terminal box back to the motor starter, even if 2-wire sensors are used Detector protection: • Insulation schemes not reliant on surge diverters are preferred • If overvoltage surge diverters are required, they shall be short-circuit type

Terminal boxes	Separate terminal boxes are required for each type of cable:
	• Motor power cable terminal boxes
	  ○ Motors <30kW may have anti-condensation heater cables terminated into the motor power terminal box
	  ○ Stud type terminals required, marking as per AS 60034.8
	  ○ Tunnel type terminals are not permitted

PARAMETER	REQUIREMENT
	○ Motors <45kW require ≥3mm thick gland plate ○ Motors ≥45kW require ≥3mm 316SS or ≥6mm brass gland plate • Auxiliary power cable terminal boxes ○ Motors ≥30kW shall have anti-condensation heater cables terminated in an auxiliary terminal box separate to the motor power terminal box ○ Cooling fan cables ○ Brake circuits • Instrument cable terminal boxes ○ Temperature sensor connections ○ Permanent vibration sensor connections ○ Terminals sized to accommodate instrument cables (e.g. 0.5 - 2.5mm^2) ○ 20% spare terminals shall be provided ○ Spare instrument cores shall be terminated ○ Site standard terminals and ferrules shall be used All terminal boxes shall meet the following requirements: • Totally enclosed (sealed against air from the motor) • Flanged joints with neoprene gaskets • Suitable for mounting on left, right and top sides of the motor • Suitable for rotation through 360° in 90° increments • Accessible without having to remove covers (e.g. fan cover) • Oversized, capable of accommodating: ○ Additional cables ○ Larger OD cables ○ Space for large cable bending radii • Threaded cable entries shall be ISO tapped • Terminal blocks shall meet the following requirements: ○ Made of insulating material (e.g. synthetic resin) ○ Terminals of different voltages shall be separated by an insulating barrier (note: a warning label stating 2 sources of supply required in these cases) • Engraved identification & warning labels, visible from the drive end ○ Warning labels may include “2 Sources of Supply” and “RTD Terminals DO NOT MEGGER” • Lids >5kg shall be fitted with handles • An earthing terminal shall be provided ○ Permanently marked with the International earth symbol
Motor heater	• Anti-condensation heaters shall be provided for motors ≥30kW • Heaters shall operate at 240V AC and be switched on automatically when the motor is not running • Set temperature shall be above the dew point or 10°C above ambient, whichever is greater, when the motor is not in service

PARAMETER	REQUIREMENT

Motor Bearings	• OEM recommended bearings shall be fitted for motors <185kW
	• Insulated bearings required for VSD-driven motors ≥185kW
	  ○ Removable earthing connection required at the drive end bearing
	  ○ Warning label required against bridging the insulation
	• OEM recommended bearing grease shall be used
	  ○ Grease labyrinth type seals shall be used to prevent dust entry
	  ○ Grease nipples shall be located to allow access without dismantling parts or use of a ladder / elevated work platform

Hazardous Areas	Motors, including accessories (e.g. heaters) and terminal boxes used in Hazardous Areas shall comply to AS 60079 and TMS1732

7.1.1 Whole of Life Costs

Whole-of-life costs/benefits including capital cost, install costs, operational duty, expected loading, electricity charges and maintenance costs shall be considered as part of the motor selection process.

In the absence of a specific operating schedule, yearly energy consumption costs shall be calculated based on operation at 75 % rated load and 6 hours operation per day.

7.1.2 Drain Holes

Motors with frame sizes ≥ 150kW shall be provided with porous type drain holes and plugs at either end of the motor, to suit the shaft orientation. Any openings shall be fitted with fine stainless-steel mesh to prevent entry of insects.

Drain holes shall be provided in the motor's stator enclosure where water might collect, as per AS 60034-5. Drain holes shall be sealed sufficiently to maintain the motor's IP rating.

7.1.3 Lifting Eye Bolts

Motors heavier than 15 kg shall have eye bolts or lifting lugs for hoisting. Motor IP rating shall be maintained regardless of any such eye bolts or lugs. A label identifying the weight of the motor shall be affixed to the motor. Lifting eye bolts and lifting lugs shall be marked with maximum load values.,

Note that for vertical motors, a method to remove the motor cowling prior to lifting the motor (to ensure lifting chains do not damage the cowling) shall be provided.

7.1.4 Motor Earthing

An external earthing boss is required on the motor frame. Earthing bolt lengths shall allow for 2 fixing nuts and suit a minimum 35mm^2 cable earth lug connection. Component parts of the frame shall be effectively bonded together and to the earth boss.

The motor earthing terminals shall be shown on the general arrangement drawing.

7.2 Sewage Pumping Stations

All civil and mechanical components of sewage pumping stations shall be designed and constructed in accordance with the requirements of the SEQ Water Supply and Sewerage Design & Construction Code – Sewage Pumping Station Code WSA04.

Specific amendments to the Sewage Pumping Station Code of Australia can be found here (http://www.seqcode.com.au/seq-sewage-pumping-station/).

7.3 General Requirements for Pumps

All pump selections shall consider the following design criteria:

- Duty flow, head requirements
- Efficiency at duty point
- Overall specific energy of pumping for the predominant operating point for the application
- How well the predicted pump duty point will fit within the allowable operating range of the pump.
- Required design life
- Specific application and required modes of operation
- Process fluid
- Shaft seal operating conditions and design
- Solids handling capability
- Operating and site conditions
- Materials of construction suited to process medium
- Interior, exterior and submerged installation
- Pump cooling requirements
- Maximum and minimum system heads for varying sump or tank levels
- Preferred motor speed
- Non overloading motor or minimum reserve motor power buffer for worst case hydraulic load condition.
- Maximum number of starts per hour, when considering the minimum sizing of operating tank or sump volume.
- Surge mitigation if required in Project Documentation
- Local representation of pump supplier
- Availability of spare parts
- Commonality of equipment within Urban Utilities facilities

All pump selections shall include data sheets with performance curves. Performance curves shall indicate the following:

- System head (maximum, minimum and design if applicable)
- Pump curve for selected impeller size
- Best Efficiency Point (BEP)
- Speed curves from 50Hz to 20Hz for variable speed driven pumps

- Pump efficiency curves
- Shaft power curves
- NPSHR curves

Pump selections may be reviewed and subject to acceptance by Urban Utilities. Also refer to Pump selection criteria in TEM687 for sewage pumping applications and TEM688 for water supply network application.

7.4 End Suction Centrifugal Pumps

Complete end suction centrifugal pump sets (pump + drive motor) used on Urban Utilities facilities shall be in accordance with the requirements of the WSA pump specification WSA 131. The "wet end" bare shaft pumps used on Urban Utilities facilities shall be in accordance with the requirements of the WSA End suction centrifugal pumps specification WSA 130.

Where self-priming pumps are the preferred choice of pumping equipment, acceptance by Urban Utilities shall be required prior to supply of the self-priming pump.

7.5 Submersible Pumps

Submersible sewage pumps used on Urban Utilities facilities shall conform to the requirements of WSA 101-2008 except where Urban Utilities minimum requirements are further clarified or modified in the table below, which references clauses within WSA 101-2008.

Dry mounted submersible pumps shall conform to the same requirements as submersible pumps.

The Project Documentation may also contain requirements for submersible pumps which shall be met.

Table 7-1 - Submersible Sewage Pumps

WSA101-2008 CLAUSE	ADDENDUM
Table 2.1	For impeller and wear plate material, the high chromium abrasion-resistant white iron option is required as per appendix B of WSA 101-2008. Other materials may be used to provide equivalent overall wear resistance, corrosion-resistance, and durability. Grey cast iron AS 1830 250 Grade impellors are not accepted.
3.1 (d)	Pumps must be capable of continuous operation with the motor housing not submerged.
3.7.4	Provision for adjustment of impellor clearances is preferred.
3.7.6	All pump units must incorporate a leakage detection device such that leakage past the mechanical seals is detected and alarmed.
3.7.7.1	The maximum number of starts per hour for projects where an existing site is being upgraded and where the pump is operated through a VSD may be relaxed from requirements specified in Table 3.3 subject to acceptance by Urban Utilities.

WSA101-2008 CLAUSE	ADDENDUM
3.7.7 (a)	Two-pole motors may be accepted if the pump selection is best suited for two-pole speed. Deviation from WSA – 101 will require approval from Urban Utilities. This shall be listed as a partial non-conformance and submitted to Urban Utilities.
3.7.7.3	Motor cooling by passing part of the pumped fluid through a water jacketed arrangement within the motor housing as per option (c) are not accepted because of the increased risk of blockage or corrosion of cooling liquid galleries. Internal, closed loop liquid cooling as per option (b) is required.
5.2.1	All pumps greater than 100 kW shall be performance tested in accordance with the requirements of ISO 9906, 1B

7.6 Recessed Impeller Slurry Pumps

Recessed impellor centrifugal pumps are considered suitable for the pumping of grit slurry from the base of grit vortex traps to grit washers and other similar grit slurry applications.

When used as grit removal pumps, as this is a cyclic function and the grit slurry concentration will change throughout the grit pumping cycle, the pump duty shall be checked at both the greatest and lowest hydraulic duty conditions.

Where recessed impeller slurry pumps are specified in the Project Documentation, the pumps shall be in accordance with the following criteria:

- Pumps shall be of proven design and suitable for continuous or intermittent operation.
- Impellers shall be recessed “chokeless” style.
- Pump design and selection shall include head, flow and efficiency de-rating factors for pumping slurries, as required to suit the process fluid (e.g. solids, viscosity and froth de-rating factors)
- Pump casings shall have liners to be abrasion resistant. Metal liners shall be used in preference over rubber liners when pumping grit slurries, due to the large range of grit sizing and coarse grain particle shapes that can shred rubber linings prematurely.
- When pumping grit slurries, the pump duty range shall be suitable for both the greatest grit slurry duty of 40% weight per volume of grit with an SG of 2.65 versus the least grit slurry duty being effluent without grit content.
- Where pumps are not specified as having variable speed control, they shall be equipped with either belt drive systems, or impellers that can be trimmed, or a combination of both.
- The margin between NPSHA and NPSHR at maximum specified continuous duty flow shall not be less than 1.0m
- Pump shaft seals shall be suitable for the process medium and shall be double mechanical seals with flushing. Where packed glands are used, suitable gland flushing

water and water supply control equipment shall be supplied to achieve the manufacturer's required flow and pressure of flushing water when operating.

- Pump bearing vibration shall not exceed the acceptable limits for centrifugal pumps given in ISO 10816-0 Table A.3, zone boundary B, support class "Flexible"
- Pump casings shall be clearly marked with an arrow showing the direction of rotation of the shaft
- The materials of construction for pump components shall be selected to suit the slurry characteristics.
- Where specified in the Project Documentation, pumps shall be factory tested in accordance with the requirements of ISO 9906, Grade 2B unless otherwise stated. Tests shall be of 2 hours minimum duration and shall cover at least five points on the curve including rated flow, minimum flow, shut off and one point beyond rated flow (fully open valve if feasible)

7.7 Self-Priming Pumps

Technical specifications for Self-priming pumps are intended to be developed in future revisions of this document. The use of self-priming pumps shall be subject to the acceptance of Urban Utilities.

