Specification

Technical Specification - Mechanical

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Revision details

Version No.	Clause	Description of revision
12.0	General	Reformatted, references updated, numerous minor amendments & corrections.
	M1.5	Notes amended.
	M2.6	Ref to CPDMS0023 added, last para deleted.
	M4	Deleted – content moved to CPDMS0023.
	M6.3	Testing venues & standards clarified.
	M9.1	Amended item nos. 7, 12, 16, 17, 30, 34, 38, 39 & 40. Item nos. 35 & 41 inserted.
	M9.4	Valves operating element positions amended.
	M9.5.3	Valves with external thrust retention disallowed.
	M9.6.1	Heading amended and clause revised.
	M9.6.2	1st & 3rd paragraphs amended.
	M9.7.1 & M9.7.4	Revised.
	M9.7.9	2nd paragraph added.
	M9.8.1 & M9.8.2	Revised.
	M9.11	Amended to allow three-piece ball valves.
	M9.21 & M9.22	New clauses.
	M10	Revised to include cordless portable actuators.
	M13.1	Amended item nos. 6, 9, 12 & others.
	M13.2	Table amended. Chopper pumps added.
	M13.3.1	2nd last paragraph amended to align with AS/ISO 9906 and last para added.
	M13.3.2	Minor amendments & item 4 added.
	M13.4.3	New clause for chopper pumps added.
	M13.7.6	Amended to include universal joints.
	M13.7.9	Last para added.
	M13.7.12	Rotor material changed from SS 410 to SS 316 & tungsten carbide coating added.
	M16.1	1st paragraph added.
	M16.3	Long radius bends specified for grit & digested & thickened sludge. Biogas pipe velocities included.
	M16.4.2	Tables A & B revised.

Version No.	Clause	Description of revision
	M16.4.8	Amended & table added.
	M16.4.9 & M16.4.11	Added press fit (crimped) fittings.
	M16.4.13	Amended – ABS pipes & fittings excluded.
	M16.5.2.5	Revised.
	M16.5.8	Victaulic couplings excluded for permanent installations in pumping stations.
	M16.6	Parts a), b), e), h) & Table D amended.
	M18.2.1	1st paragraph –single phase fans added.
	M18.3.2.2	Requirement re flat faced and raised face flanges added in last paragraph.
	M18.3.7	New clause.
	M18.5.1	Access panel sizes amended.
	M18.9	Deleted - content moved to D0002071.
	M18.12	New clause.
	M25.2.1	Revised.
	M25.3	Revised.
	M28.3.1	New clause.
	M30.2.1	Revised.
	M30.2.5	Amended & last sentence added.
	M30.2.9	Item c) revised & item d) added.
	M31.8	Clause deleted.
	M34.10	New clause (previously M34.12.3).
	M34.12	Clause deleted.
	M35.1.3	Revised.
	M37.2.4.1	Lagging requirements amended.
	M37.5.4 & M37.6.2	Last paragraphs added.
	M37.7.2	Items b) amended, c) & d) added.
	M37.7.3	Item b) inserted.
	M37.8.3	Amended & last paragraph deleted.
	M37.8.9	1st paragraph amended.
	M3710	Flow measurement instrument type amended.
	M37.11.7.1, M37.11.8.1	Dilution water requirement amended.

Version No.	Clause	Description of revision
	M38.1	Items p) & q) added.
	M38.2, M38.3.2, M38.3.5, M38.6, M38.7.3	Amended
	M38.3.6, M38.7.3.2	New clause.
	M38.4	Item j) added.
	M38.7.4 & M38.7.5	Uniformity coefficient added & table deleted.
	M38.10.3, M38.13.2, M38.13.3	Amended.
	M39.2.2, M39.2.3	Amended.
	M39.2.5	Item h) deleted.
	M39.4	Last paragraph amended.
	M40.1	2nd paragraph amended
	M40.2	1st & 2nd points amended, 4th & 5th points added.
11.0	Whole document.	Changed 'shall', 'should' and 'may' to 'must' where relevant. 'Approved' replaced with 'accepted'. Minor editorial changes elsewhere.
	M2.6, M4.1, M9.1 items 32 & 37, M9.4, M9.8.1, M9.8.2, M9.8.3, M9.11, M13.3.1, M13.4.2.9, M13.5.2, M13.6.6, M13.7.11, M13.7.12, M15.2, M16.4.2, M16.4.9, M16.4.11, M16.5.1, M16.5.6, M16.5.9, M16.8, M16.9.2, M16.10, M16.11, M17.1, M17.3, M17.7.7, M18.8, M18.9, M18.10, M18.11, M25.4.4, M25.5.4, M27.1.12, M30.2.3, M31.2, M31.7, M31.8, M32.3, M32.4, M35.1.4, M36.3.1, M37.1.4.3, M37.2.4.4, M37.4.1, M37.6.3, M37.7.2, M37.7.4, M37.8.3, M37.11.1, M37.11.7.2, M37.11.7.5, M37.11.8.8, M37.11.8.9, M38.7.3, M38.10.2, M39.3.5 & M45.	Minor amendments.
10.0	Whole document.	Reformatted. Title changed. Foreword and Copyright added. 'Principal' replaced with 'Sydney Water'. "Approved' replaced with 'accepted'.
	M1.1, M1.2, M1.4, M1.5, M1.6, M2.2, M2.3, M2.6, M3.1, M3.2, M3.3, M4.1, M6.1, M6.3, M7.2, M7.3, M7.4, M7.5, M8, M9.1, M9.2, M9.3, M9.4, M9.5.4, M9.5, M9.6.1, M9.6.2, M9.6.4, M9.7.1, M9.7.3.2, M9.7.4, M9.7.8, M9.8, M9.9, M9.10.3, M9.11, M9.12.1, M9.14, M9.17, M9.20, M10, M13.1, M13.2, M13.3.1, M13.3.2, M13.4.2.2, M13.4.2.4, M13.4.2.5, M13.5, M13.5.1, M13.6.2, M13.7.1, M13.7.5, M13.7.10, M13.8, M15.1, M15.2, M16.1, M16.3, M16.4.2, M16.4.3, M16.4.5, M16.4.6, M16.4.7, M16.4.9, M16.4.10, M16.4.11, M16.4.13, M16.5.1, M16.5.2.1, M16.5.6, M16.5.8, M16.5.9, M16.7,	Minor amendments.

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	M16.8.1, M16.9.1, M16.9.2, M16.9.10, M16.11, M16.9.12, M16.14, M18.1, M18.2.1, M18.3.1, M18.3.2, M18.3.4.1, M18.3.4.2, M18.3.6, M18.4, M18.5.2, M18.6.1, M18.8, M18.9.1, M18.10, M18.11, M19, M22.1, M22.2, M22.4, M22.6, M22.9, M22.12, M22.13, M23, M26.1, M26.4, M26.6, M27.1.10, M27.1.12.3, M27.2.2, M27.7.1, M28.8, M28.11, M28.13, M29.5, M30.1.1, M30.2.1, M30.2.2, M30.2.9, M30.2.10, M30.3, M30.5, M31.1, M31.2, M31.3, M31.4, M31.5, M31.6, M31.7, M32.5, M33.1, M33.5.1, M33.6, M34.1, M34.2, M34.4, M34.5, M34.6, M34.7, M34.8, M34.9, M34.10.1, M34.10.2, M34.10.3, M34.10.4, 34.10.5, M34.11, M34.12.2, M34.12, M35, M35.1.1, M35.1.2, M35.1.3, M35.1.4, M35.1.5, M35.1.6, M35.1.7, M35.1.8, M35.1.10, M35.1.12, M35.1.13, M35.1.14, M35.2, M35.2.3, M35.2.4, M35.2.5, M35.2.9, M36.1, M36.3, M36.3.10, M37.1, M37.1.1, M37.1.2, M37.1.3, M37.1.4.1, M37.1.4.2, M37.1.4.3, M37.2.3, M37.2.4.1, M37.2.4.4, M37.2.5, M37.3.1, M37.3.2, M37.4.1, M37.5.2, M37.5.3, M37.5.4, M37.5.5, M37.6.1, M37.6.2, M37.6.3, M37.7.1, M37.7.2, M37.7.3, M37.7.5, M37.7.6, M37.8, M37.8.3, M37.8.8, M37.8.9, M37.8.10, M37.9.3, M37.9.4, M37.9.5 (former M37.9.6)), M37.11, M37.11.7, M37.11.8.1, M37.11.8.2, M37.11.8.8, M37.9.1, M37.9.2, M37.9.3, M37.11.8.8, M37.11.8.9, M38.3.1, M38.2, M38.3.1, M38.3.3, M38.3.5, M38.5, M38.6, M38.7.2, M38.7.3, M38.7.6, M38.8, M38.10, M38.10.4, M38.12.1, M38.12.2, M38.12.3, M38.12.5, M38.12.6, M38.12.8, M38.13.1, M38.13.3, M38.14, M39.1, M39.2.1, M39.2.2, M39.2.3, M39.2.5, M39.3, M39.3.1, M40.1, M40.7, M41, M41.5, M41.6, M42, M42.1.3, M42.2, M43.1, M43.2, M43.3, M43.4, M43.5.1, M43.6 & M45.	
	M5, M17 & M25.	Complete revision.
	M2.7, M4.2, M9.3, M9.17, M9.18, M9.19, M14, M16.6, M34.12.3, M36.4.4 & M37.11.9.	New.
	M12, M35.1.13, M37.9.5, M37.11.7 & M37.11.8.	Deleted.
9.0	M1.1, M1.2, M1.4, M2.2, M2.3, M2.6, M3.1, M4, M5, M6.2, M8, M9.1, M9.2, M9.3, M9.4.4, M9.4.5, M9.5.1, M9.6.1, M9.6.2, M9.6.3, M9.6.3.1, M9.6.3.2, M9.6.7, M9.6.9, M9.7.1, M9.7.2, M9.8, M9.9.4, M9.15, M13.1, M13.2, M13.3.1, M13.4.2.2, M13.4.2.7, M13.4.2.11, M13.6.3.3, M13.6.6, M13.7.1, M15.1, M15.2, M16.1, M16.3, M16.4.2, M16.4.3, M16.4.7, M16.4.8, M16.4.11, M16.5.1, M16.5.2.1, M16.5.3, M16.5.10, M16.8, M17.2, M17.3.1,	Minor amendments.

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	M17.3.2, M17.3.3, M17.4, M17.4.1, M17.4.2, M17.4.3, M17.4.6, M17.4.6, M17.4.6.5, M17.4.8, M18.1, M18.2.1, M18.3.1, M18.3.3, M18.3.4, M18.4.1, M18.4.2, M19.1, M20, M22.1, M22.2.1, M22.2.2, M22.4, M22.6, M22.9, M23, M25.2.6, M27.2.6.2, M28.1, M32.1, M34.8, M34.10.1, M34.10.5, M35.1.1, M35.1.2, M35.1.3, M35.1.15, M35.2.3, M36.1, M38.1, M38.4, M38.7.2, M38.10.2, M38.12.8, M38.13.2, M40.5, M41.2, M41.5, M41.6, M43.2, M43.3.1, M43.3.2, M44, M45.	
	M7, M13.8, M17.1, M37, M43.1, M43.3.	Complete revision.
	M9.6.4, M9.15, 16.5.9, M16.7, M18.9, M18.10, M22.10, M36.4, M43.4.	New.
	M9.4.6.	Deleted.
8.0	M1.2, M5, M7.3, M7.4.1, M9, M9.1, M9.3, M9.4.4, M9.5.1, M16.3, M16.4.1, M22.10 & M23.	Minor amendments and editorial changes.
	M13.7, M16.4.10 & M16.4.11 (now M.16.4.11 & 12), M16.4.9 (now M16.4.10).	Complete revision.
	M9.4.5, M9.4.6, M16.4.3	New.
	M9.6.6	Deleted.
7.0	Whole document.	References to DECCW changed to EPA. References to PCS 100 changed to WSA 201 and SW's Supplement. References to SW Product Specifications changed to WSAA Product Specifications.
	M1.5, M8, M9.1, M9.3, M9.4.4, M9.5.1, M9.6.10, M9.7.1, M9.7.2, M9.11.1, M13.1, M13.2, M13.3.1, M13.3.2, M13.3.3, M13.4.2, M13.5, M13.5.1, M13.5.2 and M13.6.1	Minor amendments.
	M13.7 & M14.	M13.7 moved to M13.8 and M14 moved to M13.7. M14 now 'Not Used'.
	M16 and M22.	Complete revision.
6.0	M5, M9.1, M9.3, M9.4.3, M9.5.1, M9.6.2, M9.6.9, M9.7.1, M16.1, M16.4.5, M16.4.6, M33.2, M33.5.1, M37.6.5.1, M37.8.3 and M43.3.	Minor amendments.
	M1.6 and M37.6.5.3.	New.
5.0	Whole document	Revision Details table added. References to protective coatings updated to refer to Principal PCS 100. References to WSAA Purchase Specifications updated to refer to Principal Product Specifications. Other minor corrections and changes implemented.

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	M1.5, M2.2, M3.1, M4, M5, M6.1, M8, M9.1, M9.3, M9.4.1, M9.4.2, M9.5.1, M9.6.1, M9.6.5, M9.6.6, M9.6.11, M9.7.1, M9.10, M9.11.1, M9.12.1, M9.13, M9.14, M13.4.2.5, M9.14.7, M16.1, M16.4.2, M16.4.3, M16.4.4, M16.4.5, M16.4.6, M16.4.7, M16.4.9, M16.4.11, M16.4.12, M16.4.13, M16.4.14, M16.5.3, M16.5.5, M16.6.1, M16.6.2, M16.11, M18.3.4.2, M22.1, M22.2.2, M22.6, M22.9, M22.11, M23, M34.10.3, M35.1.1, M35.1.3, M35.1.4, M35.1.5, M35.1.6, M35.1.8, M35.1.9, M35.1.11, M35.1.13, M35.1.14, M37.1, M37.2, M37.3, M37.4.1, M37.5.2, M37.5.3, M37.6.2, M37.6.5.1, M37.6.5.2, M37.6.11, M37.7 and M37.10.	Minor amendments.
	M9.14, M14.2 and M35.1.2.	New.

Introduction

This Specification is for the design, supply and installation of mechanical works for Sydney Water assets.

This Specification is not intended to be a stand-alone document. Project specific documents and, where required, additional technical clauses must be added to the contract document.

Sydney Water makes no warranties, express or implied, that compliance with the contents of this Specification will be sufficient to ensure safe systems of work or operation.

It is the user's sole responsibility to ensure that the copy of the Specification is the current version as in use by Sydney Water.

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Acronyms

Term	Definition
ABS	Acrylonitrile butadiene styrene
ACL	Acrylic latex
AEP	Annual exceedance probability
AGMA	American gear manufacturers association
ANSI	American National Standards Institute
AOR	Allowable operating region
ARWG	Australian Recycled Water Guidelines
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
CAC	Calcium aluminate cement
CCEW	Certificate of compliance of electrical work
CCP	Critical control point
CML	Cement mortar lined
CPS	Counter pressure screw
DN	Diameter nominal
DO	Dissolved oxygen

Term	Definition
EPA	Environment protection authority
EPDM	Ethylene propylene diene monomer
EUH	Epoxy ultra-high build
FBE	Fusion bonded epoxy
FPE	Fluorinated ethylene propylene
FRP	Fibre reinforced plastic
GRP	Glass reinforced plastic
HBW	Brinell hardness number
HDPE	High density polyethylene
IBC	Intermediate bulk container
IDAL	Intermittently decanted aerated lagoon
IDEAT	Intermittently decanted extended aerated tank
ISO	International organisation for standardisation
kPa	Kilopascal
LOTO	Lock out Tag Out
LRV	Log reduction valve
NATA	National association of testing authorities
NFR	Non-filterable residue
NPfI	Noise Policy for Industry
NPSHa	Net positive suction head available
NPSHr	Net positive suction head required
NTC	National transport commission
O&M	Operations and maintenance
OCU	Odour control unit
OL	Oil lubricated
PN	Pressure nominal
PD	Positive displacement
PE	Polyethylene
POR	Preferred operating region
PREN	Pitting resistance equivalent number
PTC	Positive temperature coefficient
PTFE	Poly Tetra Fluoro Ethylene
PVC	Polyvinyl chloride
PVC-C	Polyvinyl chloride post-chlorinated
PVC-U	Polyvinyl chloride unplasticised
PVC-M	Polyvinyl chloride modified

Term	Definition
Q/H	Flow/Head
RCD	Residual current device
RDT	Rotary drum thickener
RPZ	Reduced pressure zone
RPZD	Reduced pressure zone devices
RSP	Rotary screw press
RTD	Resistance temperature detector
RTU	Remote terminal unit
SMA CNA	Sheet metal and air conditioning contractors national association
SOC	System operations centre
THP	Thermal hydrolysis process
TSR	Total solids residual
UHMWP	Ultra-high molecular weight polyethylene
UV	Ultraviolet
VSD	Variable speed drive
WAC	Work as constructed
WAS	Waste activated sludge
WL	Water lubricated
WSA	Water services association
WSAA	Water services association of Australia

General Terms and Definitions

Term	Definition
Competent Engineer	Suitably qualified and experienced engineer with the ability to apply knowledge and skills to achieve the intended design, construction, testing or monitoring task. For engineering tasks related to design, engineering personnel who meet requirements of the Sydney Water Engineering Competency Standard.
Design life	The period adopted in design for which a product, equipment or component is required to perform its function within the specified parameters with periodic maintenance but without replacement or major overhaul.
Supplier	The person or organisation responsible for the fabrication or manufacture and/or supply of products, materials, equipment and components described herein.
Sydney Water	The nominated person or organisation that has written authority to act on Sydney Water's behalf.
WSAA Codes	Codes of Practice issued by Water Services Association of Australia
WSAA Code – Sydney Water Edition	WSAA Code with modifications by Sydney Water for use in Sydney Water assets, where available.

M1. General requirements

M1.1 Scope

This Specification covers minimum requirements for the design, supply and installation of typical mechanical equipment in sewage, water and recycled water pumping stations, sewage treatment and water filtration plants, water and recycled water reservoirs, and other Sydney Water assets.

M1.2 Standards

Equipment supplied and installed must be new and in accordance with the requirements of:

- this Specification,
- needs specification (if supplied),
- drawings,
- job specific technical specification (if supplied), and

the latest editions of the relevant Australian Standards and Technical Specifications, Water Services Association of Australia (WSAA) Codes of Practice, Water Industry Standards and Product Specifications.

Where there is no suitable Australian Standard available, an agreed international standard and/or industry current best practice must be adopted.

If an international standard is proposed in lieu of an Australian Standard, a detailed assessment to show that the proposed standard is equivalent or superior to the relevant Australian Standard must be provided to Sydney Water for acceptance.

The work must also comply with the requirements of all relevant bodies or codes, including but not limited to:

- SafeWork NSW
- NSW Environment Protection Authority (EPA)
- Power Supply Authorities
- Australian Communications and Media Authority
- Local Government Authority.

In the event of any ambiguity or discrepancy Sydney Water must be consulted as to the interpretation to be followed in carrying out the work.

M1.3 Equipment compatibility

Where more than one item of equipment is supplied and installed to perform a particular function, all such items of equipment must be identical and completely interchangeable.

M1.4 Equipment design

All items of equipment must be designed, manufactured and installed to achieve the specified performance and other requirements and perform their required functions reliably and efficiently. All equipment must be

designed so that it is safe to install, operate, maintain and decommission in accordance with Sydney Water's Safety in Design Procedure D0000653. The safety in design must incorporate the safety hierarchy principles (eliminate, substitute, engineering controls, administrative controls, personal protective equipment) to ensure the asset is easy to operate and maintain with a view to achieve Sydney Water's corporate policy in safety i.e. zero harm (minimise manual handling and injuries).

All isolation devices must comply with Sydney Water's Energy Isolation - Lock Out Tag Out (LOTO) Procedure and be able to be locked in either closed or open position.

Particular attention must be given to equipment installed in an adverse environment and/or exposed to weather. All equipment must be selected, stored, handled and installed in accordance with its manufacturer's specifications and all materials and components must be new and unused and the best of their respective kinds.

The equipment must be suitable for the purpose intended and must be standard commercial equipment proven in actual service conditions in similar applications. Only manufacturers who are fully experienced, reputable and qualified in the manufacture of such equipment must supply the equipment specified herein. All equipment supplied must have spare parts readily available in Australia and be serviceable for operation over its design life.

Mechanical equipment and process facilities must be designed, selected and installed on the basis that they will generally need to provide continued service for long periods, without frequent maintenance and attention being necessary to continue operating in accordance with the design intent.

Provision is to be made for ready renewal of all wearing parts. Unless sealed for life, all gearboxes, bearing housings and other pieces of equipment must allow for lubricant drain and fill facilities. All equipment and appurtenances (e.g. gauges) must include isolation devices (e.g. valves) to allow for servicing without interrupting the process.

Particular attention must be taken in the design to ensure ease of operation, inspection and maintenance, protection from corrosion and wear, cleanliness of the surrounding areas and safety of operation. All equipment must be fit for intended purpose and must remain so for the design life of the equipment materials, fair wear and tear expected.

The equipment must be designed and installed to enable operation maintenance personnel to carry out their routine tasks without the need to shut down process units. Equipment service points must be readily accessible. All indicators, instrumentation, nameplates and labels must be at easy to read locations.

All equipment must be appropriately designed with provisions for lifting or moving, including lifting lugs or eyebolts. Effort must be made to design out any risk of manual handling during operation and maintenance. Where necessary, equipment must be fitted with adequate lifting devices or have provision for use of portable lifting equipment.

For all equipment and instrumentation supplied, schedules of technical data showing all technical information, settings and calibration data must be provided.

M1.5 Materials

Materials must be selected appropriate to the application to afford a long life free from corrosion and wear and with the required strength. The quality and finish of materials must be in accordance with the relevant

Australian Standards. The strength of the parts must be such as to provide ample margin for all possible stresses to which they may be subjected under all conditions of service.

The material grades where stated in this Specification represent the basic or minimum requirements. Materials of equal or superior quality for the intended application may be used instead.

Dissimilar metals that may become wet in a conductive liquid (electrolyte), which can cause galvanic corrosion must not be in direct contact. The materials must be selected to ensure that the galvanic potential between adjacent components does not exceed 0.3 Volts. Where necessary, components must be electrically isolated from each other to meet this requirement.

Notes:

a) Wherever grade 304 or 316 stainless steel is specified, equivalent or superior grades of duplex stainless steel may be used.

b) Stainless steel items must be adequately protected if non-stainless (e.g. carbon steel) items are being grinded, cut or welded nearby to prevent surface contamination and onset of corrosion.

c) Stainless steel components and welds, except hardened ferritic grades (series 400), must be factory pickled and passivated in accordance with ASTM A380.

d) Materials in contact with potable and recycled water must comply with AS 4020.

M1.6 Recycled and reused materials

Recycled and reused materials must not be used unless accepted by Sydney Water.

Recycled and reused materials must be free from hazardous substances as defined in the Work Health and Safety Regulation 2017. Carcinogenic substances such as asbestos or asbestos containing material in both friable and bonded forms must not be present in any materials.

Prior to their use, a detailed description of the composition and origin of the recycled and reused materials must be provided for acceptance by Sydney Water.

M2. Safety equipment and safety signs

M2.1 General

All equipment must be designed to afford maximum protection and a safe working environment for operating personnel.

Inspection covers must be readily opened without the use of tools. Grills, bars or mesh must be provided behind covers where moving equipment may be reached. Alternatively, interlocks must be provided to stop equipment if covers are opened.

Warning siren and beacon light must be installed for equipment where potential hazard may occur when equipment start automatically or fail to start.

M2.2 Guards

All couplings, pulleys, belts, chain sprockets, chains and other exposed moving parts and hot surfaces must be adequately covered by sturdy fixed guards acceptable to SafeWork NSW and meeting the requirements of the relevant part of AS 4024. Guards must afford maximum protection and a safe working environment for operating personnel, staff and visitors.

Guards must be fabricated from solid, expanded metal, perforated or slotted steel plate, as specified.

Guards must be painted yellow to AS 2700, colour code Y14. The painting must comply with WSA 201.

Guards must be easily removable by standard tools for maintenance access. All drive guards must be fabricated such that the guards can be removed without disturbing the sensing devices, chain or belt tensioners, field instruments and lubricators.

Where specified, the guards must be fitted with limit switches wired into the starter circuit so that removal of a guard will prevent operation of the machinery.

M2.3 Safety signs

Safety and warning signs must comply with the Sydney Water's Facilities' Site Signage Specification SDIMS0026, AS 1318, AS 1319, AS 2508 and AS 2927, as applicable, and must be installed where necessary.

The signs must warn of potential hazards, assist in preventing accidents and give operational and emergency procedures for potentially hazardous situations. Signs must provide warnings where equipment may start automatically, where equipment may move without warning and where other potential hazards may occur.

The contents of piping, conduits and ducts must be identified as per AS 1345. Arrows must be provided to show the direction of flow.

All signs installed outdoors must be UV resistant.

M2.4 Safety interlocks

Necessary safety interlock devices must be provided to facilitate protection of operating personnel, as well as to prevent damage to the mechanical portions of the equipment.

M2.5 Fail safe

All items of equipment must be designed for safe operation.

The machinery must be designed to leave the plant in a safe condition in the event of any failure in part of the machinery or its associated safeguards, control circuits or its power supply.

M2.6 Protection from vehicles

Adequate safety facilities must be used to protect structures, equipment and personnel from moving vehicles. The safety facilities, including barriers, corner protectors, speed humps, stop signs, bollards, chains etc. must comply with relevant Australian Standards, including but not necessarily limited to AS 1318, AS 1742, AS 1906, AS 2890 and AS 3845.

Unless specified otherwise, all bollards must be min. Ø140 mm x 1200 mm high and painted yellow in accordance with AS 1318, with two min. 50 mm wide Class 400 ultra-high intensity self-adhesive red and white striped reflective bands to AS 1906.1. First band is to be installed at the top of the bollard and the second 150 mm below it. Permanent bollards must be concrete filled and designed for the loads specified in Technical Specification – Civil (CPDMS0023).

Removable bollards must be provided where occasional vehicular or maintenance access is required. Where installed outside protected structures, the removable bollards must be secured with Sydney Water padlock system.

M2.7 Work at heights

Effort must be made to design out working from heights while operating and maintaining equipment.

All access covers and openings in structures that may present hazard from falling from heights must have a safety system, such as covers, safety grilles, handrails, safety barriers etc. Where permanent anchor points are used, they must be positioned at a safe distance to compliment fall restraint / limited free fall arrest systems.

A safe means of access to anchor points in accordance with AS 1657 must be provided. This must consider the possibility of a fall prior to personnel connecting securely to the anchors, and after disconnection at the completion of the task. Provision must also be made for the protection of users while transferring between fall arrest systems.