7.8 Positive displacement pumps

This specification provides the minimum requirements for Rotary Lobe Pumps and Progressive Cavity Pumps.

7.8.1 Rotary lobe pumps

Rotary lobe pumps shall conform to the following requirements:

ITEM	REQUIREMENT
Process installation arrangement	In-line, flange to flange, horizontal shaft, horizontal pipe.
Protection from abnormal operation.	Pumps must be protected to prevent damage to pumps and other parts of the system. Refer to Section *6.13.1.6 System Protection*
Machine arrangement	Twin synchronised rotor positive displacement pump, using an oil bath synchronising gearbox with an easy system to set up shaft synchronisation and rotors indexed on the shaft by a keyway. All gearboxes shall have means for checking correct oil level and topping up with the machine in place. A ball valve, spout and plug shall be provided to assist with draining oil from the gearbox with the machine in place. Alternatively, speed reduction and synchronisation of shafts may be by double sided toothed belt with rotors indexed by a special tool to hold the rotors in the correct position, before being locked onto the drive shafts. Rotors may be locked onto the drive shaft by taper lock collet or a centre hub and high tensile machine screw with sealing cap. Minimum service factor through drive

ITEM	REQUIREMENT
	train shall be 2.0 based on worst case design duty conditions.
Pump and rotor shaft arrangement	Replaceable elastomer internal sealing liner and hardened stainless steel rotors, or adjustable hardened stainless-steel sealing plates with elastomer covered rotors. Interfaces between steel and elastomer shall be fully vulcanised.
Rotor shafts	One-piece construction with a minimum service factor of 2.0 based upon the maximum (pull-out) motor torque when started direct-on-line under maximum backpressure conditions.
Rotor shaft bearings	Include bearings within the pump (excluding motor bearings) selected for a LH10 service life of 100,000 hours in continuous pump operation at maximum rated conditions (calculated in accordance with the requirements of AS 2729/ISO 281).
Mounting	A single, rigid mounting frame to support pump and gear motor/drive as a single rigid assembly. Motors shall be positively located, concentric flange mount motors for easy replacement and alignment.
Motor rating	Drives shall be rated for not less than 120% of maximum required design power, allowing for losses and inefficiencies within the system.
Motor mount standard	IEC standard flange mount motors (adapter plates and couples shall be fitted between motor and gearbox, if necessary)
Rotor and pump body materials	The Certifying Engineer and the supplier shall review the application, the process fluid and the operating conditions and confirm the most suitable materials and rotor geometry. Where the process fluid may contain abrasive solids and grit, the following precautions are required as a minimum: • Replaceable, hard wearing rotor tips • Clearance adjustable and replaceable, hard wearing radial and end liners • Double mechanical seals with pressurised, clean water flushing • Automatic process train flush with service water, at pump start-up and shut-down. • Flow rate monitoring and training for operators so that they are able to assess when clearances need to be adjusted to prevent excessive slipping. • clearance adjustment on pre-emptive maintenance periods, based on wear rates to prevent running the pumps with excessive clearances and thereby exacerbating clearance wear rates.

ITEM	REQUIREMENT
Shaft seals	Balanced single SiC/SiC replaceable mechanical cartridge seals shall be considered as a minimum requirement where seals are lubricated by process fluid under positive pressure. Pumps operating at negative pressures shall have double seals with external lubrication supply reservoir. Seals shall provide 20,000 hour minimum service life. Bearings and gear housings shall be protected from possible seal leakage by either an integrated drain or early detection of primary seal leakage. The supplier shall consider the intended process fluid and operating conditions and propose a higher specification seal if warranted. Upgrading of the seal to a higher specification shall be a simple replacement of an interchangeable part.
External protective coatings	Conforming to Section 6.19.1.
Corrosion resistance	All internal wetted parts shall be manufactured from highly corrosion resistant materials or lined with corrosion resistant materials. The Contractor and the pump supplier shall provide evidence that the overall pump bearing frame and housing assembly can provide the required minimum 25 year service life with the required adjustment and replacement of wearing parts such as liners, bearings, seals and rotors.
Process pipework	The pipework to and from the pump shall include: A rise, such that the pump will always have a minimum volume of liquid to lubricate and cool rotors on start-up; 1¼" BSP sockets with 25NB stainless steel grade 316 ball valve and industrial hose connector for flushing points and drains on both the suction and discharge pipework; 1" BSP sockets with 15NB stainless steel grade 316 ball valve for pressure gauge connections. The suction and discharge rise pipe connections on the upstream and downstream ends shall be AS 4087 PN16 Flanges.
Rotation direction	Rotary lobe pumps may be used for reversible service applications. It is envisaged that this will be achieved using native features of the VSD driving the motor.
Priming and dry running	The pumps shall be capable of self-priming without damage to the internal components. The pumps shall be capable of dry running, without damage, for short duration events, and be designed to cater for the surging associated with intermittent wet and dry operation. The pump drive motors shall be capable of and be rated for accepting the shock loading associated with these conditions
Replacement parts	Key parts, including replacement rotors, wear plates, shaft sleeves, liners and couplings, mechanical seals, bearings and motors shall be readily available in Australia.

7.8.2 Progressive Cavity Pumps

The use of the term helical rotor pump or progressive cavity pump are interchangeable i.e. meaning the same.

Progressive cavity pumps (or Helical Rotor pumps) shall conform to the following requirements:

Table 7-2 Progressive Cavity Pump Requirements

Item	Requirement
Rotation Direction Markings	The normal forwards flow shaft rotation direction must be clearly and permanently marked on the pump casing and on the gearbox that forms part of the drive unit if it is a separate assembly.
Base Frame	The whole pump including motor and drive unit must be mounted on a single, rigid base plate. Refer to Section 6.25 *Machine mounts*
Bearings	Include bearings within the pump (excluding motor bearings) selected for a LH10 service life of 100,000 hours in continuous pump operation at maximum rated conditions (calculated in accordance with the requirements of AS 2729).
Temperature of fluid pumped	15-30°C (unless otherwise impacted by treatment process)
Pump period	Intermittent (continuous not accepted). Consider pump starting conditions and allow sufficient starting torque.
Protection from abnormal operation.	Pumps must be protected to prevent damage to pumps and other parts of the system from mechanical damage. Refer to Section 6.13.1.6 *System Protection*
Operating speed	Maximum 400 rpm, preferred speeds 200-300rpm or lower for pump selection purposes
Drive shaft	The pump supplier shall review the application, torque requirements and process fluid to confirm the most suitable coupling and shaft option. The minimum requirement is lubricated and sealed pin connectors with hardened steel pins and bushes.
Rotor	The Certifying Engineer and the pump supplier shall confirm rotor connection design and the rotor the material selection based on the application duty and process fluid. The minimum requirement is hard chrome plated hardened tool steel. Details of the chrome surface welding process must be provided. Electro-plated chrome is not suitable and is not allowed. Where possible, the rotor must be capable of being quickly and easily disconnected from the drive shaft, without the need to disturb the cardan shaft couples.
Stator	To suit application. Wherever the application allows, the pumps shall have a split stator housing cover to allow easy stator removal with the rotor and pump nozzles still in place (i.e. maintain in place). The ability to provide limited crush of the stator for limited extension of stator life is also required where the application permits.
Inspection ports	Required to allow access to the shaft couples where possible.

Item	Requirement
Starting torque and motor drive system requirement	Full rated pump pressure plus 20% (minimum).
Gearbox lubrication	Oil, splash method
Seal	The pump supplier shall review the application and the process fluid. Replaceable or serviceable SiC/SiC, mechanical seals with elastomer boot protecting the spring shall be used as the minimum requirement for light duty applications without abrasive solids. Higher duty applications with abrasive solids may require a balanced double mechanical seal with external flushing/lubrication fluid. Gland seals are not acceptable.

7.9 Booster Pump Sets

Water booster pumping stations (typically for service/wash water duties) shall be a manifold set of the same model of pump. Pumps may be controlled by a single multi-pump variable speed controller or alternatively the system may work as a network of variable speed pumps such that the master control/coordination of the multi-pump set can be by any of the microprocessors controlling the VSD on the individual pumps on the manifold.

The pumps shall be controlled to stop and start and change speed to maintain the discharge set-point pressure as flow from the system varies. Where specified in the Project Documentation, water booster pumping stations shall include an electromagnetic flowmeter, with all pumps and instruments integrated into the SCADA system for trending.

Water booster pump sets shall comply with the following requirements:

Item	Requirement
Manifold	Pipework shall be stainless steel grade 316L to ASTM A312M Connections shall be provided on the manifolds for air release, pressure gauges and pressure transmitters. Air release connections shall be 1¾" BSP sockets with 25NB ball valves. Pressure gauge and instrument connections shall be 1" BSP sockets with 15NB stainless steel grade 316 ball valves.
Pump redundancy	During peak flows, the system shall run as duty/standby configuration (N+1). Each pump shall be capable of being removed without disturbing the other pumps and while the other pumps in the skid remain in service.
Flange connections	Flanges shall be to AS 4087 PN16 (clearly stamped). The pump supplier shall provide details of pump nozzle connections.
Isolation valves	Each pump on the manifold pump skid shall have its own suction and discharge isolation valves. Pump isolation valves shall be concentric, bed grooved, seal in body, tapped lugged butterfly valves conforming to AS 4795. Valves shall be supplied with lockable double action lever handles (Ebro Armaturen Z014-A or accepted equal product).

Item	Requirement
Non-return valves	Each pump on the manifold pump skid shall have its own non-return valve. Non return valves should be installed with dismantling functionality for each individual pump. Materials of construction shall be as follows: Seat: EPDM Disc: Stainless steel grade 316 Shaft: Stainless steel grade 316 or 420 Return spring: Stainless steel grade 316 For applications where the suction pipe pressure may be below atmospheric pressure, under certain operating conditions, the pump NRV shall be on the suction side of each pump to prevent air leaking into the pump through the seal while the pump is stopped.
Pump skid mounting frame	The pump skid shall have a steel frame to provide a rigid base for the pump bases to be bolted down to and to rigidly locate the manifold pipes relative to the pump mounting base plate. The pump skid mounting frame shall be hot dipped galvanised to achieve 600 g/m² coating in accordance with the requirements of AS/NZS 4680.
Pressure vessel	The pump station shall be supplied with a bladder type pressure storage vessel sized for one pump operating at minimum speed without excessive numbers of starts. For practical purposes, the Certifying Engineer may size the accumulator with effective working volume between cut in and cut out pressure with the pump operating at minimum speed at the minimum design flow value, such that the pump will be able to remain off for a minimum of 2 minutes. For constant pressure control systems the difference between cut in and cut out pressure shall be taken as + 10% to – 10% of the set point pressure value. Water pressure accumulator vessels shall be conforming to the requirements of AS 2971 or an equivalent international standard for simple unfired pressure vessels designed to contain air.
Pump performance	The head-flow performance curve of the individual pumps on the pump skid shall have a steady rise from maximum to the minimum flow. The shut-off head value shall be a minimum of 20% higher than the head at the best efficiency point.
Pump materials	Materials of construction shall be as follows: Impellers, diffusers and stage rings: Stainless steel grade 316 Shaft: Stainless steel grade 431 Shaft journals and stage bearings: Silicon Carbide/Silicon Carbide O rings: EPDM
Seals	Pumps shall be fitted with SiC/SiC cartridge seals with stainless steel grade 316 springs, EPDM bellows and O-rings as a minimum. The Certifying Engineer and the supplier shall review the operating conditions and provide a higher spec seal if needed.
Pump features	Each pump shall be fitted with a valved air bleed port at the top of its casing.