In-ground permanent anchor points must be used in conjunction with full body harness and adjustable personal lanyard equipped with shock absorbing facility, all meeting the requirements of AS 1891. Together they must provide a fall restraint facility to the user avoiding the risk of falling from height or into an opening or penetration.

Each anchor point must be embedded in a concrete deadman designed and constructed in accordance with Sydney Water Technical Specification – Civil (CPDMS0023).

Each anchor point must be for single person use, rated for 1.5t, provided with a 360^{O} swivelling type lashing point and held down by a stainless steel hexagonal bolt operable from the working surface into a M16 stainless steel DynaSet®, or equivalent, drop in anchor.

Anchor points must be installed by qualified tradespeople using manufacturer approved tools and installation instructions.

Each anchor point must be tested immediately after installation and then annually by axially proof loading to 50 % of its ultimate strength in accordance with AS 1891.4 by a NATA accredited agency.

A test tag of material suitable for external use must be attached to the anchor point clearly showing test date/month and the agency who did the test.

Hard and soft copy test certificates must be provided and maintained on-site.

A colour coded laminated plan of anchor points for the whole site must be maintained on-site. For unmanned sites such as submersible pumping station, this plan and test certificates may be stored in the RTU panel of the electrical kiosk. For manned sites these must be stored in an appropriate place, e.g. along other quality documentation such as O&M manuals and WAC drawings.

A grade 316 stainless steel label must be provided next to each anchor point showing its asset number, a short descriptor and the name of the opening it belongs to.

Any anchor points from which a person has received a fall must be immediately quarantined until re-tested for its suitability for further use.

Location of anchor points must meet the following requirements:

a) Each anchor points must be located 1500 mm away from the opening it will be used for.

b) Where anchor point is provided for an opening equipped with a hatch / safety grille, the anchor point must be installed as far as practical in line with the hatch / safety grille hinges such that it allows the person attached to it freedom to move with the hatch / grille from its fully closed position to fully open position and vice versa.

c) They do not get covered by opening of other hatches / grilles / equipment at any time.

d) They allow un-hindered access to the users and their movement when attached to the anchor point.

e) Lanyard of the person attached to the anchor point does not rub against any other structure at any time of its normal use except when avoiding the lateral swing (pendulum effect) with the use of edge stops (refer AS 1891.4 – fig 3.1).

f) Anchor points must not be installed in vehicular traffic area or where they will be within the reach of lawn mower blades.

g) Anchor points must be installed at least 100 mm from the nearest concrete edge or a construction joint.

As far as practical, all anchor points are to be kept outside the main walking areas and placed in locations where they pose less of a trip hazard.

M3. Fasteners

M3.1 General

Items of equipment must include all necessary fasteners, tightened to the torques specified by their manufacturer and, where necessary, secured from becoming lose.

Metric bolts, screws and nuts must comply with AS 1110, AS 1111 and AS 1112. The threads must comply with AS 1275. All unified bolts and nuts must comply with AS 2465 with threads complying with AS 3635. A flat metal washer must be fitted under each bolt head and nut. Washers must be in accordance with AS 1237.

Bolt lengths must be such that after joints are made up, the bolts must protrude through the nuts by a minimum of two full bolt threads, but not by more than 15 mm.

Unless accepted otherwise by Sydney Water, stud bolts may only be used as tie rods in load bearing dismantling joints and similar fittings and where normal bolts cannot be used due to space constraints, e. g. for joining short bodied valves and fittings. The stud bolts must be of an appropriate material similar to the bolts, and with rolled threads. One end of stud bolts must have a machined flat or square suitable for a standard size spanner.

Lock nuts or spring washers are to be used for vibrating equipment. Lock nuts are to be added for extra security in hard to reach or critical installations and, where used, must be of full metallic construction. Nylon-insert lock nuts must not be used.

High strength insulating washers must be fitted under metal washers and adequate bolt stem insulating sleeves must be used when dissimilar metals are joined in wet, humid, high condensation, outdoor or buried installations and wherever there is a potential for galvanic corrosion between the fasteners and adjoining metals, e.g. stainless steel bolts used on ductile iron pipework in wet wells, valve chambers within 1 km from the sea etc. The bolt holes may have to be oversized to allow for protective coating and insulating sleeves. All interfaces of dissimilar metals must also be insulated or fully and effectively coated.

Pipe flange fasteners must comply with the requirements of the relevant flange standards.

Structural fasteners must comply with Sydney Water Technical Specification -– Civil (CPDMS0023)

M3.2 Stainless steel fasteners

Stainless steel bolts, nuts, screws, studs and washers must be used where:

- submerged or buried in ground
- cast or grouted into concrete, including all anchor bolts
- in contact with raw sewage, sludge or effluent
- exposed to corrosive environment such as sewage gas and salt loaded atmosphere (e.g. in sewage pumping stations wet and dry wells, emergency storages, valve chambers, maintenance holes, marine environment etc.)
- used for joining stainless steel
- used for joining dissimilar metals

- supplied as part of dismantling joints (stud bolts, nuts and washers)
- used in gland joints and couplings
- for all proprietary equipment such as valves, pumps etc.

As a minimum, stainless steel bolts, nuts, screws, studs and washers must be minimum A4-70 grade 316 stainless steel. In order to prevent seizing or galling of stainless steel fasteners the following measures must be applied:

- where possible, use different hardness stainless steel grades for bolts and nuts
- bolt and nut threads must be rolled or buffed smooth before installation
- nuts must be hand tightened at low speed to reduce the heat generated by friction
- nuts must be tightened with a torque wrench to prevent over tightening
- the threads must be thoroughly coated with non-corrosive anti-seize compound prior to assembly. If in contact with potable and recycled water the anti-seize compound must comply with AS 4020.

M3.3 Non-stainless steel fasteners

The bolts and nuts must be hot dipped galvanised in accordance with AS 1214 and washers in accordance with AS 4680.

Electro galvanising, nickel, cadmium, chrome or any other plating process must not be used.

M4. Platforms, walkways, stairways, ladders and handrails

Refer to Sydney Water Technical Specification – Civil (CPDMS0023).

M5. Bearings and lubrication

M5.1 General requirements

Bearings must be of modern design, of rolling or plain (anti-friction) type and ample capacity for carrying all thrust and radial loads. All bearings must be readily available metric sizes, lubricated efficiently and capable of long service without maintenance.

All rolling bearings must be of ball or roller type, rated in accordance with AS 2729 for a minimum basic rating life (L_{10}) of 100,000 operational hours. Bearings with non-metallic cages must not be used.

Plain bearings must have steel shafts running in bronze or self-lubricating graphite impregnated bushes and must have a loading, based on projected area, of not more than 300 kPa. Materials other than steel and bronze are subject to Sydney Water's acceptance.

All bearings must be to ISO standard design dimensions and must be readily available from commercial bearing suppliers.

All bearing housings must be fitted with seals and must be grease or oil lubricated. Grease nipples with captive screw caps must be provided for all grease lubricated bearings and, where practicable, capillary tubing must be run from the bearings and grouped at a convenient accessible location. Where they may become in contact with potable water, all bearing materials, lubricants and painting must comply with AS 4020.

Bearings must be adequately cooled to accommodate operation of the equipment in an ambient temperature situation of up to 45 ^{O}C under most extreme loading conditions without reduction in calculated load rating or rating life. This must be achieved without special or additional cooling arrangements, such as water-cooled heat exchangers or similar.

All bearings must be furnished with the correct lubricants for at least one year's operation. The bearings must also be adequately lubricated to prevent corrosion during storage and installation and for starting and commissioning the plant. Lubricants must be as recommended by the relevant equipment manufacturer and have a minimum change period of 12 months.

Plates indicating the type of oil or grease, quantity and change period must be fixed to the equipment items adjacent to the oil or grease lubrication points. Plates must be engraved stainless steel grade 316, fastened with stainless steel fixings.

All bearings must be capable of maintaining their seal for life 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. Neoprene “V” type grease and dirt seals must be provided. Seals must protect against ingress of water and foreign matter and from egress of lubricant for the life of the bearing. Where locking collars are required to maintain seal element tension these must be of grade 431 stainless steel. Locking screws must be fixed in position using Loctite® or equivalent at final adjustment.

To avoid damage to bearings (work hardening or “brinelling”) due to vibration during transportation, bearings must be packed separately, or other suitable precautions taken to protect them.

M5.2 Grease lines

Where grease lines are fitted, they must not be attached to removable parts.

The grease lines must be as short as possible, have sufficient radius to prevent crimping, and be adequately supported and protected from normal traffic around the machine's location.

The grease lines from the greasing point to the bearing must be 3mm internal diameter made from Grade 316 stainless steel thin walled tubing and/or stainless steel double braided PTFE hoses. The use of nylon grease lines is not acceptable.

All connections between fittings must be threaded connections. Grease nipples and other fittings on braided hoses must be factory fitted. The lubrication points must be readily accessible without removing guards and visible from normal access points to the machine and not in area or excessive dirt or moisture.

It must be possible to grease the bearings with the machine running without danger to the operator or damage to the seals. Bearing housings must be fitted with pressure relief devices to prevent over pressure.

The use of electrochemical and electromechanical auto greasers must only be considered if agreed with Sydney Water. If used, these must be installed directly on the bearing housings.

M5.3 Oil lubricated bearings

Oil lubricated bearings must incorporate the following:

1. An integral oil circulation system. The design of the circulation system and venting arrangement must not allow escape of oil from the bearing.
2. A large capacity adjustable constant level oil make-up system
3. An oil level indicator
4. A permanent marking of normal oil level on the bearing housing adjacent to the oil level indicator
5. They should, preferably, be suitable for both mineral and synthetic lubricants.

M5.4 Electric motor bearings

For electric motor bearing requirements refer to Technical Specification – Electrical (CPDMS0022).

M5.5 Bearing condition monitoring for large machines

Bearings of machines larger than 600 kW must be fitted with accelerometers. Thrust and locating bearings require monitoring in all three planes, while for other bearings the accelerometers must cover the two radial planes. The accelerometers must be used for continuous on-line vibration monitoring, warning and shut down when vibrations exceed pre-set maximum levels.

Furthermore, all bearings of machines larger than 600 kW must be fitted with RTD temperature sensors wired to monitoring, warning and shut down protection system. Temperature detectors must be 3-wire, 100-ohm resistance type PT100. All three wires from each temperature sensor must be wired back to the associated auxiliary terminal box and from there connected to the unit’s control system.

M6. Vibration

M6.1 General

Sydney Water employ a mixture of portable handheld and on-line permanently mounted condition monitoring equipment. Data collected from these tests is loaded into Sydney Water's Corporate Condition Monitoring Database (Rockwell-Entek Odyssey Software). Generally, handheld condition monitoring is only carried out on equipment above 25 kW unless an asset is of critical importance to the production process. Equipment over 600 kW requires on-line permanently mounted condition monitoring equipment, such as the Rockwell-Entek Enwatch or XM products, which can download readings directly to the Sydney Water's database.

Other equipment whose long-term operability and performance depends on severity of vibrations must also be provided with vibration monitoring facilities.

For accurate readings to be taken by a hand-held probe a direct metal path between the bearings and the outside surfaces of the machine is required. This monitoring point must be accessible for a variety of handheld accelerometer types to be attached while the machine is operating under normal operating conditions. Examples of accelerometer types used within Sydney Water include Magnetic, Probes and Quick Connect.

Where a direct metal path accessible to the probe does not exist, a solid metal stud must be securely fitted to the metal in contact with the bearing. This pick-up mounting must be min. ϕ8 mm and be long enough to allow measurements to be taken by the condition monitoring equipment. Where clearance holes are required, they must be at least 2 mm greater than the stud diameter. If sealing of the hole is necessary, an elastic damping material such as soft rubber must be used. Where it is not feasible to use this method, an alternative method is to be provided for Sydney Water's acceptance.

Where equipment is to be inaccessible, caged/guarded or enclosed within an acoustic cover, hardwired accelerometers must be mounted on the equipment (in a suitable position as described above) with cabling run to a termination panel mounted on the cover or in safely accessible position.

M6.2 Natural frequencies

The lowest natural frequency of the combined industrial machines and support system, such as complete pumping units installed on their foundations, must be at least 25 % higher than the main excitation frequency, which is the machine maximum speed, when measured in any direction. The designer must assess the combined lowest natural frequency and design the machines and foundations to meet this requirement.

For installation of pumping units, special care must be taken to avoid resonances in the connected piping system and foundation with the impeller vane passing frequency, which may be two, three or more times the running frequency, as such resonances can cause excessive vibration.

M6.3 Vibration severity

M6.3.1 General industrial machines

Vibration levels of industrial machines, other than rotodynamic pumping units measured at the manufacturer's test facility and in situ, must comply with the requirements of relevant parts of ISO 10816. Vibration severity of industrial machines not covered by ISO 10816 must not exceed the maximum levels specified by their manufacturers.

M6.3.2 Rotodynamic pumping units

Vibration levels of rotodynamic pumping units, other than submersible, but including solids handling and slurry pumps must comply with the requirements of ANSI/HI 9.6.4 or ISO 10816.7.

Vibration levels of dry and wet mounted submersible pumping units must comply with Sydney Water's Supplement to WSA 101 (D0000677) and ANSI/HI 11.6.

Vibration levels of pumps not covered by the above ANSI/HI standards must comply with relevant ISO standards or, in their absence, with the maximum values specified by their manufacturers.

Where pump supply includes all parts of a complete pumping unit, such as pump, coupling, motor and baseplate, the pump must be assembled and tested at the manufacturer's test facility and in situ as an assembled unit.

Fixed speed pumps must be tested at their nominal speed. Variable speed pumps must be tested over the speed range from the specified minimum speed to their maximum speed. Vibration severity of variable speed pumps must not exceed the above limits at any speed over that speed range.

M7. Noise

M7.1 Introduction

The equipment, plant and systems must be designed to:

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

M7.2 General

The equipment, plant and systems must comply with the objectives, recommendations and requirements of SafeWork NSW, EPA NSW Noise Policy for Industry (NPfI) 2017, AS 1055 Acoustics - Description and Measurement of Environmental Noise, and AS/NZS 1269 Occupational Noise Measurement.

Where there is a difference between the recommendations or requirements contained in the above-mentioned documents, the more stringent recommendation or requirement must apply.

During testing and commissioning, occupational and environmental noise tests must be undertaken to prove compliance for final acceptance. Background noise tests, which must be used as a basis for acceptance of the environmental noise levels, must also be undertaken.

The plant operating under normal conditions that does not meet the following requirements for noise during site testing must be rectified and retested.

M7.3 Occupational noise

M7.3.1 General

In NSW the criteria used for evaluating noise exposure is based on the Code of Practice for "Noise Management and Protection of Hearing at Work". This Code of Practice provides guidance on complying with the SafeWork NSW WHS Regulation 2017.

Noise exposure resulting from the equipment, plant and systems designed, supplied and installed under the Contract must be adequately controlled to ensure that people are not exposed to noise on site or arising from site operations which exceeds an exposure limit of:

1. 85 dB(A) for LAeq, 8-h
2. 82 dB(A) for $L_{Aeq,\ 12\text{-}h}$
3. Peak must not exceed 140 dB(C).

In addition, under normal operational conditions the maximum noise produced by new or modified equipment within the new or modified workplace must not exceed an overall A-weighted sound pressure level $L_{Aeq,(SPL)}$ of 85 dB(A) when measured no further than one metre from the operating unit.

M7.3.2 Noise analysis

Definitions, test and noise evaluation methods, procedures, instrumentation and calibration as described in AS/NZ 1269 must apply. All test instruments must be Class 1 Type 1 instruments as per AS IEC 61672 (or to available superseded AS 1259).

The measured noise levels must include room reverberation effects and any other noise associated with the supplied equipment.

M7.4 Environmental noise - EPA compliance

M7.4.1 General

With respect to environmental noise the operating plant supplied and installed must comply with the EPA NSW Noise Policy for Industry (NPfI) 2017, even if the occupational noise levels are within the specified limits.

The NPfI is primarily aimed at assessing noise from industrial noise sources scheduled under the Protection of the Environment Operations Act 1997 (NSW).

M7.4.2 Environmental noise criteria

The noise criteria, noise limits and noise assessments must be determined and carried out in accordance with the NPfI.

Both the intrusiveness and the amenity noise criteria as per the NPfI must be considered.

The noise criteria must be met at all plant's site boundaries.

M7.5 Noise control

M7.5.1 General

Noise levels must be contained by appropriate equipment design. Acoustic enclosures may only be used where agreed by Sydney Water.

Both the occupational and environmental noise impacts that would result from the works must be covered in design report or, in the absence of the design report, in a separate document.

M7.5.2 Acoustic enclosures

If an acoustic enclosure is provided, then the enclosure must form an integral part of the equipment and must not adversely affect the safety or function of equipment.

The acoustic enclosure must not impede the flow of cooling air when fully installed.

The acoustic enclosure must be constructed so that it can be easily removed for maintenance purposes, e.g. to be wheeled across the floor. The enclosure must have locks / latches to keep the enclosure closed when it is over the equipment.

Normal operation must be possible without opening or removing enclosure. Hinged access doors must be provided on all sides for easy access for routine inspection and maintenance.

The acoustic enclosure must have longer design life than the enclosed equipment.

M8. Painting and corrosion protection

Painting and corrosion protection must be in accordance with the requirements of WSAA Manual for Selection and Application of Protective Coatings WSA 201.

For all proprietary mechanical equipment such as pumps, motors, gearboxes, conveyors, etc. whether fully immersed or not, the painting must be upgraded to be equal to or better than the requirements in the WSA 201.

All painting in contact with potable or recycled water must comply with AS 4020.

Care must be exercised to protect all instruments, bearings, and all operational parts from contamination and damage when applying the paint system.

Equipment which has been coated must not be drilled or penetrated. Where cables, pipes, floorings and other equipment are to be fixed to structural steelwork to which protective coating, including galvanising, has already been applied, they must be fixed using clamping systems that do not damage the protective coating.

M9. Valves

M9.1 General

Unless stated otherwise in this Specification or accepted by Sydney Water, the valves must satisfy the following minimum requirements:

1. The number of different types and makes of valves used must be kept to a minimum. Valves of the same size, duty and type supplied for the same project must be identical.
2. Valves must be designed and manufactured in accordance with the latest editions of relevant Australian Standards and WSAA Product Specifications. In their absence suitable ISO, EN or other international standards may be considered, subject to Sydney Water's acceptance.
3. All parts of valves must be suitable for the worst-case operational conditions, including maximum (emergency) flows, pressures and temperatures.
4. Valve materials best suited for the service conditions and resistance to corrosion must be selected.
5. The galvanic potential between adjacent parts of valves, including gearboxes, actuators and connecting shaft keyways, must not exceed 0.3 Volts. Where necessary parts must be electrically insulated from each other to achieve this requirement. Stainless steel of grade 303, 416, or other “free machining” grades must not be used.
6. Minimum pressure class must be PN16
7. Valve flanges must be circular and conform in dimensions and drilling to AS 4087. Where the sizes and/or pressure classes are not covered in AS 4087, valve flanges must conform to AS 4331.2, AS 2129 or relevant international standards as agreed with Sydney Water. Flanges must be either raised or flat face type and faced parallel and square by machining. The backs of flanges must be machined or spot faced to provide a satisfactory bearing for bolt heads and nuts.
8. Valves must have proven record of reliable operation in the intended environment.
9. Valves must be of standard and proven design to give optimum performance in meeting the specified operating conditions.
10. Actuated valves must be fitted with suitable manual operating elements, such as hand wheels or handles. Loss of power or failure of the actuator must not prevent manual operation of the valve.
11. Isolation valves must be supplied with spindle caps. Spindle caps and keys for valve operation must be designed in accordance with the relevant Australian Standards. The colour of spindle caps for water must be blue and for recycled water purple in accordance with Sydney Water’s Edition of Water Services Association of Australia Code WSA 03. The colour of spindle caps for valves used in sewage applications must be black.
12. The manual operating elements, such as hand wheels or handles on isolating and control valves DN80 and larger must close the valve in an anti-clockwise direction. Valves DN65 and smaller and all hydrant / air valve isolation valves (globe valves with vertical spindle installed on a standpipe) must close in clockwise direction. The direction to turn the valve open and close must be indicated on the valve manual operating elements and stainless steel plates fitted on or adjacent to the valve. The sign on such plates must be laser cut through (i.e. not a weld bead).

13. The hand wheel diameter must not exceed 600 mm.
14. Isolation valves must be capable of opening and closing against full unbalanced head and maximum flow and must open and close smoothly without damage to any components.
15. All isolation and control valves must be fitted with non-rising spindles.
16. Manually operated valves must open and close with a maximum operator force (torque) of no more than 160 N (approx. 100 Nm) applied on the operating element to overcome their normal running torque, based on the maximum differential pressure, maximum flow and orientation of the valve.
17. The on-seating and off-seating ('cracking') forces (torques) of manually operated valves required to be applied for approximately ½ to 1 turn to off-seat or on-seat the valve under maximum differential head conditions must not be larger than 320 N (approx. 200 Nm) applied on the operating element.
18. Gate, butterfly, knife-gate, ball, globe, plug, diaphragm and piston valves must be bi-directional, i.e. capable of operation with flow in both directions and pressure on either side of the valve.
19. The size, shape, strength and rating of all valve parts must be sufficient to provide an ample factor of safety under all working conditions, taking into account corrosion and wear.
20. Valve castings must be sound and clean. Structural defects in ductile or cast iron valve components must not be repaired and used in valve assembly. No welding is permitted on cast components.
21. Drainage holes must be drilled or formed in any external pockets on the valve body or associated equipment, when necessary, to prevent moisture ponding.
22. Valves DN80 and larger must be supplied with support feet or include lugs to allow for the mounting of feet and attachment of anchor bolts or legs.
23. All internal and external fasteners must be made of grade 316 stainless steel and must have standard ISO thread to AS 1110, AS 1111 and AS 1112. This includes flange fasteners on integral bypasses etc. Stainless steel bolt threads must be coated with anti-seize lubricant.
24. Valve parts requiring grease lubrication (e.g. gearboxes) must be fitted with grease nipples.
25. The valve leakage rates must not exceed that specified in the relevant standard and this Specification.
26. Valve assemblies exceeding 25 kg must be provided with adequate lifting attachments. The lifting attachments must be designed to withstand the total assembled mass of the valve, including the gearbox and actuator, if supplied. Where eyebolts are provided, they must comply with AS 2317.
27. The valve internal surfaces must be devoid of sharp protrusions which may initiate secondary cavitation at high velocities.
28. All valve materials, coatings, lubricants etc. for drinking and recycled water application must comply with AS/NZS 4020.
29. Isolating and control valves may be electrically, hydraulically or pneumatically actuated or operated by portable actuators, as specified.
30. Valves fitted with electric actuators must include position transmitters and torque and limit switches. Pneumatically and hydraulically actuated valves must have limit switches. Where specified, manually operated valves must also be fitted with limit switches and torque limiting devices. The position

transmitters and limit switches must comply with this Specification and Sydney Water Technical Specification – Electrical (CPDMS0022). All actuated valves must have manual override.

31. For valves fitted with pneumatic, electric or hydraulic actuators the gearbox and all valve components must be designed to withstand the maximum rated torque capacity of the actuator plus 20%.

32. Isolation valves DN450 or larger up to PN16 and DN300 or larger for PN21 and above must be fitted with bypass arrangements, which may be integral with the valve (gate valves only) or external. The bypass arrangements and sizes must comply with the requirements of Sydney Water's Edition of WSAA Water Supply Code of Australia WSA 03. Subject to Sydney Water's acceptance, reduced size integral bypasses may be used on gate valves where the specified size fittings cannot be accommodated on valve body castings. The bypass valves must also fully comply with the requirements of this Specification. No bypass arrangements are required for isolation valves used in sewage and sludge applications.

33. Manually operated gate, butterfly and knife edge gate valves larger than DN300 or valves which require more than 100 turns from fully closed to fully open position must have an adapter on the valve spindle for use of a portable electric actuator. This spindle needs to be in the vertical position.

34. Gate valves DN600 and above must be fitted with gearboxes. Gearboxes must also be fitted to smaller gate valves if the effort on their operating elements required to overcome their normal operating torque exceeds 160 N or the effort to on-seat or off-seat the valve exceeds 320 N.

35. Manually operated valve gearboxes sized for 'cracking' forces (torques) which require more than 200 turns to open/close must be fitted with dual input shafts, one for 'cracking' and the other to overcome normal operating forces (torques).

36. Valve gearboxes must not be buried, installed in locations where they may become submerged, or where they cannot be readily accessible for maintenance.

37. Isolation valves must be able to be locked in both, closed and open position. Where specified, valves must be fitted with a keyed locking mechanism to prevent their unintentional operation. If the provision to lock out the isolation point directly using a hasp or lock is not available, isolation devices, such as surface box locking plates, which allow effective lockable isolation must be used.

38. Where used, valve extension spindles must be fabricated from the same material. Steel or stainless steel rods or tubes welded or attached to ductile or cast iron valve keys or caps are not acceptable. Extension spindles in buried, submersed or aggressive environments installations must be grade 316 stainless steel. Extension spindles must be secured to the valve spindle by a corrosion resistant fastener.

39. Unless buried, isolation valves ≥DN750 must be provided with suitable power actuators.

40. Notwithstanding the above, valves ≥DN450 installed in sewage pumping stations wet wells, dry wells and valve chambers must be electrically actuated.

41. Buried isolation valves must have a minimum clear access of 1m radius around the surface fitting and vehicular access for operation and maintenance.

42. Automatically operated valves must be fitted with suitable guards to prevent injury resulting from automatic operation whilst undergoing maintenance activities.

Notes:

e) The term “isolation valve” defines a valve (such as gate, butterfly, knife-gate, plug, globe, ball, diaphragm etc.) that is normally fully open or fully closed. Isolation valves are not used to control flow or pressure. They may be opened or closed under full unbalanced head or flow conditions.

b) The term “control valve” defines a valve (such as butterfly, needle, plug, globe, ball, diaphragm etc.) that may operate in a partially open or closed position to control flow or pressure.

M9.2 Marking

Unless specified otherwise in the relevant standards, as a minimum the following lettering must be cast on the body of each valve equal to or greater than DN80:

- Manufacturer's name or mark
- Nominal size (DN)
- Year of manufacture
- Pressure class (PN)
- Body material designation
- Standard to which manufactured
- Serial number
- Gear ratio (if applicable)
- An arrow denoting the preferred flow direction (if applicable)
- Arrows on the face of each operating element with the words OPEN and CLOSE (if applicable). Where operating element can be removed or is not supplied, this marking must be provided on other prominent place on or next to the valve, e.g. spindle cap, surface box, valve chamber cover etc.
- Valve total mass.

The lettering must be in legible block type letters projecting not less than 3 mm. The lettering must be as large as practicable but not less than 6 mm high for sizes up to DN 150, 10 mm high for DN 200 to DN 300, 20 mm high for DN 350 to DN 600 and 25 mm high for DN 700 and above.