7.10 Pipework

7.10.1 Pipes General

Mechanical pipework is defined as all above-ground pipework including the tie-ins to all buried pipework. Below-ground pipework is considered Civil pipework unless specified in the Project

Specification. Above-ground includes above concrete at ground level or above and piping below ground level that is within open or covered pits.

Buried pipework shall be designed and installed in accordance with AS 2566 and WSA 03. Buried non-metallic pipework shall have continuous detectable marker tape placed in the trench above the pipe to allow detection.

Pipes and pipework fittings shall be in accordance with the requirements of this specification and the following specifications where applicable:

- WSA Product Specifications
- *SEQ Water Supply and Sewerage Design and Construction Code* where applicable to network piping
- AS 4041 and other relevant AS standards specified in this Specification.

7.10.2 Mechanical Pipe Limits

The mechanical / civil pipework boundary interface or battery limits shall be in accordance with the requirements of the Project Documentation. These battery limits shall typically be at the last civil piping flange (or fitting), located approximately 150mm above the ground..

7.10.3 Mechanical Pipe Design

Unless specified otherwise in the Project Documentation, mechanical pipe design requirements shall include conformance with or resolution of the following pipeline considerations:

- Design Life, refer to Section 6.2 Operating conditions and Design life
- Be thrust resistant and adequately braced under all load conditions;
- Include valves, flange connections, fitting arrangement and adequate pipe supports to allow for easy dismantling and re-instatement of each section of pipework;
- Enable manual flushing (unless specifically omitted otherwise in project documentation);
- Eliminate dead ends and stagnant sections;
- Include blind flanges and fittings as required to facilitate testing of pipe sections;
- Include isolation valves at every branch (unless authorised otherwise), and at all operating equipment to allow for the equipment's safe removal;
- Not restrict access to mechanical equipment, electrical equipment or instrumentation;
- Provide safe access for monitoring and maintenance of in-line instrumentation and operation and maintenance of equipment (including all primary isolation valves) from the finished surface levels where feasible, and access platforms otherwise;
- Minimise the number of access platforms without restricting access to equipment;
- Not interfere with the safe removal of equipment by crane or hoists;
- Allow for thermal expansion across the maximum foreseeable temperature range;
- Allow for differential settlement at locations where pipelines transition from buried to out of ground pipe, supported from structures or supported from separate structures exposed to possible different settlement; and
- Have flow direction arrow sticker with colour in accordance with the requirements of TMS76 section 4. Where section 4 is silent on an application then use colour identification may be accordance with AS 1345.

Pipework subject to blockages shall include allowance for mechanical or hydraulic purging in the event of a blockage. Details shall be submitted to Urban Utilities for review upon request.

Air entrainment shall be considered by the designer for all pipelines and where necessary, high points on pipes shall have allowance for venting entrapped air. Alternative designs for removing trapped air within pipelines such as operating an increased velocity may be considered. Designs and details shall be issued to Urban Utilities upon request for review.

Drainage of pipework for maintenance shall be considered by the Certifying Engineer and provision included in the design. The drainage assessment shall extend beyond the immediate equipment slab through existing drains to the main drainage pumping station (where applicable).

Pipelines carrying concentrated grit slurries from grit vortex traps to grit washers shall be designed with suitable velocities to transfer the heterogeneous grit slurry up to 40% grit concentration by weight. A Specific Gravity (SG) value of 2.65 shall be used for grit slurry calculations. The pipeline velocity shall be not less than the critical settling velocity calculated for the slurry pipeline or a minimum of 2.3m/s for a DN100 or DN80 pipe.

Instrumentation and indicators shall be located and orientated so they can be conveniently read and accessed.

7.10.4 Isolation Requirements

All items of plant shall be capable of being adequately isolated so that work on the plant may be undertaken in a safe manner. Isolation methods shall address liquids, gasses and vapours, electrical and mechanical energy. Refer to the requirements in PRO379 - Energy Lock Out Tag Out Procedure - The design must capability to isolate and secure sources of hazardous energy to allow work activities to be performed safely at Urban Utilities workplaces.

Block valves and isolation valves shall be capable of being padlocked in the closed or open position appropriate to the safe isolation being provided.

For gas handling systems, facilities shall be provided to purge isolated sections.

Where an actuated valve is being used as an isolation for the purpose of maintenance, the driving mechanism must be capable of being locked in the maintenance position and its motive force (e.g., electricity or air) must be capable of being positively isolated.

Where a double block and bleed is required, the vent shall be appropriately sized and located to ensure that the isolation can be adequately proven.

7.10.5 Piping Materials

Pipe materials shall be in accordance with the requirements of this Specification, WSA Products Specifications, Australian Standards and, where applicable for network reticulation, the *SEQ Water Supply and Sewerage Design and Construction Code* (refer to the following webpage: www.seqcode.com.au), subject to specific requirements for pipe materials in the Project Documentation.

All pipework shall be suitable for the intended purpose and design. The pipework design shall address the following considerations:

a) The compatibility with the service fluid and operating conditions including pressure, velocity and temperature.
b) Resistance to sunlight (UV radiation).
c) External resistance to sulphuric acid attack, caused by airborne hydrogen sulphide gas.
d) The pressure rating of the pipe in comparison to the MAOP.
e) Pressure de-rating due to temperature, and cyclic fatigue.
f) Pressure surge effects due to loss of power to the pump plus any additional relevant scenarios such as fast closing inline valves
g) Allowable pipe spans between supports.
h) Design life.
i) Any other service condition that is likely to have an effect the durability of the pipe material.

Where pipe material is not nominated in the Project Documentation, alternative pipe materials may be offered based on an optimum whole of life outcome, considering cost, durability, maintainability and risk. Pipe system selection is subject to review and acceptance by Urban Utilities.

7.10.6 Above ground Piping Layout

Pipework shall be arranged in such a way that access to all parts of the plant is not impeded. Where possible pipe runs shall be along walls, or if suitable, run overhead at a height of 2.1 metres or more above floor level, or in pipe trenches. Where pipework contains equipment requiring regular access, the pipe level shall be located at an ergonomically preferred height for operation and maintenance. Pipework may not be installed at heights less than 2.1 metres above floor level, if this would cause obstruction to access pathways that are needed for access to certain areas and alternate pathways cannot be provided.

7.10.7 Pipe Supports

The pipework shall be rigidly and safely supported on racks, brackets or reinforced concrete supports at spans not exceeding the lesser of the pipe manufacturer's recommendations or the relevant industry standard for the piping material and type. Steel brackets and their fasteners restraining hydraulic forces, including transient and cyclic loads, shall also be designed with the necessary a fatigue allowance, along with all other loads.

Pipe support for above-ground piping in general environmental conditions shall be manufactured from structural steel; hot dip galvanized.

Where pipes are supported in corrosive environments deemed High or Extreme, supports shall be manufactured from grade 316 stainless steel, or other corrosion resistant material such as FRP, GRP or PVC. Supports shall be fully resistant to process mediums within pipes.

Stainless steel pipe may be supported on galvanized steel bracket provided that the pipe is separated from the bracket by a layer of non-hygroscopic material such as Polyethylene , Refer to Section 6.18.4

High or Extreme Corrosive environments for pipe supports can include (but not limited to):

- less than 2km from the coast;
- exposed to hazardous or corrosive chemicals;
- exposed to H2S gas emissions from sewage;
- or be in a splash zone or tidal zone of sewage, mixed liquor or final effluent.

Where possible, pipes should be supported off walls or using elevated bracket supports, to minimise the exposure to increased corrosion potential from liquid pooling on the floor. All floor mounted supports shall have a minimum of 35mm of grout under the base of the support to allow correct levelling of the support and to elevate the support above spills on the concrete slab, reducing corrosion potential of the support.

Detail drawings of pipe supports shall be provided to Urban Utilities for review upon request.

Where pipework is supported by brackets, the brackets shall be in accordance with the requirements of AS 4041 Section 3.28.

Pipework subject to axial float, or movement, shall incorporate sliding supports. Polyethylene strips, or similar approval material shall be used to minimise friction between surfaces. Details of such supports shall be provided to Urban Utilities for review if requested.

Pipe supports installed in floor trench drains, shall be manufactured from Grade 316 stainless steel, FRP, PE or other suitable corrosion-resistant material.

Where possible, piping installed in floor trench drains shall be supported off the trench walls and not the trench floor, ideally as high as possible within the trench wall to minimise potential contact with liquid in the floor drain, minimising potential hydraulic restrictions and corrosion potential.

Above ground pipework shall be designed with joints at all intersections, branches, changes of direction, valves and dead ends suitable to withstand tensile forces tending to separate the joint when the pipeline is subjected to an internal gas or liquid pressure.

Anchorage shall be provided where there is the possibility of pulling joints or subjecting pipework to excessive stresses. Pipe anchorages shall be provided to absorb static and dynamic thrusts from pipe fittings, bends and valves.

Where out of ground pipes are supported on structures, expansion bellows shall be provided to allow for differential movement at all transitions between structures with separate foundations or between all structures and buried pipelines.

7.10.8 Thermal Expansion

Thermal expansion and contraction must be fully allowed for in the design and installation of new pipework, particularly in long pipe runs. All new pipes must be checked for acceptable stresses due to thermal expansion/contraction.

Expansion loops and/or expansion bellows shall be incorporated into all pipes which are exposed or subject to thermal expansion to absorb angular, rotational and axial movement.

Details of expansion mechanisms shall be provided to Urban Utilities for review on request.

Supports of pipework near elbows, bends and changes in direction shall make allowance for potential thermal expansion of the pipe in such a manner as to prevent increasing stress on the pipe.

7.10.9 Plastic pipe

When considering plastic pipe materials for the pipe design, the following pipe materials product and installation standards are considered suitable for above ground piping applications on water and wastewater treatment facilities.