Where, owing to the size or any other reason (e.g. valves smaller than DN80), casting of the above lettering is not practicable, such information must be shown on an engraved stainless steel nameplate or a permanent label. This nameplate or label must be permanently attached to a raised pad on the body of the valve casting or to the rim of the flange using suitable adhesive and must be positioned to be clearly visible after installation. Nameplates must have minimum 3 mm high etched or engraved letters. Labels must be printed with minimum 8 mm high letters.

Buried valves must be provided with secondary marking in the form of an engraved stainless steel nameplate securely fixed to the underside of the surface box lid. Apart from containing the same information as above, the nameplate must also clearly designate the valve type and seal design.

M9.3 Type of valves

Various types of valves may be considered for water and wastewater applications. The type of valves to be used must be in accordance with the table below. Use of other type valves must be subject to Sydney Water's acceptance. Valve materials must suit their application.

Type of valve	Valve service	Functionality
Gate valves - metal seated	Clean, potable or recycled water and effluent, raw water.	Open or closed. Must not be used for throttling or flow control.
Gate valves - resilient seated	Raw and screened sewage and sludge.	Open or closed. Must not be used for throttling or flow control.
Non-return valves - long bodied swing flex	Clean, potable or recycled water and effluent, raw water, raw and screened sewage.	Operates automatically.
Non-return valves - short bodied tilting disc	Clean, potable or recycled water and effluent, raw water.	Operates automatically.
Non-return valves - ball check	Clean, potable or recycled water and effluent, raw water, raw and screened sewage.	Operates automatically.
Non-return valves - flexi check (swing flex)	Clean, potable or recycled water and effluent, raw water, raw and screened sewage.	Operates automatically.
Non-return valves - double leaf (duo) check (resilient seated)	Clean, potable or recycled water and effluent, raw water.	Operates automatically.
Non-return valves - nozzle check	Clean, potable or recycled water and effluent, raw water.	Operates automatically.
Butterfly valves, seal-on-body, concentric	Clean, potable or recycled water and effluent, raw water, aeration and sparge air, biogas.	Open or closed, limited flow control (except for raw water, air and gas where a characterised positioner or SCADA function must be applied).
Butterfly valves, seal-on-disc, double offset	Clean, potable or recycled water and effluent, raw water.	Open or closed, limited flow control (except for raw water), discharge regulating (guard valve).
Butterfly valves, metal seated, double or triple offset	Clean, potable or recycled water and effluent, raw water.	Open or closed, throttling, limited flow control (except raw water) (used as pump discharge control valves).
Knife-gate valves	Clean, potable or recycled water and effluent, raw water, raw and screened sewage, sludge, grit slurry, aeration and sparge air.	Open or closed.

Type of valve	Valve service	Functionality
Diaphragm valves - straight through type	Clean, potable or recycled water and effluent, raw water, raw and screened sewage, corrosive fluids.	Open or closed, limited throttling. Not to be used for grit slurries.
Diaphragm valves - weir type	Clean, potable or recycled water and effluent, slurry, corrosive fluids, chemicals.	Open or closed, throttling. Not to be used for grit slurries.
Plug valves - eccentric	Clean, potable or recycled water and effluent, raw water, raw and screened sewage, sludge, grit slurry, digester gas.	Open or closed, flow control.
Plug valves - lubricated	Gas service.	Open or closed.
Ball valves	Clean, potable or recycled water and effluent, raw water, raw and screened sewage, oil, gas, chemical application, air.	Open or closed, limited throttling.
Air valves for water supply	Clean, potable or raw water, recycled water, effluent.	Operates automatically.
Air valves for sewage supply	Raw and screened sewage.	Operates automatically.
Reduced pressure zone valves	Clean, potable water.	Operates automatically.
Automatic control valves – hydraulically operated	Clean, potable or recycled water.	Flow control, level control, pressure reducing, pressure sustaining.
Automatic control valves - electric, piston (‘needle’) type	Clean, potable or recycled water	Flow control, pressure reducing, pressure sustaining, discharge regulating (guard valve).
Globe valves	Clean, potable or recycled water and effluent, oil, gas, general purpose.	Open or closed, throttling, flow control.
Pressure / Vacuum relief valves (gas)	Compressed air or gas	Operates automatically.
Pressure / Vacuum relief valves (liquid)	Water, sewage, sludge, effluent	Operates automatically.
Pinch valves	Grit slurry, lime dosing (full bore pinch valves)	Open or closed. Must not be used for throttling or flow control and high temperatures. Not recommended for high-pressure, or in gas applications.
Other DN65 and smaller valves	Clean, potable or recycled water and effluent, oil, gas, general purpose.	Open or closed.

M9.4 Valve installation

Valves must be installed strictly in accordance with manufacturers' instructions and this Specification. Valves may be installed in the following applications:

- Above ground / floor
- Valve chamber with extended spindle
- Buried with extended spindle.

All valves must be independently supported.

The valves, their gearboxes, actuators and operating elements must be installed so that they are easily accessible for operation and maintenance.

Adequate dismantling means, such as load bearing dismantling joints, flanged pipe elbows or threaded unions for threaded valves, must be provided close to each valve to facilitate its dismantling and re-installation. Union joints may be used on sizes up to DN50 for metal and up to DN100 for thermoplastic valves.

Non-return and butterfly valves must be installed such that they can be easily maintained, e.g. in suitable pits, valve chambers, pumping station buildings or above ground. They must not be buried.

Butterfly and short bodied tilting disc non-return valves must be installed so that they can be safely removed from the pipework even if jammed open. This may include a load bearing dismantling joint on one side and a pipe not shorter than the length of the valve disc protruding outside the valve body on the other.

Butterfly and non-return valves must be installed with their shafts / hinge pins horizontal and the bottom of their discs must open in the direction of flow. The valve discs must operate freely from open to close into adjacent pipework, fitting or dismantling joint internal diameters. Disc clearance dimension must be stated for each butterfly and non-return valve. Sufficient space must be allowed around the non-return valves to remove the hinge pins.

During installation of butterfly valves their discs must be in partially open position.

Isolation valve operating elements, such as hand wheels, handles and removable keys must be easily accessible. They must preferably be positioned horizontally approx. 1000 mm to 1300 mm or vertically with the spindle centreline approx. 1000 mm to 1400 mm (1800 mm where no head hitting hazard present) above the operating platform level. Subject to Sydney Water's acceptance, other positions may also be considered. Where necessary, adequate operating or "step up" platforms must be provided.

The centreline of a horizontally installed operating element and valve spindle must not be more than 300 mm from the operating platform hand railing, or edge of the operating platform where no hand railing is required. The face of the vertically installed operating elements must be within the operating platform. Operating elements must have minimum. 100 mm clearance all around and at any operating positions from other fixed items such as handrails, walls, pipes etc.

Valves installed at heights must be fitted with chain wheels and chains. Such installations may be considered only where suitable operating platforms cannot be provided and manual operation cannot be eliminated, e.g. by installing valve actuators.

Chain wheel operated valves must be equipped with a chain guide to prevent chain from coming off the wheel and permit reasonable side pull on the chain. The chain wheel must be keyed. The chain wheel and chain guide must be secured to the valve or gearbox input shaft, where fitted, by means of a locking bolt which must prevent them from becoming loose or falling off the shaft under any possible operating conditions. The locking bolt must be prevented from becoming loose. Grub screws, retaining washers, circlips, split pins or similar must not be used. Operating chains must be hot dipped galvanised or painted and must be looped to extend within 900 mm of the operating level below the valve. Suitable hooks must be provided to tie the chain when not in use. The maximum operating effort (pull) on the chain must not exceed 200 N.

Manual operation of the valves must be carried out with ease and without the need for any other extra equipment. All valves must be capable of being removed from their location in a pipeline without obstruction by the pipeline or other equipment.

Where necessary, buried isolation valves and those installed under and operated from operating platforms or valve chamber covers must be fitted with extension spindles.

The extension spindles must comprise a rigid shaft or tube capable of transmitting the maximum torque requirement of the valve. The extension spindles for gate valves must be manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS - 262 and AS 2638.2 or AS 2638.1, as applicable. The extension spindles for all other valves must comply with WSAA Product Specification WSA PS - 269.

In buried valve installations, extension spindles must be enclosed in a rigid tube or shroud. The spindle cap must be protected by a surface box. The surface box must be installed in accordance with WSAA Water Supply Code of Australia WSA 03 – Sydney Water's Edition, drawing no. WAT-1303-V and WAT-1304-V. Unless accepted otherwise, the depth of buried valves must not exceed 3 m to invert.

Buried valves must be provided with clear and permanent marking showing their operating fluid, i.e. sewage, water or recycled water. The marking must be provided at the surface, either next to or underside the surface box lid or on a permanent structure next to the valve spindle.

For valves installed in valve chambers or below operating platforms, their (extension) spindles must end approximately 50 mm below the platform level and the platforms must be provided with adequate keyholes directly above the spindles to enable operation with removable keys. The extension spindles must be fitted with supporting brackets. Valves installed with horizontal spindle (if accepted by Sydney Water) must be fitted with bevel gearboxes and extension spindles for operation from the top of the valve chamber or operating platform.

One removable key for each valve / spindle size supplied must be supplied for operation of buried, submersed or valves installed below operating platforms.

Where permanent operating elements (hand wheels or lever handles) need to be provided on valves installed below operating platforms, the valves must be fitted with extension spindles and spindle pedestals fastened to the top or side of the platform.

Valves not installed directly below but operated from platforms must also be supplied with extension spindles ending above the platforms hand railing. The extension spindles must be fitted with supporting brackets as required and be suitable for installation of operating elements.

M9.5 Gate valves

M9.5.1 Metal seated gate valves

Metal seated gate valves DN80 and larger must be double flanged or double socketed, as specified, manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS - 261 and certified compliant with AS 2638.1.

The valves must be of the required class, suitable for installation in horizontal, vertical or inclined pipelines with their spindle in vertical, horizontal or inclined position, as specified. The double flanged valves face-to-face dimensions must comply with AS 2638.1. Unless accepted by Sydney Water, no alternative face-to-face dimensions, including those specified in older versions of this Standard, will be accepted.

The gate valves must be used for isolation purpose and must in normal operation be either fully open or fully closed.

Gate guides must be provided in all gate valves to ensure alignment of the gate and carry the loads imposed. Integral gate guides cast in the valve body may be used for valves up to and including DN600. Separately fitted, replaceable guide liners and gate slippers must be provided in gate valves DN700 and above and in all gate valves installed in vertical or inclined pipelines or with their spindle in horizontal or inclined position. The guide liners and gate slippers must be recessed into the valve body and gate and held in position to resist loads imposed.

M9.5.2 Resilient seated gate valves

Resilient seated gate valves DN80 and larger must be double flanged or double socketed, as specified, manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS - 260 and certified compliant with AS 2638.2.

The valves must be of the required class, suitable for installation in horizontal, vertical or inclined pipelines with their spindle in vertical, horizontal or inclined position, as specified. The double flanged valves face-to-face dimensions must comply with AS 2638.2. Unless accepted by Sydney Water, no alternative face-to-face dimensions, including those specified in older versions of this Standard, will be accepted.

The resilient seated gate valves must be used for isolation purpose and must normally be either fully open or fully closed.

Integral gate guides cast in the valve body must be provided in all resilient seated gate valves to ensure alignment of the gate and carry the loads imposed.

The gates of resilient seated valves must be fully vulcanised internally and externally to the substrate metal with no metal parts exposed to the medium. The gate nut must preferably be integral with the gate.

M9.5.3 Thrust retention

Gate valve design must incorporate a fail-safe method of thrust retention, such as a thrust collar that is an integral part of the valve spindle, a separate split ring, or other multiple part assembly. The thrust retention mechanism must be supported off the valve body under the spindle seal retainer. Valves which require external thrust retention are not acceptable.

M9.5.4 Gearboxes

Gate valve gearboxes must be sized in accordance with Appendix D of AS 2638.1 or AS 2638.2, as appropriate, such that the maximum force to operate the valve applied on the operating element to overcome its normal running torque, based on the maximum differential pressure, maximum flow and orientation of the valve does not exceed 160 N. The force required to be applied for approximately ½ to 1 turn to off-seat or on-seat the valve (i.e. “cracking” torque) for gearboxes with single input shaft may exceed this value.

Unless specified otherwise, for gate valves DN750 and above the gearboxes must be supplied with two gear ratios and dual input shafts. The primary input shaft must have a lower gear ratio and must be used for normal operation. The secondary input shaft must have a higher gear ratio and must be used for off-seating and on-seating. Unless agreed otherwise, the maximum force applied on the operating element required to off-seat or on-seat the valve using the secondary input shaft under maximum differential head must also be no more than 160 N. Both input shafts must turn in the anti-clockwise direction to close the valve.

The gearboxes must be capable of withstanding the forces generated by an output torque of not less than 1.5 times the minimum strength test torque given in the relevant standards.

The gearboxes must be self-locking in all positions.

Gears must comply with AS 2938 and the input and output bearings must be of corrosion resistant materials.

The gearboxes must be manufactured in accordance with AS 60529 with an enclosure rating of IP68, suitable for 5m immersion in water for 72 hours. Mounting flanges must comply with ISO 5210 or ISO 5211, as applicable, using an adaptor piece if necessary.

The gearboxes must incorporate adjustable mechanical position stops to limit valve travel. Where valve actuators are fitted the stops will only restrict travel if the actuator travel limit stops fail.

Unless specified otherwise in the relevant standards, the gearboxes must have the following markings:

- Manufacturer's name
- Model and series number
- Year of manufacture
- Gear ratio
- Maximum allowable gearbox input torque.