PIPING MATERIAL	ABOVE GROUND APPLICATIONS	RELEVANT STANDARDS		
		PIPES	FITTINGS	INSTALL
Unplasticised Polyvinylchloride (UPVC) Pressure Piping	chemical dosing or chlorinated water applications	AS3879 ASTM D1785	AS3879 ASTM D1785	AS2032
Unplasticised Polyvinlchloride (UPVC)- DWV	for drain, waste and vent applications;	AS1260 AS3879	AS1260 AS3879	AS2032
Chlorinated Polyvinylchloride (PVC-C)	Specialist applications for high corrosive substances. Requires agreement by Urban Utilities to use For chemical dosing systems only, subject to agreement.	ASTM D1784	ASTM D1784	AS 2032
Polyethylene (PE100PE)	Pressure applications for Water and wastewater treatment fluids	WSA PS 207	WSA PS 208	AS 2033
Centrifugally Cast Glass Reinforced Plastics (CC-GRP)	Corrosive fluids or gases Odour ductwork or gravity pipelines	WSA PS 237	WSA PS 237S	
Filament Wound Glass Reinforced Plastics (FW-GRP)	Pressure and Non-Pressure Applications – Drinking water and non-drinking Water Supply	WSA PS 205	WSA PS 205	
Filament Wound Glass Reinforced Plastics (FW-GRP)	Pressure and Non-Pressure Applications – Sewerage	WSA PS 205S	WSA PS 205S	
Acronitrile butadiene styrene (ABS)		Not Allowed	Not Allowed	

All plastic piping exposed to sunlight and external weather shall be stabilised against UV degradation and/or externally coated as specified in WSA201 and TMS76.

7.10.10 Metal pipe

When considering metal pipe materials for the pipe design, the following pipe materials product and installation standards are considered suitable for above ground piping applications on water and wastewater treatment facilities.

PIPING MATERIAL	ABOVE GROUND APPLICATIONS	STANDARD		
		PIPE	FITTING	INSTALL
Mild steel cement lined (MSCL)	Pressure and Non-pressure Drinking water, non-drinking water supply and sewerage	WSA PS 203 and AS1281	WSA PS 204 and AS1281	Section 4 of AS 4041 and AS 3892
Ductile Iron cement lined (DICL)	Drinking Water, Non-Drinking Water Supply and Sewage	WSA PS 200	WSA PS 201	Section 4 of AS 4041 and AS 3892
316 Stainless Steel	Water, wastewater and process piping, subject to agreement by Urban Utilities. Gas containing high H2S (See Note 1)	AS 4041, AS 1579, ASTM A312M. ASTM A358M, ASTM A790M	AS 4041, AS 1579, ASTM B16.9	Section 4 of AS 4041 and AS 3892
Steel, Galvanized	Non-corrosive fluids, protective conduits, Subject to agreement by Urban Utilities.	AS4041 HDG AS 4680	AS4041 HDG AS 4680	Section 4 of AS 4041 and AS 3892
Carbon Steel	Pressure pipe for natural gas, oil, steam	AS4041	AS4041, ASTM B16.9	Section 4 of AS 4041 and AS 3892

Note 1: Gas containing high H2S shall be rated as a Very Harmful Gas (VHG) as per Table 3.2 (flammable & toxic) of AS4343. Specific requirements for piping conveying high H2S gas include: Threaded joint is not permitted. Spiral wound gasket must be used in flange joints.

Alternative metal piping materials not listed in the previous table are subject to review and acceptance by Urban Utilities

7.10.11 Mild Steel (MSCL)

Service	For out of ground sections of pipe conveying most process fluid mixtures on STPs. Must be concrete encased for buried service. Not suitable for any immersed of high corrosive service. Details of the pipe materials and its chemical compatibility to the service requirements shall be provided to Urban Utilities, prior to acceptance.	
Size range:	DN15 to DN1200	
Pipe:	Welded and Seamless: ASTM A53/A53M and ASME B36.10M Seamless for High Temperature Service: ASTM A106/A106M and ASME B36.10M Dimensions to ASME B36.10M From DN15 to DN40: SMLS pipe, BSP threaded ends From DN15 to DN50: SMLS pipe, butt weld ends From DN80 to DN200: SMLS pipe, butt weld ends From DN250 to DN750: EFW pipe, butt weld ends	
Fittings:	From DN15 to DN40: ASME B16.11, socket welded or BSP threaded ends From DN50 to DN750: ASTM A234M, ASTM A420M, butt weld ends. Dimensions to ASME B16.9	
Flanges:	AS4087 Flange material grade: Grade 250 AS 3678 Flange class designation: PN16 (to suit operating conditions or as indicated by Project Documentation)	
Nominal Wall Thickness (minimum)	Where operating pressure will not exceed 1200 kPa and pipe wall temperature will not exceed 60°C then the following requirements apply.	
	DN15 to DN50	Schedule 40
	DN80 to DN750	Schedule 10 Min 6.4mm for C350 Hollow Section
Weld Finish	Grade II Finish, in accordance with the requirements of AS 1554	
Pressure Testing	Hydrostatic or pneumatic testing in accordance with the requirements of AS 4041	
Weld Examination	The requirements of 6.12.5 Non Destructive Testing shall apply. Non-destructive examination requirement includes: 100% Visual examination of all welds by qualified welding supervisor or inspector, a minimum of 5% radiographic examination of all butt welds and fillet welds for each weld procedure/weld operator.	
Weld Procedure Qualification as per AS 1579	All weld procedures and ITPs shall be provided to Urban Utilities in accordance with the requirements of the fabrication section of this specification. Examination records are to be provided with documentation.	

Proof of Welder's Qualifications to be provided.	AS 1796 Certification of Welders and Welding Supervisors

7.10.12 Stainless Steel

The WSA Product Specification does not detail requirements for Stainless Steel pipe used in Water and Sewerage applications. Where the use of Stainless Steel is proposed, the following requirements shall be met:

Stainless steel piping shall be minimum grade 316, designed, manufactured, installed, tested and commissioned in accordance with the requirements of AS/NZS 4041, AS 4037, and AS 1579 and shall meet the requirements in Table 7-3.

Table 7-3 Stainless Steel Pipe Requirements

Service	For out of ground sections of pipe conveying most process fluid mixtures on STPs. Not suitable for buried service or for low pH anoxic environments or fluids. Details of the pipe materials and its chemical compatibility to the service requirements shall be provided to Urban Utilities.	
Size range:	DN15 to DN750	
Pipe:	ASTM A312 TP316L and ASME B36.19. From DN15 to DN40: SMLS pipe, BSP threaded ends From DN15 to DN50: SMLS pipe, butt weld ends From DN80 to DN200: SMLS pipe, butt weld ends From DN250 to DN750: EFW pipe, butt weld ends	
Fittings:	From DN15 to DN40: ASTM A182 F316L, ASME B16.11, socket welded or BSP threaded ends From DN50 to DN750: ASTM A403 WP316L and ASME B16.9, butt weld ends.	
Flanges:	AS 4087 Flange material grade: ASTM A240M 316L Flange class designation: PN16 (to suit operating conditions or as indicated by Project Documentation)	
Nominal Wall Thickness (minimum)	Where operating pressure will not exceed 700kPa and pipe wall temperature will not exceed 60oC.	
	DN15 to DN50	Schedule 40S
	DN80 to DN750	Schedule 10S
Weld Finish	Grade II Finish, in accordance with the requirements of AS 1554.6	
Pressure Testing	Hydrostatic or pneumatic testing in accordance with the requirements of AS 4041	

Weld Examination	Non-destructive examination requirement includes: 100% Visual examination of all welds by qualified welding supervisor or inspector, a minimum of 5% radiographic examination of all butt welds and fillet welds for each weld procedure/weld operator.
Weld Procedure Qualification as per AS 1579	All weld procedures and ITP's shall be provided to Urban Utilities in accordance with the requirements of the fabrication section of this specification. Examination records are to be provided with documentation.
Proof of Welders Qualifications to be provided.	AS 1796 Certification of Welders and Welding Supervisors

Stainless steel pipe shall not be used for buried services. This is due to risk of low pH or anoxic environment or fluids. Where transitions from above ground pipe to underground pipe in stainless steel material is unavoidable, the stainless steel pipe and connecting flange requires appropriate engineered backfill material, good drainage and oxygen access.

The data specified in the above table shall be checked in accordance with the requirements of the operating parameters and site conditions for the Project. Urban Utilities shall be notified beforehand in writing if pipes and/or fitting classes, pressure ratings, sizes or other data is proposed to be changed by the Certifying Engineer, with all appropriate reasoning.

All 316 stainless steel components shall be supplied in the solution annealed; heat treated condition. All 316 SS components shall be cleaned and passivated. Cleaning and passivation treatment shall be applied after fabrication. No stainless steel welding for new construction will be permitted on site unless fields welds are unavoidable and agreed to in advance by Urban Utilities.

For all field stainless welds pickle and passivation treatment shall be applied in accordance to 6.12.7 – Weld Finish for Stainless Steel.

Where a weld needs to be carried out on a pipe place that cannot be effectively cleaned and passivated after welding, back gas purging with inert gas shall be used to prevent oxidation on the inside surface of the pipe to provide maximum corrosion resistance for the new pipes. All other welds must be mechanically and chemically cleaned prior to passivation to provide maximum corrosion resistance.

Stainless steel parts shall be effectively isolated from dissimilar metals. Details of isolation methods shall be provided to Urban Utilities for review.

7.10.13 Uni-Flanges

The use of Uni-Flanges in facilities shall be subject to agreement by Urban Utilities.

Uni-Flanges, Gripper Flanges and similar types of jointing systems shall not be permitted on new development projects or upgrades to existing installations.

The use of Uni-Flanges (or similar types of jointing systems) may be allowed for emergency repairs or temporary installations provided the pipe system has been assessed by the Certifying Engineer and is suitable for the application and system operating conditions.

7.10.14 Pipework Pressure Inspection and Testing

Steel pipe welds shall be inspected according to section 6.12 Error! Reference source not found.

100% of all plastic pipe joints shall be visually inspected.

All metal pipework shall be hydrostatically tested in accordance with the requirements of AS/NZS 4041 Section 6 and AS 4037 Sections 17, 18 and 19.

Alternatives to hydrostatic testing for steel piping is provided in section 6 of AS 4041, subject to review and agreement by the authorised Urban Utilities representative.

DICL pipework shall be hydrostatically tested in accordance with the requirements of AS/NZS 2280.

PE100 pipe shall be tested in accordance with the requirements of Clause 7.2 of AS 2033.

FRP/GRP pipework shall be tested in accordance with the testing procedure specified in ISO10639:2017 and AS 2566.2 Section 6.3.

Test Method statements shall be developed and provided to Urban Utilities for review. The pressure test packs shall be developed for each pipe system with marked up P&ID's and test specific details showing the extent of each test.

All pressure tests of pipework may be witnessed by the authorised Urban Utilities representative, who will countersign the ITP as witnessed. Witness points shall be included in ITPs for the respective Urban Utilities representative.

Piping requiring insulation shall be insulated after completion of pipe testing.

7.11 Valves

7.11.1 Valves General

Valves shall comply with the relevant valve product specification produced by the Water Services Australia where possible.

Valves shall be installed strictly in accordance with Manufacturer's instructions.

Unless specifically required for plant function, valves shall be sized at or above the nominal pipe size. All valve bodies shall be suitable for the maximum pressure as specified, including test pressures.

All machine screws and bolts that are used on the valve assembly shall be A-4.70 (grade 316 SS cold formed bolts with markings as defined in Section 6.17and shall be assembled with metal-free, anti-seize compound.

The construction of valves shall be suited to the process fluid and external environment that the valve is intended to be used.

Wafer type valves may not be used for isolation and servicing of system components or where pipe on either side of the valve may need to be removed during maintenance events.

Tapped lugged type valves suitable for bolting between flanges with stainless steel grade 316 machine screws shall be used where the valve may be required to isolate the pipeline and allow dismantling of the pipework on the isolated side of the valve. Derating of the valve must be accounted for when one or other of the flanges has been removed.

All valve assemblies exceeding 25kg shall be provided with lifting attachments. Such lifting attachments must be designed and rated for lifting the entire mass of the complete assembly, including the valve, gearbox and actuator. Where lifting attachments are not specifically built into the valve, the designer shall consider how soft slings can be utilised to assist the lifting process.

The following Quick valve selection guide in Table 7.4 lists suitable WSA product specifications for the various valve applications.

Table 7.4 - Quick valve selection guide				Valve Function				Yes = suitable, No = unsuitable, ok = suitable but with limitations
Valve type	Application	Specification	Size Range	Isolation	Control	Regulating	Solids handling suitability	Comment
				On/Off	On/Off	4-20mA		
Butterfly[1]	drinking water and non-drinking water; aeration system	WSA PS-263 AS 4795.1&2	DN50 - 1200	Yes	Yes	Yes	No	Not suitable for sewage due to ragging. Preferred orientation is stem and disc horizontal to avoid debris collection at shaft and bearing. Need to confirm disc does not clash with pipe ID.
Ball[1,2]	drinking and non-drinking water without grit[3]	AS5830.1[4]	DN6 - 100	Yes	Yes	No[2]	No	Valve type starts becoming an expensive option for low pressure isolation over 50mm. Available in PN16 up to PN40.
Resilient seated Gate	water and sewage	WSA PS-260, 278 or 279, 281	DN80-750	Yes	Ok	No	Yes	Good safety isolation valve. Not preferred for on/off control due to wear on spindle bushes. PN16 or PN25
Metal Seated Gate	water and sewage	WSA PS-261	DN80-900	Yes	No	No	Yes	Good safety isolation valve. Suited for infrequent use or higher pressure applications. Refer SEQ Code limitations for buried valves. PN16 or PN35
Knife gate	water and sewage	WSA PS 266	DN50-1500	Yes	Yes	No	Yes	Rated to PN10 up to DN600. Recommended to use RS Gate valves for isolation purposes where possible.
Eccentric Plug valves	Sewage	AWWA C517	DN80-1800	Yes	Yes	Yes	Yes	No WSA product specification, considered specialist valve. Orientation of seat should always be towards pump, so that when not pumping the pressure pushes the plug against the seat to seal. Orientation of valve in horizontal should allow the plug to open to the top of the pipe, out of settled solids. Orientation in the vertical should allow the seat end up so that settled solids do not collect in the valve.
Diaphragm valves[1]	water and sewage with solids and chemical dosing	MSS[5] SP88	DN15-300	Yes	Yes	Yes	Yes	No WSA product specification, considered specialist valve. Recommended use with pipelines containing solids or corrosive substances. Applications can be plastic bodied or metal bodied with rubber liners, weir type or full bore.
Non-return valves	water and sewage	WSA PS 264	DN80-750	-	-	-	-	Should be sized to avoid mechanical damage from continual opening and closing based on the flow being enough to keep the disc open. Orientation needs to be checked. PN16 or PN35

Notes:

1. Table excludes recommendations and details for plastic valves for chemical dosing applications.
2. V-groove Grey uPVC ball valves can be used for regulating flow on small DN15 lines.
3. Grit or abrasive materials can scratch the ball preventing the valve from sealing.
4. This standard is for one- and two-piece ball valves not 3-piece ball valves.
5. Manufacturers Standardisation Society (MSS)

7.11.2 Gate Valves

When considering gate valve selection for the piping system design, refer to the Quick Valve Selection Guide table for suitable valve product specifications produced by Water Services Australia (WSA) for above ground piping applications on water and wastewater treatment facilities.

In addition to compliance with the WSA specifications listed in the quick valve selection guide table, Gate valves shall only be used for isolation of pipework and not to control flow. The most suitable seating of valve shall be dependent on the fluid, differential pressure and the accessibility of the valve for future replacement versus the acceptability of a small passing flow when the valve is closed. The designer shall also determine if a gearbox is required to limit required manual operation force to 120N at the key or handwheel, or for remote or automated operation by an electric actuator. Where a gearbox is used, the gearbox shall include mechanical over-torque protection and a position indicator. Above ground, manual valves on process fluid pipelines within treatment plant facilities shall have hand wheels provided.

All types of gate valves shall be installed with the spindle vertical, unless horizontal installation is required to provide a prudent and efficient installation. Horizontal installation must be explicitly justified as part of the design and acceptance by Urban Utilities.

7.11.3 Knife Gate Valves

When considering knife-gate valve selection for the piping system design, refer to the Quick Valve Selection Guide table for suitable valve product specifications produced by Water Services Australia (WSA) for above ground piping applications on water and wastewater treatment facilities.

In addition to the WSA – PS Standards, all knife gate valves shall comply with AS 6401 and the following Urban Utilities specific requirements:

a) Be suitable for installation in applications subject to submergence in or splashing by Sewerage or sludge;
b) Have the body, gate, seat, superstructure, gland and all fasteners manufactured from stainless steel grade 316;
c) Have the valve body as a tapped lugged design suitable for bolting between flanges with stainless steel grade 316 machine screws from both sides;
d) Have gland packing manufactured from PTFE impregnated glass fibre;
e) Flange jointing with full face insertion elastomer (typically EPDM) gaskets;
f) Be provided with clear indication of closed and open positions. The indication shall provide a clear visual signal prior to over-tightening or over travel

Where a rising extension spindle is required, the standard factory product may need to be modified by having the factory spindle and lift nut removed and replaced with a new rising spindle and fabricated stainless steel grade 316L lift support structure with new lift nut and screw spindle. The final position of the handwheel, handwheel bearing or actuator is to be suitably located for operation and ease of maintenance.

There is no WSA Specification for Penstocks or Fabricated Knife Gate Valves. These shall be manufactured in accordance with the requirements of Section 7.13 of this Specification with technical data provided to Urban Utilities for review prior to manufacturing.

7.11.4 Butterfly Valves

When considering butterfly valve selection for the piping system design, refer to the Quick Valve Selection Guide table for suitable valve product specifications for above ground piping applications on water and wastewater treatment facilities.

In addition to the WSA – PS263, butterfly valves for water works applications shall comply with AS 4795.1&2.

Butterfly valves for higher temperature process duty such as aeration shall comply with EN 1349 and EN12266.

Butterfly valves shall also meet the following Urban Utilities-specific requirements:

Butterfly valves shall not be used on sewerage lines or lines carrying materials likely to rag or otherwise accumulate on the valve disk and shafts.

a) Valves shall suit the internal bore of the pipework it will be connected to including allowance for pipe linings. Modifications to internal bore or linings of pipework to accommodate valve discs would only be accepted by Urban Utilities based on the following:
   - the modifications are performed in a factory (not on site) under controlled machined tolerances
   - Modifications do not diminish the strength nor the integrity of the protective coating of the pipe
   - Design calculations are submitted with the request to modify the pipe to prove the structural and protective coating integrity are maintained.

b) Valves shall be able to open and close under an unbalanced system head of at least 1.5 times the operating pressure.

c) Butterfly valves shall be installed with the shaft in the horizontal position and the lower part of the disc opening in the direction of flow. Adequate clearance shall be provided between the butterfly valve disc and the adjacent pipes to allow full opening without clashing.

d) Resilient seating valves shall generally not be used in applications where frequent operation is required against unbalanced pressures greater than 500kPa. Butterfly valves with fully vulcanised seats may be considered in this application.

e) Have replaceable resilient valve liner securely held in place;

f) If required, have a heavy-duty right-angle geared operator with electro-mechanical actuator and shaft seals to prevent dirt or water entering the gear unit. The geared operator shall have a mechanical disc position indicator and mechanical over-travel protection acting on the input shaft side of the gearbox;

g) For sizes DN300 and larger, or in critical applications, the valve shall be double flanged with fully vulcanised rubber seats;

h) For small butterfly valves (less than DN100) a double acting lever handle may be used. Lever handles and notch plates shall be stainless steel grade 316. Where the design requires positive isolation, the levers and plates shall be capable of being stapled through with a padlock. Locking by stapling the notch plate release is not an acceptable solution where positive, lockable isolation is required.

7.11.5 Ball Valves

When considering ball valve selection for the piping system design, refer to the Quick Valve Selection Guide table for suitable valve product specifications produced by Water Services Australia (WSA) for above ground piping applications on water and wastewater treatment facilities.

In addition to the WSA – PS Standards, all ball valves shall comply with AS 4796 and the following Urban Utilities specific requirements:

Unless stated otherwise on drawings or in the project specification, ball valves used for water, air applications shall be three-piece construction with:

a) Stainless steel grade 316 body, trim, fasteners and handle;
b) Orifice size equal to port or nominal bore connector size.
c) PTFE seals and seats; and
d) Pressure rating to a minimum of PN10

7.11.6 Diaphragm Valves

There is no current WSA – PS specification for Diaphragm Valves.

Diaphragm valves shall only be used where specified in the Project Documentation.

Specifications for the use of Diaphragm Valves for Urban Utilities are intended to be provided in future specification updates.

7.11.7 Non-Return / Check Valves

When considering non-return or check valve selection for the piping system design, refer to the Quick Valve Selection Guide table for suitable valve product specifications produced by Water Services Australia (WSA) for above ground piping applications on water and wastewater treatment facilities.

In addition to the WSA – PS Standards, all non-return or check valves shall comply with the following Urban Utilities specific requirements:

Resilient seated valves that effectively seal under the weight of the disc and back pressure are preferred. “Swing-Flex” check valves by *Valmatic* or similar should be used for most applications.

Non-return valves shall have provision for the addition of external indication for open and closed position for valves DN100 and above, if required in the Project Documentation.

Titling disc, metal seated type valves shall not be used in pipework carrying high suspended solids or rags e.g. RAS, WAS, Mixed Liquor, untreated Sewerage, etc.

Duckbill valves for use on through-the-wall pumps shall be Red Valve, Tideflex 35 series or Proco 700 series or equal product.

7.11.8 Eccentric Plug Valves

Eccentric Plug Valves shall be in accordance with the requirements of AWWA C517, except where otherwise specified in the Project Documentation.

Eccentric plug valves shall be double flanged rectangular port type with open bore 100 – 80% of the pipe area on which the valve is fitted. Valves shall be non-lubricated type with a resilient faced plug vulcanised to the substrate metal.

Valves shall ensure seating pressure across the full length of the valve seat. The valve body shall be constructed from cast iron with a welded hard nickel seat, stainless steel shaft and seal packing covers. Radial bearings shall be permanently lubricated.