The information must be shown on an engraved stainless steel nameplate. This nameplate must be permanently attached with a suitable adhesive. The plate must be in a location that must be clearly visible after installation.

The lettering must be as large as practicable but not less than 6 mm nor larger than 25 mm high.

M9.5.5 Position indicators

Gate valves fitted with gearboxes must have a basic position indicator for local operation attached to the gearbox or shaft or extended spindle.

Where specified, buried or submerged gate valves and those fitted with extension spindles must be fitted with remote position indicators visible at the operating position. For buried valves the indicator must be housed in the surface box.

The position indicator must be sealed against ingress of moisture and contaminants and must provide indication of the valve in the fully open, intermediate and fully closed positions. The position indicators must be manufactured in accordance with AS 60529 with an enclosure rating of IP68, suitable for 5m immersion in water for 72 hours.

M9.5.6 Testing and certification

All gate valves must be subject to full production tests and, where specified, full type tests in accordance with AS 2638.1 or AS 2638.2, as applicable. Test certificates must be supplied with each valve.

Permissible seat leakages and minimum test durations for metal seated gate valves up to DN900 and resilient seated gate valves up to DN750 must be as specified in the appropriate standard. For metal seated gate valves larger than DN900 the permissible seat leakage during valve seat tests must not exceed 10 mL/min and the minimum test duration must be 10 minutes. For resilient seated gate valves larger than DN750 no leakage must be allowed, and the minimum test duration must be 10 minutes.

M9.6 Non-return valves

M9.6.1 Swing check and tilting disc non-return valves

Swing check and tilting disc non-return valves DN80 and larger must be double flanged, manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS - 264 and certified compliant with AS 4794.

Non-return valves must be suitable for horizontal, vertical or inclined installation, as specified. However, wherever possible non-return valves in raw sewage applications must be installed in horizontal position to avoid solids settlement on the back of the disc. Hinge pins must always be installed horizontally.

Tilting disc non-return valves must be provided with a disc hinge pin extended through the valve body on one or both sides. The extended hinge pin must be fitted with a lever arm and adjustable counterweight. Tilting disc non-return valves face-to-face dimensions must comply to AS 4794 or EN 558 Series 14.

Swing check non-return valves must be fitted with a disc hinge pin extended on one side, lever arm and adjustable counterweight.

The counterweight lever arm must be fitted directly onto the disc hinge pin. Separate hinge pins for the disc and the counterweight lever arm must not be used.

Fixed guards must be fitted to all non-return valves provided with permanent lever arms and counterweights. The guard side panel must be removable for counterweight adjustment and fabricated from expanded metal or perforated or slotted plate so that the position of the lever arm is easily visible.

The counterweights must be fitted to the side of the non-return valves away from the area that is likely to be accessed by maintenance personnel, e.g. closer to the wall in case of valve chamber installation.

Unless it can be removed through the inspection cover, there should be enough space between the valve and adjacent object to enable the removal of the hinge pin.

Non-return valves must have a BSPP (parallel thread) tapping point provided on the highest point of the valve body or, where fitted, on the valve inspection cover. Non-return valves installed in pumping stations must be fitted with a grade 316 stainless steel two-part ball valve for air bleeding purposes. Other non-return valves must be provided with a plug. The tapping point size must comply with AS 4794.

Non-return valves installed on discharge side of pumps must be fitted with an adjustable proximity limit switch (also referred to as “no-flow” switch). The control system must stop the pump if there is no flow detected through the associated non-return valve by its proximity limit switch, i.e. if the valve closes or does not open when the pump operates. In case of variable speed pumps, the proximity switches must also be used for their speed ramp control during starting and stopping.

Where fitted with a damping device, the valve hinge pin / shaft and lever must be designed to withstand the maximum torque and force that could be developed under extreme conditions of reverse flow.

M9.6.2 Other types of non-return valves

Nozzle check, double-leaf (duo) check, ball check, flexi check / swing flex and other types of non-return valves may be used only where accepted by Sydney Water. Hydraulic dampers (‘dashpots’) may be considered for swing check and tilting disc non-return valves in special circumstances, e.g. where water hammer or valve slamming may be an issue. Non-return valves fitted with hydraulic dampers must be able to close by gravity.

Flexi check valves with elastomeric encapsulated discs and grade 316 stainless steel hinge pin must have the elastomeric material made of EPDM. The discs must have a ductile iron or steel insert and nylon reinforcement in the rubber hinge. The valve seat must be slanted to reduce disc closing time. The valves must be designed with provision to accommodate a position indicator and an adjustable proximity limit (“no-flow”) switch and a backflow actuator and, where required, supplied with these appurtenances. They must be manufactured by companies with extensive experience and supported by test data to prove the valve performance. The valves face-to-face dimensions must comply with AS 4794 and must be type and production tested in accordance with AS 4794.

The double-leaf check non-return valves must be used for aeration services.

For low head drainage applications, non-return valves with elastomeric flaps or “bills” may be used, subject to Sydney Water’s acceptance. The valves must be of a proven design with the flap or bill and liner of elastomeric material. If a clamp ring is required, it must be made of grade 316 stainless steel. The valve must not incorporate any metal or mechanical hinges or fasteners to secure the flap or bill to the body of the valve.

M9.6.3 Damping devices

If required or specified, the damping devices must employ hydraulic damping in operation and must facilitate fast, but soft closing of non-return valves, preventing disc slamming under reverse flow conditions and minimising vibration and water hammer. The device must allow free and rapid disc opening and movement over the normal operating range and become active only within the damping zone which must extend to 5-15° (adjustable) off the fully closed position.

The hydraulic damping devices must be of a simple, reliable and compact design, generally consisting of hydraulic cylinders, pressure tubing and flow control valves. No power pack or similar device is to be employed. The damping device may be installed externally to the disc and activated via the valve shaft, or

inserted into the flow way (in clean water application only) and acting directly on the disc. In either case the device must be supported off the valve and require no external support or mounting separate to the valve. It must be possible to undertake routine and preventative maintenance of the device without dewatering or accessing the pipeline. The device must be designed to withstand the maximum inertia that could be developed under extreme conditions of reverse flow.

The damping device must be single acting i.e. it must only be effective in the closing direction. The damping zone and time must be externally adjustable by simple means, such as by operating a flow control valve installed on the damping cylinder. The closing time must not be significantly affected by the varying ambient temperature and fluid viscosity. Once set the closing time must not be readily adjustable, and the adjustment device locked or permanently tagged.

M9.6.4 Testing and certification

All non-return valves must be subject to full production tests and, where specified, full type tests in accordance with AS 4794, using clean water at ambient temperature. Test certificates must be supplied with each valve. Valves that do not comply with AS 4794 must also be type tested in accordance with this standard and supplied with type test certificates.

The duration of the valve body and seat hydrostatic tests for valves up to DN750 must comply with AS 4794. For larger valves the tests duration must be minimum 10 minutes.

Permissible seat leakage for valves up to DN750 must be as specified in AS 4794. For larger valves the leakage must not exceed 30 mL/hr for each 25 mm of valve diameter.

M9.7 Butterfly valves

M9.7.1 General

Resilient seated butterfly valves DN80 and larger must be double flanged type, manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS - 263 and certified compliant with AS 4795.2.

Lugged type resilient seated butterfly valves may be used only where accepted by Sydney Water. Lugged type butterfly valves must comply with WSAA Product Specification WSA PS - 263 and certified compliant with AS 4795.1. Wafer body butterfly valves must not be used.

Metal seated butterfly valves must be double flanged type complying as far as practicable with WSAA Product Specification WSA PS - 263, AS 4795.2, this Specification and a Sydney Water agreed International Standard.

The valves must be designed and selected such that they can operate over the required range of flow and pressures without damage to any components.

The valves must be bi-directional, of the required class and suitable for horizontal or vertical pipeline installation, as specified.

In order to avoid galvanic corrosion, all wetted surfaces and interfaces of dissimilar metals must be insulated or fully and effectively coated.

The shaft bearings must be secured in the body of the valve and must not rotate.

Shaft bushes must be made from Grade 316 stainless steel or aluminium bronze.

The butterfly valves must be capable of opening and closing against full unbalanced head and design emergency velocity as specified. The design emergency velocity associated with maximum flow rate in case of burst water main downstream of the valve must be calculated for each valve but must not be less than 7.5 m/s. When requested by Sydney Water, details showing the derivation of the maximum generated torque under emergency velocity conditions must be supplied.

Butterfly valves must not be used for unscreened sewage, slurries, sludge or process streams which may contain suspended solids, screenings or grit.

M9.7.2 Application

Butterfly valves should normally be used for isolation purposes where they are either fully open or fully closed. They may also be used for flow control providing that the design flows and pressures are within their cavitation-free operating range.

Unless specified otherwise, valves used for flow control must be double offset (double eccentric) to increase their seal/seat life.

M9.7.3 Resilient seated butterfly valves

Resilient seated butterfly valves must be either concentric seal-on-body or double offset seal-on-disc, as specified. Seal-on-body valves may be used for waterworks purposes in normal applications (e.g. small to medium trunk mains), low emergency velocities (up to 7.5 m/s) and up to PN16. Seal-on-disc valves must generally be used for strategic assets (e.g. dam outlets, large trunk mains), high emergency velocities (above 7.5 m/s) and above PN16. Resilient seated butterfly valves must provide drop tight sealing from both sides when closed.

M9.7.3.1 Seal-on-body butterfly valves

Seal-on-body type butterfly valves must be provided with solid synthetic resilient seal, vulcanized to the body. The valve seal must extend over the flanges forming integral flange gaskets so that separate gaskets or O-rings are not required. Their shaft must be positioned concentric to the valve bore. The valve disc must be manufactured from stainless steel or aluminium bronze.

M9.7.3.2 Seal-on-disc butterfly valves

Seal-on-disc type butterfly valves must be provided with solid synthetic resilient seal fixed on the valve disc. The seal for valves DN750 and above must be readily replaceable in situ without requiring the removal of the valve from the pipeline. The seal must be of a low profile, resistant to high velocities and cavitation damage.

The seat ring and seal clamp must be manufactured from stainless steel grade 316 or other suitable corrosion and cavitation resistant material.

The seat ring must be secured to the body to provide a corrosion resistant seating surface and prevent the valve from leaking past the seat. The seat ring must not be secured to the body by welding.

Fasteners securing the seal clamp and seat ring in ductile or cast iron components must be protected against the ingress of water with a sealant or thread seal.

All wetted ductile iron or carbon steel surfaces and interfaces must be fully coated and sealed respectively to eliminate contact with moisture.

The shaft of seal-on-disc butterfly valves must be positioned eccentrically to the valve body and valve centreline to minimise the seal to seat contact when closing and opening and to achieve better sealing properties.

M9.7.4 Metal seated butterfly valves

Metal seated butterfly valves must be of double or triple offset design, seal-on-disc type.

Metal seated butterfly valves must be used as pump delivery control valves to assist pump starting and stopping and control water hammer surges in the pipework. They must open and close against full pump shut off head over an extended period of time.

Due to the arduous operating conditions, metal seated butterfly valves must be of a simple and sturdy design, with minimum number of internal components that may get damaged or become loose or dislodged. The valve seal and body seat must be made from cavitation and corrosion resistant materials. Seal and seat retainer rings must be fabricated as single pieces, adequately secured to the valve disc or body. Segmented seal and seat retainer rings are not acceptable. Shaft must incorporate a thrust plate or similar to minimise wear on the seat/seal and maintain correct position of the disc when exposed to the high velocities and turbulences that may occur during operation.

Metal seated butterfly valves must also be bi-directional so that they can be used for isolation during maintenance of pumps and other pipework components.

M9.7.5 Position indicators

Butterfly valves must have a basic position indicator for local operation attached to the gearbox or shaft. Valves fitted with extension spindles must have remote position indicators visible at the operating position. The position indicator must be sealed against ingress of moisture and contaminants and must provide indication of the valve disc in the fully open, intermediate and fully closed positions.

M9.7.6 Locking devices

Butterfly valves must have a locking device which must enable locking of the valve disc in either the open or closed position, to facilitate safe pipeline inspection and allow repair work to the gearbox or actuator when the pipeline is under pressure. The locking device must be manually fitted. It must be capable of withstanding the full stall torque of the actuator or twice the rated input torque of the valve or the gearbox.

Where access is not available (e.g. in buried installations) and where specified, the butterfly valve spindle must be fitted with a keyed locking mechanism to prevent its unintentional operation.

M9.7.7 Torque limiting devices

Manually operated butterfly valves must be fitted with torque-limiting devices.

The torque limiting device must be incorporated in the input shaft to the gearbox. It must be fully enclosed, adjustable and set by manufacturer to the nominated torque.

The torque limiting device must be of sturdy and corrosion resistant metal construction, tamper proof and the set torque must be permanently marked on a stainless steel plate attached to the torque limiting device with a suitable adhesive.

The torque limiting device must require no maintenance and must be lubricated for life. Wherever possible, the device must be located in a position where it cannot become submerged or affected by groundwater.

M9.7.8 Gearboxes

Butterfly valves DN300 and larger must be provided with suitably sized gearboxes. The valve gearbox must be self-locking in any position of the valve disc. Butterfly valves smaller than DN300 must have facility to lock valve disc at selected positions.

Unless specified otherwise, the valves must be installed with gear boxes, input shafts and actuators on the left hand side with the input shaft vertically upward, when viewed from the upstream face.

The gearboxes must be capable of withstanding the maximum hydrodynamic torque generated by the valve under maximum velocity for the application.

Valve gearboxes must be sized such that the required force applied on the operating element to operate the valve under the worst conditions of differential head, unseating force, or emergency flow must not exceed 160 N.