7.11.9 Manual Valve Operators (Hand levers)

All manual valve operators shall be sized to limit the radial force required to operate the valve over its operating range (including on and off seating and against maximum differential pressure) to no greater than 120 Nm. Where this condition cannot be met with lever operator then a gearbox shall be used.

7.11.10 Extension Spindles and Hand Wheels

When considering extension spindle and hand wheel selection for the piping system design, the following valve product specifications produced by Water Services Australia (WSA) are considered suitable for above ground piping applications on water and wastewater treatment facilities.

Extension spindles shall be in accordance with the requirements of WSA – PS 269 and Urban Utilities-specific requirements as specified below:

The use of valve extension spindles shall be prevented where possible, however where the use of an extension spindle is the most practical alternative, the following criteria shall be met:

- Extension spindles shall be of rising type, unless otherwise specified in the Project Specifications or requested by Urban Utilities
- Spindles shall be solid bar or tubular construction
- Spindles shall be manufactured from grade 316 SS
- Spindle lengths shall be supported from deflection using adjustable UHMWPE guides, supported on 316 stainless steel brackets.
- Handwheel or actuator pedestals shall be manufactured from grade 316 stainless steel and shall be positioned for easy operation of the valve or penstock.
- All spindle bearings shall be accessible for greasing.
- Rising spindles shall include a spindle cover.
- Spindles shall include mechanical end stops, manufactured from grade 316 stainless steel.

Valve and penstock handwheels shall comply with the following:

- All handwheels shall be manufactured from grade 316 stainless steel, aluminum or cast iron with suitable corrosion protection.
- Opening and closing directions shall be clearly identified on handwheels
- Handwheel diameters shall be designed for minimal torque when opening and closing valves or penstocks. A maximum radial force of 120N shall be applied to open or close a valve or penstock.
- Chain operated handwheels shall not be used unless otherwise agreed with Urban Utilities.

7.12 Pressure / Vacuum Relief Valves

Where required by AS 1210, pressure and/or vacuum relief valves shall be used on pressure vessels and storage tanks containing compressed air or gas to prevent excess internal pressure or vacuum during operation.

The pressure/vacuum relief valves for pressure vessels to AS1210 shall comply with AS 1271. Pressure/vacuum protection of liquid storage tanks, large low pressure gas storage tanks such as s biogas digester tank shall comply with API STD 2000.

Relief valves may also be required to protect positive displacement pumps from mechanical damage, if it is possible for the suction or discharge pipes to become blocked or closed by incorrect valve operation. Primary protection pumped systems must be provided by the normal system controls, backed up by high- or low-pressure switches. Relief valves shall maintain a positive seat with no partial passing, unless the pressure switch has failed to operate correctly.

The inlet or exhaust shall be located so as not to create a hazard or nuisance.

7.13 Penstocks

7.13.1 Penstocks General

The design, supply, installation, testing and commissioning of Penstocks shall be in accordance with the requirements of the Project Documentation. In addition to requirements of the Project Documentation, the following criteria shall apply:

All penstocks for water or wastewater works purposes shall:

a) Be designed to open and close under an unbalanced system operating head;
b) Be flat back, square opening, flush bottom, full frame type;
c) Have a maximum allowable leakage rate of 0.3 L/min per metre of sealing surface at maximum operating head;
d) Be leak tested on site after installation;
e) If wall mounted, have precision non-shrink grout between the penstock frame and the wall incorporating an embedded hydrophilic water stop seal around the full frame to concrete structure interface;
f) If embedded, have precision non-shrink grout around the frame flush with the concrete face incorporating an embedded hydrophilic water stop seal around the full frame to concrete structure interface;
g) Ensure safe and efficient access considering operating locations such as handrails and flooring;

h) Have the gate or door fabricated from plate with stiffening elements;
i) Include replaceable, extruded, UHMWPE low friction, sealing, mechanically located, single piece side guides of 2.0 times the gate height as a minimum;
j) Have all components designed for maximum deflection of 1/500th of span under worst-case loads;
k) Have a minimum bolt size, including seal pressure adjustment, of M12 (except for any seal fasteners). Anchor bolts shall be included complete with two nuts and a washer per anchor; and
l) Gate guide and seals shall be capable of being replaced with the penstock frame in place. Instructions on replacing the seals and guides shall be provided to Urban Utilities for approval prior to ordering of any equipment.
m) Where confined space entry to a chamber may be required at various intervals in throughout the life of the facility, gates shall be backed up by manually installed stop boards to provide effective double isolation of the chamber.
n) The possibility of a body parts becoming trapped between the gate and other structures or the frame must be eliminated for all actuated penstocks.

7.13.2 Penstock Design

The basis for design, hydrostatic loads, performance requirements, corrosion environment category, process fluid, performance requirements and other design criteria shall be clearly stated in the product data sheet.

Data sheets with spindle thread details and design pressure values shall be provided in the O&M Manual.

Calculations of deflections, operating torques and stem capacity shall be provided to Urban Utilities for review on request, prior to ordering of any equipment.

General Arrangement, fabrication and installation drawings for all penstocks shall be provided to Urban Utilities for review upon request. Drawings shall detail as a minimum, the following information:

- Gate fully open size
- Outer frame size and material thickness
- Spindle thread designation
- Actuator details (if applicable)
- Anchoring details with dimensions from anchors to wall opening (concrete cover allowance)
- Opening and closing cycle time
- Opening and closing torque data
- Materials of construction and corrosion protection systems
- Overall penstock weight

7.13.3 Penstock Materials

Penstocks shall be constructed using materials as listed in Table 7-4.

Table 7-4 Penstock Materials

Component	Material
Frame	Stainless steel grade 316, only.
Gate	Marine grade aluminium or, Stainless steel grade 316 (stainless steel to be used in areas subject to high wear or where the unit is frequently operated)
Pedestal	Stainless steel grade 316, only.
Stainless Steel Weld Finish.	Grade II Finish, in accordance with the requirements of AS 1554.6
Bolts, Nuts, Washers and Machine Screws.	316 SS - A4.70, cold formed, with markings. Assembled with metal free anti-seize compound/grease.
Bottom seal	Polyurethane, neoprene, or NBR.
Side and top seals	Low friction, low wear, resilient backed material such as ultra-high molecular weight polyethylene (UHMWPE) with neoprene backing. Seal profile must be designed for the purpose and is subject to acceptance by QUU.
Lift nut	Bronze or non-metallic
Limit nut	Bronze
Stem	Stainless steel grade 316
Stem cover	Stainless steel grade 316 or clear polycarbonate
Hand wheel	Stainless steel grade 316. “Close” and “Open“ direction must be stamped on hand wheel with a direction arrow.

7.13.4 Penstock Spindles

Penstock spindle thread shall be a right hand (RH) single start, trapezoidal die or machine cut ACME or DIN103 threads. The thread designation must be stamped on the end of the spindle and on the nut, as well as provided in the drawings and in the O&M Manual.

Stems shall be not less than 28 mm diameter, but in any case, shall not have a slenderness ratio (L/r) greater than 200. A mechanical limit nut shall be supplied on rising stems and set such that excessive force applied by the operator at closure cannot buckle the stem. The penstock shall be rising spindle arrangement with the lift nut bearing frame pedestal located above coping or platform level in a location where it can be easily accessed for maintenance.

Lift, bearing, spindle and actuation mechanism shall be designed as a closed weatherproof, durable housing to protect the moving parts from the environment. Manual actuation shall be by a 316SS hand wheel with maximum input rim force effort of no more than 120N. Opening and closing direction arrows must be clearly embedded, engraved, or stamped in the hand wheel and on the top of the lift mechanism. The entire lift bearing and nut mechanism must be capable of being dismantled for replacement or repair with the gate in place and from the platform or coping level.

High duty actuated penstocks shall have automatic lubrication and spindles with high tolerance, ground and polished threads. The drive nut shall be sized to achieve the required thread stress and at least one replacement nut shall be provided for each high duty actuated penstock.

7.13.5 Stop Boards and Stop Logs

Stop boards shall include suitably designed lifting handles or load rated, lifting lugs.

Small stop logs intended to be installed manually shall include suitably designed lifting handles. Stopboard gates shall be designed within an acceptable weight class to allow manual removal and replacement without negatively affecting the worker. WorkSafe QLD guideline *Hazardous manual tasks Code of Practice 2021* shall be consulted to define the acceptable loads for lifting equipment.

7.14 Actuators

Actuators are required where frequent cycles or the size and therefore the manual effort required makes manual operation impractical or where remote or automatic valve or penstock operation is necessary. The requirement and type of actuators for valves and penstocks will normally be detailed in the Project Documents.

7.14.1 Electro-Mechanical Actuators

a) Electric actuators shall be selected from the IPAM or TMS62 Preferred Equipment Lists as applicable. Electric actuators shall:
b) Have a hand wheel for "Manual" operation which shall display an embossed or engraved direction arrow, together with English language "Open" and/or "Close" legend;
c) Include a clutch to prevent operation of the motor when the hand wheel is engaged, and to disengage the motor drive from the hand wheel when the motor is engaged;
d) Require a force of no more than 120 N force on the rim of the hand wheel for hand wheel operation when unseating and reseating the valve;
e) Include torque sensing and an absolute position encoder to support programmable torque control and programmable end of stroke position feedback, via inbuilt programmable output relays;
f) Be equipped with a control system that will not lose position reference or configuration settings if operated without power supply;
g) Maintain relative actuator/valve position during manual operation with the power supply off;
h) Not be dependent on an internal battery;
i) Where practicable the motor should be a three-phase squirrel cage induction type having Class "F" insulation to AS 2768;
j) Be designed for at least 50% more operating cycles (opening/closing) per hour than is required under the worst-case operating scenario (12 cycles per hour shall be taken as a minimum, with the actuator able to complete two full open and close cycles without pause at the end of the hour);
k) Be equipped for remote operation and include a "Test/Off/Auto" selector switch as an integral part of the actuator. When "Auto" is selected the local "Stop" button shall still be operative;

l) Include a local mechanical position indicator fitted in the actuator to clearly indicate when the valve or penstock is fully open, fully closed, or in any intermediate position;
m) Have waterproof enclosures forming part of each actuator in accordance with the requirements of AS/NZS 61439;
n) Have a motor enclosure and actuator terminal box rated to Class IP65 or IP 68 for in pit installations. (Electronics for the valve controller shall have conformal coating and be in a separate sealed compartment to prevent effects from moisture and H2S);
o) Have clear labelling of the terminals on the actuator terminal block corresponding with the identification shown on the manufacturer's diagram of connections;
p) Have a torque rating approximately 50% in excess of that required to operate the valve or penstock under the highest load parts of the valve stroke (typically this is at seating and unseating);
q) Have adjustable torque and limit switches set to protect the valve/penstock, gearbox, and actuator under all operating conditions specified. Quarter turn valves with gearboxes shall have mechanically adjustable end of travel locking nuts to mechanically stop the drive input shaft to prevent over rotation of the valve;
r) Actuators with 3-phase motors must have phase direction protection for the incoming supply and arranged such that it will render the actuator inoperative if the phase rotation of the power is reversed. Alternatively, the phase discrimination relay can correct actuator rotation to suit supply.

Simple Open/Close function actuators shall be provided with the following inputs and outputs as standard:

Actuator Input/Output	Function	Requirement
Control supply	24 V DC supply	If required.
Input	Position Control	If Required. 4-20mA control signal. Valve drives to calibrated position plus/minus dead band.
Output	Position Feedback	4-20mA feedback signal to indicate position as a proportion of the valve stroke range.
Input	Close	Closes valve while output from PLC is high
Input	Open	Opens valve while output from PLC is high
Output	End of stroke (opened)	Relay contact open until valve opened
Output	End of stroke (closed)	Relay contact open until valve closed
Output	Hardware failure	Normally closed when healthy
Output	Overtorque	Normally closed when healthy

Actuator Input/Output	Function	Requirement
Output	Remote unavailable	Monitor relay will de-energise under the following conditions: Selector in "Stop/Off" Selector in "Local Selected" Lost phase fault Valve jammed Motor over-temperature Normally closed when healthy

7.14.2 Pneumatic Actuators

Where specified in the Project Documents, pneumatic actuators shall be supplied in accordance with the requirements of AS 2019, AS 2788 and the Urban Utilities specific requirements below.

7.14.3 Air Solenoid Valves

Solenoid valves providing direct control of pneumatic actuators shall:

a) Be spool type control valves with 5-port, 2-way or 3-port, 2-way configurations, replaceable with an adaptor plate;
b) Provide high flow capacity to give the pneumatic actuators good response times;
c) Be suitable for mounting directly onto actuators or in a remote box;
d) Include speed controllers with an operating range of 0.25 to 240 seconds, and silencers as standard items with the supply of the valves;
e) Be suitable for operating from a compressed air system with a pressure range between 550 - 1000 kPa.
f) Have field replaceable, 24 V DC solenoid coils;
g) Be provided with a manual override button and an energised indicator light;
h) Have a standard threaded process connection to suit the application and air main
i) Be fabricated with either 316 stainless steel or an anodised aluminium alloy body and spool, nitrile O-rings; and
j) Be supplied with certificates of compliance, product verification report and test result certificates.

7.14.4 Quarter Turn Pneumatic Valve Actuators

Quarter turn pneumatic actuators shall:

a) Be a compact rack and pinion type with double piston, internal airports, adjustable travel stops and shall be grease lubricated for life;
b) Have a replaceable 24 V DC air control solenoid mounted either directly to the body of the actuator or separately in a remote box;
c) Be capable of having accessories such as solenoid control valves, limit switch units, de-clutchable manual override gearboxes and high visibility indicators attached directly to the body of the actuator;

d) Include pistons complete with anti-friction pads to ensure no metal-to-metal contact between pistons and the bore of the actuator;
e) Be pressure rated to 1000 kPa for the body and all the fittings;
f) Be selected to operate trouble-free with a minimum actuator air supply pressure of 550 kPa;
g) Have adjustable control air flow restrictors to control opening and closing speed where necessary;
h) Have an available torque operating margin at least 30% greater than the required seating or unseating torque (whichever is the greater) of the valve;
i) Have replaceable 24 V DC rated end of stroke position switches for feedback to the PLC;
j) For control valve with modulating function, be supplied and installed with an electronic positioner. The positioner shall be electro-pneumatic type with a 4-20 mA position feedback to the PLC. The positioner enclosure shall be suitably robust for the installed environment, as well as chemical, UV and impact resistant with IP66 or higher level of ingress protection. Where appropriate the positioner controller and control valves shall be remote mounted. Position feedback shall be provided via a non-contact device with minimal hysteresis. Unless specified otherwise, positioners shall hold the valve in position on electrical signal supply or instrument air supply failure; and
k) Be supplied with certificates of compliance, product verification report and test result certificates.
l) Conformal coating of electronics PCB sub-assemblies to address high humidity and H2S in the installed environment.

Quarter turn pneumatic actuators shall be constructed from the materials listed in Table 7-5. To prevent stifling innovation, alternative materials of construction are subject to the review and acceptance of Urban Utilities prior to procurement of equipment.

Table 7-5 - Electro-Pneumatic Actuator Materials

Component	Material
Body	Anodised aluminium. Painted with Polyurethane or Epoxy 2 Pack protective coating system after assembly, or alternatively using Electrostatic Powder Coating system.
Piston	Anodised aluminium.
Piston shaft	Stainless steel grade 316
Bearing	Delrin
O-rings and seals	Nitrile
Machine screws	A4.7 minimum grade hex head. Metal Free Anti-Seize grease/compound shall be applied during assembly.
Mounting frames	Stainless steel grade 316
Position indicator Covers	Clear polycarbonate. These need to be an inexpensive and easily replaceable part.

7.14.5 Linear Pneumatic Valve Actuators

Linear pneumatic valve actuators shall:

a) Be diaphragm or piston style pneumatic actuators suitable for the automation of diaphragm, gate or knife gate valves;
b) Have a replaceable air control solenoid mounted either directly or via a bracket to the body of the actuator;
c) Be capable of having accessories such as solenoid control valves, limit switch units, electro-magnetic positioners and high visibility indicators attached directly to the body of the actuator or separately in a remote box;
d) Include pistons and stems with suitable sealing arrangements such as O-rings;
e) Be pressure rated to 1,000 kPa for the body and all the fittings (minimum);
f) Be selected to operate trouble-free with a minimum actuator air supply pressure of 550 kPa;
g) Enable a minimum gate valve opening and closing speed of not less than 300 mm per minute;
h) Have adjustable control air flow restrictors to provide for opening and closing speed adjustment, where necessary;
i) Have an available operating force margin at least 30% greater than the required seating or unseating force (whichever is the greater) for the valve;
j) Be supplied with certificates of compliance, product verification report and test result certificates.

Linear pneumatic actuators shall be constructed from the materials listed in Table 7.6. To prevent stifling innovation, alternative materials of construction are subject to the review and acceptance of Urban Utilities prior to procurement of equipment.

Table 7-6 Linear Actuator Materials

Component	Material
Body	Cast iron/aluminium (anodised)/GRP. Painted with Polyurethane or Epoxy 2 Pack protective coating system after assembly.
Piston	Cast iron/aluminium
Piston rod/shaft	Stainless steel grade 316/High strength alloy steel with Hard Chrome surface.
Diaphragm	Nylon reinforced neoprene
Bearing	Delrin
Fasteners	Stainless steel grade 316 (hex head)
Shaft seal	Nitrile
O-rings and seals	Nitrile

8. MECHANICAL INSTALLATION

8.1 General Requirements

Mechanical equipment shall be installed in accordance with the requirements of this Specification and all regulatory and statutory requirements.

8.2 Inspection and Test Plans (ITPs)

All installation scope included within each work package shall be referenced in Inspection and Test Plans (multiple if required) to deliver a quality installation.

Each work package shall include an ITP to ensure each key step or procedure of the installation process has the necessary review, hold and or witness points to ensure the required level of quality assurance is delivered. Each ITP shall be submitted to Urban Utilities upon request prior to attending site, unless otherwise agreed by Urban Utilities.

ITPs shall indicate all Hold and Witness Points where the Accountable Party may acknowledge that a step or procedure during installation has been successfully achieved. An Urban Utilities representative may request inclusion in various Witness Points on ITPs. Commissioning of equipment may not commence until all ITP Witness Points have been signed off by the Accountable Party(s).

The key steps or procedures on the overarching work package ITP may include all, or most of the following typical key steps in a mechanical installation:

KEY STEP OR PROCEDURE	QUALITY ASSURANCE
Delivery of goods to site	Ensure equipment is supplied in undamaged condition to site.
Site survey	Ensure key levels and dimensions on site match the design levels within tolerances nominated by the Certifying Engineer in the Project Documentation.
Major Equipment installation	Ensure equipment installed matches the design requirements.
Access Platforms	Ensure relevant access platforms are installed to design requirements.
Levelling	Ensure equipment is installed level.
Machine Mounting Checks	Ensure that all the machine “feet” are making good contact with all the “foot points” on the frame.
Fixing / Fasteners	Ensure fixing of equipment is to the design and/or equipment manufacturer’s recommendations.
Pipework	Ensure process piping installed matches the design and is pressure tested to ensure it is safe for use.
Alignment	Ensure equipment is aligned in accordance with manufacturer’s recommendations, if applicable.

KEY STEP OR PROCEDURE	QUALITY ASSURANCE
Lubrication	Ensure necessary gearboxes, drives, bearings etc. are lubricated in accordance with manufacturer's recommendations prior to operation, to reduce risk of damage and prolong service life.
Balancing	Ensure necessary balancing of equipment as per manufacturer's recommendations, to prolong service life. Refer 6.24.
Services Installation	Ensure necessary ancillary services are installed as per design and manufacturer's recommendations, to ensure the equipment functions as intended.
Isolation of dissimilar materials	Ensure isolation of dissimilar metals has been achieved for pipework and structural materials, in accordance with the requirements of this specification, Section 6.18.4.
Pipework Installation and Testing	Ensure pipework and fittings comply with the relevant pipe specification and valve specification.
Noise compliance	Ensure necessary noise attenuation equipment is installed as per design.
Certifications	Ensure statutory certifications are undertaken.
Coatings Repair	If necessary, repair coatings due to damage during delivery or installation.
Tagging/Labelling	Ensure equipment, valves and pipes are tagged and labelled appropriately.
Grouting	Ensure grouting of supports etc. are completed as per design materials, mixture and grout installation procedure. Grouting shall be in accordance with the requirements of this specification, Section 8.18.
Handover	Signoff of mechanical installation ready for electrical installation and safe handover to commissioning.

It is anticipated major work packages shall reference additional ITPs and or check sheets as necessary to assist documentation of the installation sign-off and review process.

8.3 Delivery, Storage and Preservation of Equipment

All equipment shall be protected from damage and contamination during handling and storage. Goods supplied shall be packed for delivery and storage in accordance with the requirements of AS 2400. Where specified in the Project Documentation, equipment shall be inspected at the manufacturer's premises and signed off by an Urban Utilities representative with approval for dispatch.

At a minimum, the ITP shall include the following witness point checks for delivery, storage and preservation of equipment:

- Final inspection and release from factory (this may form part of the manufacturing quality control plan).
- Inspection of equipment after delivery to site and offloading. This will require a visual inspection to ensure the equipment, paintwork, galvanizing or other surface treatment has not suffered damage during transportation, and to check scope of supply for completeness.
- Periodic inspection of equipment in storage and during installation to ensure preservation is maintained.

Soft slings shall be used wherever possible for equipment fastening and lifting, to minimise potential damage to surface coatings of equipment.

The proposed method of storage for mechanical equipment, where applicable, which provides details for safe storage and protection of equipment before installation, shall be prepared and issued to Urban Utilities. Storage shall include all proposed methods for preservation, and weather protection, should equipment be stored outside.