The gearboxes must be capable of withstanding the forces generated by an output torque of not less than 1.5 times the minimum strength test torque given in the relevant standards. Where the minimum strength test torque is not specified, the gearboxes must be capable of withstanding the forces generated by an output torque of not less than 1.5 times the published maximum operating torque required to operate the valve under the worst conditions, including maximum or emergency flow, maximum differential head and seating and unseating torque.

The gearboxes must be grease-lubricated and incorporate seals on the input and output shafts to prevent ingress of foreign matter and water.

The gearboxes must incorporate adjustable mechanical travel stops to limit valve travel. Where valve actuators are fitted the stops must only restrict travel if the actuator input stops fail.

The gearboxes must be manufactured in accordance with AS 60529 with an enclosure rating of IP68, suitable for 5 m immersion in water for 72 hours. Mounting flanges must comply with ISO 5210 or ISO 5211, as applicable, using an adaptor piece if necessary.

The gearboxes must have the following markings, unless specified otherwise in the relevant standards:

- Manufacturer's name
- Model and series number
- Year of manufacture
- Gear ratio
- Rated input torque.

The information must be shown on an engraved stainless steel nameplate. This nameplate must be permanently attached with a suitable adhesive. The plate must be in a location that must be clearly visible after installation.

The lettering must be as large as practicable but not less than 6 mm nor larger than 25 mm high.

M9.7.9 Testing and certification

Resilient seated butterfly valves must be subject to full production tests and, where specified, full type tests in accordance with AS 4795.2 or AS 4795.1.

Metal seated butterfly valves must be inspected and tested in accordance with EN 12266.1 or API 598, as agreed. In addition to the tests specified in these standards, the valve free end test, disc strength test, shaft strength test and operation test must be undertaken in accordance with the relevant clauses of AS 4795.2.

Test certificates must be supplied with each valve.

M9.8 Knife-gate valves

M9.8.1 General

Knife gate valves must be manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS-266 and AS 6401. Valves which in size and pressure class not covered in AS 6401 must be manufactured, tested and supplied in accordance with Sydney Water's agreed International Standard.

Knife gate valves must be PN16. Subject to Sydney Water's acceptance, PN10 and PN6 knife gate valves may only be used in gravity and low pressure applications where max. pressures don't exceed 50% of the valve pressure class.

Knife-gate valves must be either lugged or double flanged, as specified. Wafer type knife gate valves must not be used.

The valves must be suitable for horizontal or vertical installation.

Knife gate valves will be used for isolation purpose and will normally be either fully open or fully closed. They may also be used for flow control of sludge, scum or similar materials in pipelines. The valves must be of rugged construction with materials suitable for corrosive and abrasive sewage grit, sludge and scum slurries and operating in an aggressive environment.

Knife gate valves must be bi-directional, i.e. capable of operation with flow in both directions and pressure on either side of the gate, and suitable for end-of-line installation. Subject to Sydney Water's acceptance, metal seated knife gate valves may be uni-directional.

Knife gate valves must be made from the basic materials specified in Table 2.1 of AS 6401. Alternative materials specified in AS 6401 may be considered only if the valves are not installed in environments subjected to 'high', 'immersion & buried' or 'extreme' exposure classes as per WSA 201.

Knife gate valves installed in pumping stations dry wells, superstructures, valve chambers, machinery rooms etc. must be bonneted. The bonnets must be full pressure rated and fitted with a grade 316 stainless steel two-part ball valve for testing and de-pressurisation.

Knife gate valves installed at treatment plants in bunds or below ground in areas that are already classified as a confined space do not require a bonnet. Any locations that these unbonneted knife gate valves are used must have adequate drainage system.

Knife gate valves installed in sewage pumping stations wet wells and similar structures where they can become submerged in sewage, sludge and grit must be fitted with a Grade 316 stainless steel shroud to prevent rags and other solids being deposited around the spindle, gate and gland.

Where specified the valve spindles must also be protected by a sleeve for safety and to prevent the ingress of extraneous matter.

The valve gate must be adequately guided to ensure that at no stage over its full travel it can deflect enough to allow leakage past the seal. The packed gland for the gate must be self-aligning.

The valves must have self-cleaning features and be able to cut and dislodge stringy material that may be caught during closing.

Resilient seated knife edge gate valves must be drop tight in the closed position. The maximum leakage rate for metal seated valves must not exceed the value specified in AS 6401.

Vertically installed actuated knife-gate valves with valve spindle installed horizontally shall have an additional support for the actuator to avoid premature seal failure by minimising bending in valve spindle and/or gate.

M9.8.2 Gearboxes

Where installed, the knife gate valve gearboxes must be capable of withstanding the thrusts generated by an output torque equal to the 1.5 times the minimum strength test torque given in AS 6401.

Gears must comply with AS 2938 and the input and output bearings must be of a corrosion resistant material.

Mounting flanges must comply with ISO 5210, using an adaptor piece if necessary.

The gearboxes must be externally coated in accordance with WSA 201with a protective coating suitable for the working environment.

The gearboxes must have the following markings, unless specified otherwise in the relevant standards:

- Manufacturer's name
- Model and series number
- Year of manufacture
- Gear ratio
- Rated input torque.

The information must be shown on an engraved stainless steel nameplate. This nameplate must be permanently attached with a suitable adhesive. The plate must be in a location that must be clearly visible after installation.

The lettering must be as large as practicable but not less than 6 mm nor larger than 25 mm high.

M9.8.3 Testing and certification

All knife gate valves must be subject to full production tests and, where specified, full type tests in accordance with AS 6401.

Test certificates must be supplied with each valve.

M9.9 Diaphragm valves

Diaphragm valve must be used for flow throttling of liquids with high solids content.

Metallic diaphragm valves must be weir or full-bore type and conform to BS:EN13397, with cast iron body and bonnet and elastomer diaphragm suitable for the specified use for valves rated up to PN16. Manual diaphragm valves must have bonnet assemblies with a rising hand wheel design where the mild steel spindle is lubricated after each operation or the spindle is of stainless steel and must have a distinctive visual indicator.

Diaphragm valves made of thermoplastic materials must conform to BS:EN16138.

Lines carrying solids must be equipped with full bore valves. Where required, larger size diaphragm valves must be used to match the line internal diameter. Weir type valves may only be used on air or water pipelines.

Diaphragm valve pneumatic actuators must be "air to close/spring to open" unless otherwise specified. The actuators must be of the diaphragm type and must be purpose designed to suit the associated valve, the maximum line pressure anticipated and the supply air pressure.

Manual override and a position indicator and transmitter must be provided.

M9.10 Plug valves

M9.10.1 General

Plug valves must be of either eccentric plug type or lubricated plug type. The eccentric plug valves must be used to modulate the flow of industrial water or recycled effluent or for flow control in wastewater applications. Where plug valves are used for modulation of air or gas flow, they must be of lubricated plug type.

Plug valves must be the double flanged type. Plug valve bores may be 100% or 80% of the pipe area to which the valve is fitted.

M9.10.2 Eccentric plug valves

Eccentric plug valves must be of the non-lubricated eccentric type with a resilient faced plug vulcanised to the substrate metal. They must comply with AWWA C517, except where specified otherwise.

Unless otherwise shown or specified, valves for sizes DN80 and larger must have worm gear operators, nickel or stainless steel seats and flanged ends. Valves DN65 and smaller must have operating handles, nickel or stainless steel seats, and screwed ends. Resilient facing must be suitable for the intended service.

Submerged and buried valves, must be equipped with worm-gear operators, lubricated and sealed to prevent entry of dirt and water into the operator. All shaft bearings must be of stainless steel, furnished with permanently lubricated bearing surfaces. The operator must clearly indicate valve position.

M9.10.3 Lubricated plug valves

Lubricated plug valves must be of the tapered plug type, worm-gear operated for sizes DN80 and larger, and handle operated for sizes DN65 and smaller.

Lubricated cast iron plug valves must conform to BS5158 for valves up to PN25 rating. Lubricated steel plug valves must conform to BS5353.

Manually operated closed bottom taper valves must conform to EN331.

Lubricated plug valves for digester gas service must have grade 316 stainless steel plugs and suitable resilient seating, nitrile rubber (e.g. Buna-N, Hycar, or equivalent).

The valves must be provided with a fitting designed to provide for application of a sealant / lubricant through a check valve protected passage in the spindle, or through a stainless steel tube for worm-gear operated valves. Provision must be made by ducts or grooves to insure the maintenance of a closed pressurized sealant / lubricant system between all contact surfaces of moving parts.

The plugs must be held toward their seats by factory-adjusted gland assemblies set for proper sealing and operating torque. The gland assemblies must be adjustable from the valve exteriors and must utilize either spring washers or gland deflection to allow plug unseating when pressurized sealant / lubricant is injected.

The valve bodies and plugs must have smoothly finished water passages free from sharp corners when the plugs are in the wide-open position. Worm-gear operators must be completely enclosed in a watertight and dust-tight grease-packed case, with position indicator.

A manual lubricating gun must be supplied for lubricated plug valves in sizes up to DN150, inclusive. For larger valves a pneumatically operated lubricating gun must be provided. The guns must be of the same manufacturer as the valves. They must be equipped with flexible connector, pressure gage, and safety valve, with operating instructions and shipped in a labelled toolbox.

The valves must be leak tight. They must be supplied with a certificate stating the body and seat test pressure and indicating that there is zero leakage at shut-off under the specified differential pressure.

M9.10.4 Plug valve installation

Plug valves must be installed in strict accordance with the manufacturer's published recommendations.

Unless otherwise directed or advised by the manufacturer, the following rules must be observed for the installation of eccentric plug valves on sewage, sludge, or other liquid systems containing solids, silt, or fine sand:

1. The valves must be positioned with the spindle in the horizontal position
2. In horizontal pipelines, the plug must swing upwards when opening, to permit flushing out of solids
3. The orientation of the valve must prevent the valve body from filling up with solids when closed. However, where the pressure differential through the valve exceeds 150 kPa, the higher pressure side for valves without worm gear, electric, or air operators, must be through the valve, to force the plug against the seat.

4. Valves which may be closed for extended periods (stand-by, bypass, or drain lines), and valves with reversed flow (higher pressure on downstream side, forcing the plug away from its seat), must be equipped with worm gear operators for sizes DN100 and larger.

In addition to the above, for clean water or special applications, or when in doubt, the valve must be installed strictly in accordance with manufacturer's instructions.

M9.11 Ball valves

Metal bodied ball valves up to DN100 must be two-piece type and conform to AS 5830.1. Larger and actuated ball valves may be of a three-piece design complying with ISO 17292 or similar Sydney Water approved standard.

Valves DN50 and larger must have PTFE seals and a handle long enough so that the force required to operate the valve complies with this Specification.

Ball valves of thermoplastic materials must conform to AS 5830.2 or ISO 16135.

Manually operated ball valves for gas applications must conform to EN:331 and AS 4617.

M9.12 Air valves for water supply

M9.12.1 General

Air release or admission valves for water supply, including large, small and double orifice and anti-slam and anti-vacuum valves, must be automatic, flanged kinetic valves, manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS 265 and AS 4956.

The valves must be of the required size and class, suitable for vertical installation.

To facilitate maintenance of the air valve an isolation valve must be provided between the main and the air valve. For buried mains a hydrant/air valve isolator with vertical spindle, as specified by Sydney Water, must be used. For installations where access is available a resilient seated gate valve to AS 2638.2 must be used for isolation.

A DN20 drain valve must be installed in large orifice air valves as per AS 4956.

Air-release valves must vent accumulating air while system is in service and under pressure. The valves must be drip-tight from a minimum hydrostatic pressure of 10 kPa to the rated operating pressure.

The body and cover of valves must be made of either ductile iron to AS 1831 grade 500-7 or 400-15 or stainless steel grade 316. Floats must be made of stainless steel grade 316 or plastic.

M9.12.2 Testing and certification

All air valves must be subject to full production tests and, where specified, full type tests in accordance with AS 4956.

Test certificates must be supplied with each valve.

M9.13 Sewage air release and vacuum break valves

M9.13.1 General

Air (gas) release and vacuum break valves for sewage application must be manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS-275 and AS 4883. These valves must be flanged kinetic type, anti-slam, either of a single or double orifice design. Non-kinetic and semi-kinetic air valves must not be installed.

Sewage air valves must be designed to provide separation of the fluid from the orifice sealing mechanism to minimise fouling. The valve body must provide drainage outlet/s for air recharge in the case of air absorption by the wastewater. The design of sewage air valve must incorporate a manual ball valve located at the lower portion of the valve body to enable pressure release, back washing and testing of the valve operation.

Materials must be as per basic material requirements of the standard, except where specified. The body and cover may be made of either ductile iron to AS 1831 grade 500-7 or 400-15 or stainless steel grade 316.

To facilitate maintenance of the air (gas) release and vacuum break valve a separate isolation valve must be provided between the main and the valve.

The valves must be of the required class, suitable for vertical installation and of required size.

Sewage air release valves must vent accumulating gases during system operation. They must have long float stems and bodies to minimize clogging. The valves must be drip-tight from a minimum hydrostatic pressure of 10kPa to the rated operating pressure.

M9.13.2 Testing and certification

All sewage air (gas) release and vacuum break valves must be subject to full production tests and, where specified, full type tests in accordance with AS 4883.

Test certificates must be supplied with each valve.

M9.14 Reduced pressure zone device (RPZD)

A backflow prevention device (Reduced Pressure Zone Device (RPZD)) with hazard rating ‘High’ must be installed in the water supply line where necessary to prevent contamination of the water supply system. The RPZD must be installed upstream of the hydrant and path tap.