8.4 Site survey

Before equipment is installed, a survey of the installation area shall be conducted to allow the actual site dimensions to be measured, recorded, then compared and verified against the design dimensions. Pre-installation survey shall reference the pre-design survey and shall be done in accordance with the requirements of TEM641 *Part B Standard General Specifications SoW*.

Where the site measured dimensions are not within acceptable design tolerances, Urban Utilities shall be notified of the non-conformances.

The site survey shall be undertaken by a competent person, either an experienced tradesman or engineer, who is also experienced at using the level and distance measurement equipment, or a licensed surveyor if accuracy of survey is deemed necessary. The installation ITP shall make allowance for the key installation dimensions to be checked. Examples of key dimensions to be checked as a minimum include but not limited to the following:

- Floor slab and plinth levels
- Plinth sizes and Top of Concrete (TOC) levels
- Pipework connection sizes, connection locations, flange orientation and RL and invert levels
- Channel widths and heights
- Channel invert levels
- Overflow (or outlet) weir and lander levels
- Downstream hydraulic control points or weir levels
- Tank wall and floor levels
- Tank diameters, widths or lengths
- Tank central support TOC levels
- Access openings into buildings

- Potential site obstacles for installation

8.5 Major Equipment Installation

All mechanical equipment to be installed shall form part of either a single ITP or combined in a work package system ITP depending on the complexity of the equipment and work package and associated QA checks. Where the equipment installed is a single step in the system ITP, the equipment shall be checked and verified against the designed and procured equipment drawings and datasheets (or similar), to ensure the correct equipment is supplied.

Major mechanical equipment shall include separate ITPs which shall be submitted to Urban Utilities on request for review prior to installation.

Where applicable, or as indicated in the Project Documentation, equipment suppliers shall be required to witness, assist or carry out installation activities for major equipment. In this event, a Witness point shall be provided for an Urban Utilities representative to be present.

8.6 Access Platforms Installation

Where the work package includes installation of access platforms and /or stairs or ladders, the ITP shall include a key step or procedure for the installation and checking of the access infrastructure. This key step will confirm the material and installation matches the intended design and is in accordance with the requirements of AS 1657 and this document.

8.7 Equipment Levelling

Equipment shall be levelled and fixed in place prior to grouting of bases and frames.

Where anchoring post tension is required or specified in the suppliers' documentation, levelling is carried out with incompressible packing material or wedges.

Levelling of the equipment shall be a key step within the work package ITP and shall include a final measurement of the installed equipment level with comparison to the design level.

8.8 Machine Mounting Checks

These checks are to ensure that all the machine "feet" are making proper contact with all the "foot points" on the frame.

Where movement of the machine's foot when it is either tightened or loosened exceeds the manufacturer's recommendations while the other feet are bolted tightly in place, then the machine is deemed to have "soft foot". Where soft foot is identified during the installation checks using dial gauge or equivalent, then it must be corrected prior to proceeding with the machine alignment.

8.9 Fixings and Fasteners

Bolts, fasteners and anchors shall be in accordance with the requirements of Section 6.17of this specification.

The Installation ITP shall include suitable check points for fastener inspections. These shall include, but not limited to:

- Correct grade and material of fastener has been used
- Application of suitable anti-seize compound
- Torquing of bolts

- Thread protrusion check

Fastener tightening torques shall be in compliance with the manufacturer's recommendations and Section 6.17of this Specification.

All bolts shall be tightened using an up-to-date calibrated torque wrench in accordance with the equipment manufacturer's tightening torque values.

The work package ITP shall include a key step (procedure) for bolted connections where tightening torque values can be recorded. The same section within the ITP shall include extracts from supplier manuals referencing the recommended tightening torque values.

Pipework flanged joints shall be tightened in accordance with the requirements of WSA 109, Section D8. (Refer to Table D1 in WSA 109 for specified tightening torque values on AS 4087 flanged joints).

ITPs for hold down bolts and anchors shall be required to be signed off by the Accountable Party before grouting in may occur. Application of chemical anchors shall include hold points where Accountable Party may inspect hole depth, hole cleanliness and anchor material and that the application procedure is accurate to the manufacturer's recommendations.

Concrete plinths for mechanical equipment shall be constructed in accordance with the requirements of TMS1731 *Civil and Structural General Specification* and incorporate any specific requirements set out by the equipment installation manuals. Similarly, casting in and grouting of mechanical equipment and pipework shall be in accordance with the requirements of TMS1731.

8.10 Pipework Installation and Testing

All flange bolting and pipework installation shall be carried out by appropriately licensed and endorsed personnel. For example, personnel installing gas piping or components for a Type B gas appliance must be working under the necessary gas work license and authorization for type and scope of the work that is being performed.

Verification of bolt torque and flange integrity shall be in accordance with an appropriate flange closure/ joint integrity inspection procedure. As a minimum, this flange closure procedure shall include the use of flange tags, indicating quality control signoff confirming the following:

Status of Tag	Flange Closure Quality Control Completion
Flange Assembled	Flange faces clean and undamaged ☐ Flanges aligned and within cold spring tolerances ☐ Bolts are correct type, diameter, length, and material ☐ Nuts and washers are correct type, diameter, and material ☐ Gaskets are the correct size, class and material ☐
Flange Tightened	Flange bolts are tensioned to the correct, procedure, sequence and final torque, in accordance with the design requirement ☐
Flange Inspected	Final assembly and bolt tension witnessed and accepted ☐

ITPs for installation of process pipework shall be submitted to Urban Utilities for review upon request prior to installation of pipes and fittings.

ITPs shall include, but not limited to the following check and review points:

- All pipework and fittings shall be inspected to ensure that they comply with the relevant pipe specification and valve specification and that they are free of obstructions and foreign substances
- Correct bolt material, grade and length have been used
- Flange bolts are tightened in accordance with design requirements
- Approved gasket materials and thicknesses are used in the installation
- Sloped pipe has been installed within the allowable grade
- Fittings have been installed within the correct flow direction
- Isolation of dissimilar metals has been accommodated and is in accordance with the requirements of Section 6.18.4 of this specification

When work is not in progress, open ends of pipes and fittings shall be sealed. Pipelines shall be cleaned prior to being pressure tested and used, to remove any swarf or other installation debris that may have entered the pipe.

Gasket materials and thickness shall be in accordance with the requirements of WSA 109. Gasket data sheets shall be provided to Urban Utilities for review upon request.

Any damaged gaskets shall be discarded and prevented from being used.

Hydrostatic testing of pipework systems shall include its own independent ITP or check sheet and be in accordance with the requirements of Section 7.10.14 of this specification.

8.11 Equipment Alignment

All direct driven equipment which includes couplings between shafts shall be checked for alignment once installed and levelled.

Where pipes are connected to equipment, or rigidly fixed in place, allowance shall be made to accept any expansion or contraction to ensure that no stress is transferred through pipe connections to the equipment. For all equipment larger than 50KW, with rigid pipe directly connected, without expansion bellows, this shall be demonstrated by disconnecting the flanges after performing shaft alignment and then revalidating the shaft alignment. If the alignment has moved, then there is pipe stress transfer, which must be eliminated before completing the shaft alignment.

Where specified in the Project Documentation, a representative from the equipment supplier shall be present during installation to confirm that the installation has been completed in accordance with the manufacturer's requirements.

The installation ITP shall include a Witness Point for Urban Utilities to witness the results of alignment after installation. This shall occur before couplings and protective guards are reinstalled.

Allowance shall be made for specialised tools and equipment required for equipment alignment. At a minimum, clock gauges with magnetic bases shall be used to demonstrate concentric shafts.

Both the driver and the driven shafts must be rotated simultaneously to each of the four positions at 0°, 90°, 180° and 360° at which readings must be taken.

The maximum allowable out of alignment tolerance must be 50µm unless otherwise specified by the equipment supplier. Tighter tolerances shall be accommodated where specified by the equipment supplier.

An alignment record sheet shall be completed and signed off and provided to Urban Utilities upon request. The signed off alignment record check sheet shall be included in the Installation Quality Control Pack.

8.12 Lubrication

Lubrication after installation shall be in accordance with the manufacturer's requirements, and Section 6.29 of this Specification.

8.13 Services Installation

The required ancillary services for the work package installation shall be a key step requiring review and witnessing of the completed status.

The ITP shall detail the required services to ensure the successful and safe operation of the equipment is achieved. Key design criteria such as flowrate and feed pressure shall be test points recorded on the ITP and checked against the design to confirm the service has been supplied and installed correctly.

Site run pipes shall follow routes as indicated on the general arrangement drawings.

Adequate care and protection shall be afforded to the pipe spools, fittings and equipment during installation to avoid damages to the fittings, piping or equipment.

Supports for site run piping shall be installed in accordance with the manufacturer's recommendations.

8.14 Acoustic Enclosure / Noise Compliance

Where acoustic enclosures are necessary to achieve the required noise reduction to be compliant with section 6.22of this specification, the installation of such enclosures shall be included as a key step or procedure within the ITP.

The acoustic enclosure shall be installed as per the manufacturer's recommendations.

8.15 Certifications

Equipment requiring statutory or specified certification shall be included as a key step in the ITP and shall be completed and signed off by the Accountable Party prior to handover.

Certification process shall be in accordance with the equipment supplier's recommendations and or statutory requirements.

8.16 Coatings Repairs

The application of protective coatings shall carry its own independent ITP as defined in Section 6.19 of this Specification. This ITP along with all quality control documentation shall form a supplement to the ITP for coatings repairs.

Where protective coatings have suffered damage, either during transport or during installation, it shall be repaired to meet the minimum technical requirements. A suitable repair procedure shall be prepared and provided to Urban Utilities upon request. The repair procedure shall include an ITP witness point for inspection by the Accountable Party.

Repainting or spot repairs to painted surfaces shall be in compliance with the coating or lining manufacturer's recommendations and provided to Urban Utilities upon request, before it is undertaken.

Repair to galvanized surfaces shall be in compliance with the requirements of AS 4680 Section 8.

Extensive damage, breakthrough, flaking or damage to protective coatings may be rejected by the Accountable Party and require a full repainting of affected equipment items. Such equipment shall be returned to the factory for repainting, repairs or replacement of the item. Criteria for assessing when to carry out spot repair or full replacement shall be in accordance with the requirements of AS 2312.1 Section 8.3.

8.17 Tagging and labelling

After equipment has been installed, equipment tags and pipe labels shall be installed in accordance with the requirements of section 6.14 of this specification

An equipment tagging and pipe labelling check against the design documents and asset naming procedure shall be included as a key step in the work package ITP.

8.18 Grouting

After equipment has been levelled, aligned and fixed to its support structure, base plates and frames shall be finished off with approved precision non-shrink grout, in accordance with the manufacturer's instructions.

Grouts used for bedding of base plates, mechanical plant shall be a non shrink, fluid precision material, premixed and packaged at the manufacturer's factory.

High strength epoxy grout shall be used for bedding baseplates for vibrating machines and large pumps and motors >150 kW capacity.