The RPZD complying with AS 2845 complete with an in-line strainer and two resilient seated isolation valves must be installed and tested in accordance with AS 3500 by a licensed and backflow accredited plumber.

A “Backflow Prevention Device - Inspection and Maintenance Report” must be completed and a signed copy of this document must be provided to Sydney Water as a record of compliance with the above standard.

M9.15 Hydraulically operated automatic control valves

M9.15.1 General

Hydraulically operated automatic control valves must be double flanged, manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS-268 and AS 5081.

The valves must be of the required class and suitable for horizontal or vertical installation, as specified.

M9.15.2 Testing and certification

All hydraulically operated automatic control valves must be subject to full production tests and, where specified, full type tests in accordance with AS 5081.

Test certificates must be supplied with each valve.

M9.16 Plunger type control (needle) valves

M9.16.1 General

Plunger type control valves must be double flanged, manufactured, tested and supplied as far as possible in accordance with WSAA Product Specification WSA PS-268 and AS 5081.

The valves must be of the required class and suitable for horizontal or vertical installation, as specified.

M9.16.2 Design

Plunger type control valves must be of either vaned ring, slotted cylinder or special design, as specified. The valve body must be of a single, two-piece or three-piece design with supporting feet. The body must be internally streamline shaped. It must have an annular throttling cross section in any position to ensure a linear regulating characteristic without cavitation.

The piston must move axially in the flow direction and must be guided on a minimum of four long guide rails. The valve must be fitted with a precise O-ring seal in a recess to ensure that the piston seals only in the closed position. In intermediate positions, the piston seal must be unstressed to ensure long life and low operating torque. The piston must be pressure balanced.

The vaned ring at the valve outlet must give the flow a spiral movement to confine cavitation bubbles to the centre of pipe. Slotted cylinder must achieve similar effect by forcing the high velocity jets to the middle.

The actuating shaft must be easily operated and supported in maintenance-free bushes on both sides. The shaft-hub connection must be by means of a parallel key. An internal slider crank mechanism must turn the rotary movement of the operating shaft into the axial displacement of the piston.

Where specified, e.g. when used as a submerged outlet valve, an adequately sized air induction device must be installed downstream of the valve for cavitation-free discharge operation.

M9.16.3 Materials

Valve main components must be made from the following minimum acceptable standard materials. Alternative materials may be used, provided they are equivalent in performance, particularly with respect to strength, corrosion resistance, valve operation and durability.

Body	Ductile Iron
Guide rails	Brass
Piston	Stainless Steel grade 316
Vane Ring	Zinc Free Bronze
Air Admission Device	Ductile Iron

M9.16.4 Valve actuator

The plunger type control valve must be fitted with a slider crank mechanism driven by a manual, electric, hydraulic or pneumatic actuator, as specified. A position indicator must be fitted on the actuator to indicate the degree of open/close position of the valve. The actuator must be rated for modulating action. The actuator must also be suitable for the specified controlled opening/closing period.

The valve body and the gearbox must be suitable for fully submerged operation. In submerged conditions the actuator must be weatherproof and mounted on a pedestal, connected to the gearbox by an extended shaft. The actuators other than manual must have manual over-ride. The gearbox materials and seals must be suitable for submerged operation.

M9.16.5 Testing and certification

All hydraulically operated automatic control valves must be subject to full production tests and, where specified, full type tests in accordance with AS 5081 or relevant international standards.

Test certificates must be supplied with each valve.

M9.17 Hydrant and air valve isolation valves

Hydrant / air valve isolation valves (globe valves with vertical spindle installed on standpipe) must comply with WSAA Product Specification WSA PS-282.

M9.18 Pressure / vacuum relief devices

Where required by AS 1210, pressure and/or vacuum relief devices must be used on pressure vessels and storage tanks containing compressed air or gas to prevent structural damage due to excess internal pressure or vacuum encountered during operation.

Pressure/vacuum relief valves (dual action) must be installed on digesters to prevent structural damage due to excess internal pressure or vacuum and control tank venting to minimise emissions to the environment. They must be suitable for biogas, made from corrosion resistant materials, and provided with grade 316 stainless steel removable seat rings that can be replaced in-situ. Integral valve seats must not be used.

The pressure/vacuum relief valves must comply with AS 1271 and AS 1210.

Refer M13.7.10 for pressure relief valves with positive displacement pumps.

M9.19 Pinch valves

Pinch valves must be of full cast metal body mechanical pinch type with integral flanges on body and flexible sleeve. All internal metal parts are to be isolated from the process fluid by the flexible rubber sleeve.

Valve configuration must be full round, full port, capable of passing a sphere equal to the diameter of the mating pipe.

For all valves up to 100 mm nominal diameter, the pinching mechanism must be full round, with a single pinch bar closing the valve from the top.

For all valves 100 mm and larger, the pinching mechanism must be full round dual pinch on centreline, with two pinch bars.

M9.20 Valves DN65 and smaller

Valves up to and including DN50 must have threaded end connections. Larger sizes must be flanged. Subject to Sydney Water's acceptance, wafer type valves up to DN65 for clean water applications may be considered.

Gate, globe and non-return valves for water service up to DN65 must be metallic complying with AS 1628.

All other valves and fittings must be metallic bodied complying with AS 5200 and relevant part of ATS 5200.

Globe valves must be diaphragm-operated or piston type. Valve body and trim material must be de-zincification resistant brass or stainless steel.

Non-return valves must be bronze body full bore type with freely moving bronze disc. For clean water applications and where located close to pumps, short bodied tilting disc non-return valves are preferred. Otherwise, resilient seated single flap check valves are also acceptable. The single flap check valves must be ductile iron or SS316 with springs of Hastelloy® C or chloride corrosion resistant grade stainless steel and EPDM seal.

Float valves must be made from stainless steel and comply with AS 1910.

Safety and liquid relief valves must comply with AS 1271.

Water pressure reducing valves must be equipped with bronze bodies, neoprene diaphragms and discs.

Solenoid valves for water service must be equipped with a dampening device, to prevent water hammer. All solenoid valves must be from a single supplier. Coils must be continuously rated 24V DC with protection to IP65 in accordance with AS 60529. Solenoid valves must be equipped with a manual override with a detent as a means of operating the valve in the case of power failure. Valve body must be de-zincification resistant brass or stainless steel.

M9.21 Valves of thermoplastic materials

Industrial valves of thermoplastic materials must comply with relevant Australian Standards or, in their absence, with ISO 16135, ISO 16136, ISO 16137 and ISO 16138, as appropriate.

M9.22 Gate valves for under pressure installation

Gate valves for under pressure installation must be suitable for installation into existing pipelines without interruption of the water flow. They must be resilient seated complying with WSAA Product Specification WSA PS-283 and approved by Sydney Water.

M10. Portable valve actuators

M10.1 General

Portable actuators must be of sturdy, metal construction with direct drive onto the valve or gearbox input spindle.

Portable actuators must be supplied with a sturdy steel lockable storage box.

An operation and maintenance manual must be supplied with each portable actuator.

The actuators must be electrically motor driven powered either by mains power or by battery.

M10.2 Mains powered portable actuators

Mains powered actuators must be single phase (240 V) with a three-pin plug and minimum 3 metres of power cable. The units must be protected by an earth leakage device that can be easily tested and reset.

The motor and RCD must comply with the inspection, testing and tagging requirements of SafeWork NSW Code of Practice - Managing Electrical Risks in the Workplace and AS/NZS 3760.

Mains powered portable actuators must have the following features:

- A torque limiting device adjustable between approximately 130 Nm and 500 Nm
- Operate at 18 rpm, in both clockwise and anti-clockwise direction
- A resettable rotation counter clearly visible from the operating position
- A tamperproof “dead-man” switch
- To minimise operating effort, the distance from the operating position (“dead man” switch) to valve spindle must not be less than 500 mm
- To limit the size of the unit the maximum dimension must not exceed 1200 mm
- Lightweight and easily handled and operated by one person. Its weight must not exceed 16 kg
- A square drive adapter for valve spindle operation
- Continuous rated operation for at least 60 minutes.

M10.3 Battery powered portable actuators

Battery powered (cordless) portable actuators must have the following features:

- A torque limiting device adjustable approximately between 100 Nm and 500 Nm, unless the actuator is custom engineered for a specific valve whereby its maximum output torque must match the maximum torque required to on and off seat and operate the specific valve.
- Operate at 18 rpm in both clockwise and anti-clockwise direction, unless the actuator is designed to be supported and locked into the valve gearbox / top flange and spindle assembly so that no back torque (‘kickback’) can be applied to the operator. In such case no torque limiting device is required and its operational speed may exceed 18 rpm.

- A resettable rotation counter clearly visible from the operating position.
- A tamperproof “dead-man”, which may be in the form of the actuator trigger.
- The maximum dimension must not exceed 1200 mm.
- The weight must not exceed 16 kg.
- Continuous rated operation for at least 45 minutes.

M11. Electric valve actuators

For electric actuators requirements refer to Sydney Water Technical Specification – Electrical (CPDMS0022).

M12. Pneumatic valve actuators

For pneumatic actuators requirements refer to Sydney Water Technical Specification – Electrical (CPDMS0022).

M13. Pumps

M13.1 General

Pumps must be selected, designed and sized for the required duties, including all flow ranges, differential heads, fluids properties (including contaminants), temperatures and pressures.

The pumps must comply with, but not be limited to, the following requirements:

1. The pumps must be selected for the lowest life cycle cost and reliable and trouble-free operation.
2. The pumps must provide the required modes of operation within the design operating range.
3. The pumps suction and discharge piping must be designed conservatively so that larger pumps can be installed in the future.
4. The required design capacity, including the maximum, normal, and minimum flows to be pumped both in single and parallel operation must be considered when selecting the type and size of pumping equipment.
5. Variable speed pumps must provide the required turndown and be capable of pumping over the complete design flow range.
6. Wherever possible larger, lower-speed pumps must be used. The maximum pump speed must not exceed 1500 rpm for rotodynamic and 300 rpm for positive displacement pumps. Smaller rotodynamic pumps with maximum shaft power input of below 50 kW may run at speeds up to 3000 rpm where suitable equally efficient lower speed pumps are not available.
7. The whole pumping unit must be resistant to the corrosion and abrasive wear associated with the intended operation.
8. Pumps and driving units must be purchased from one source to ensure the parts are compatible mechanically and electrically.
9. Pump casing must withstand hydrostatic test pressure at least 1.5 times the allowable operating pressure applied for a minimum of 10 minutes.
10. Pump castings must be sound and clean. Structural defects in ductile or cast iron pump casings and other components must not be repaired and used in pump assembly.
11. Pumps must be manifolded in such a way that they can be easily isolated, removed and replaced by a spare pump during plant operation and without disturbance to the upstream or downstream pipework.
12. Pump flanges must be circular and conform in dimensions and drilling to AS 4087 with min. PN16 pressure class. Where the sizes and/or pressure classes are not covered in, or if the pump is not available with flanges complying to AS 4087, the flanges must conform to AS 4331.2, AS 2129 or relevant International Standards as agreed with Sydney Water. Flanges must be either raised or flat face type and faced parallel and square by machining. The backs of the flanges must be machined, or spot faced to provide a satisfactory bearing for bolt washers. Bolt holes must be off centre.

M13.2 Type of pumps

Various types of rotodynamic (centrifugal, peripheral or special) and positive displacement (reciprocating or rotary) pumping units may be considered. The type of pumps to be used must be in accordance with the table below. Use of other type pumps must be subject to Sydney Water's acceptance.

Pump service	Type of pump	Features
Clean, potable or recycled water and effluent	Centrifugal, single or multiple stage, horizontal or vertical.	High efficiency, double suction split casing, end suction back pull-out, or multiple stage split casing or ring section. Comply with AS 4020 for potable and recycled water applications.
Raw sewage, screened sewage	Submersible (dry or wet installed) centrifugal complying with WSA 101 and Sydney Water's Supplement to WSA 101 (D0000677).	High efficiency, impeller with non-clogging properties capable of passing min. Φ 80 mm sphere. Horizontal or vertical if installed in dry well.
	Progressive cavity positive displacement.	Macerator on pump suction.
Raw water	Submersible (dry or wet installed) centrifugal complying with WSA 101 and Sydney Water's Supplement to WSA 101 (D0000677).	High efficiency, impeller with non-clogging properties capable of passing min. ø80mm sphere. Horizontal or vertical if installed in dry well.
Grit slurry	Centrifugal with recessed vortex impeller or torque flow.	Casing and impellers treated for abrasive and corrosive nature of grit slurry.
	Air lift.	
Mixed liquor	Centrifugal or mixed flow.	High efficiency, impeller with non-clogging properties capable of passing min. Φ80mm sphere. Horizontal or vertical.
	Submersible (dry or wet installed) centrifugal complying with WSA 101 and Sydney Water's Supplement to WSA. 101 (D0000677).	
RAS and WAS	Centrifugal with recessed vortex impeller or mixed flow, chopper pump.	Impeller with non-clogging properties.
Raw sludge, digested sludge with 1 to 3% solids content	Centrifugal with recessed vortex, mixed flow or screw type impeller, chopper pump.	Impeller with non-clogging properties.
	Progressive cavity positive displacement.	Macerator on pump suction.

Pump service	Type of pump	Features
Scum	Centrifugal with recessed vortex, mixed flow or screw type impeller.	Arrangement for full mixing or other measures to prevent build-up of scum.
Thickened sludge or digested sludge with 3 % to 7 % solids content	Progressive cavity positive displacement, centrifugal chopper.	Design to incorporate feature allowing quick disassembly to facilitate maintenance
Reclaimed effluent	Centrifugal or turbine.	
Thickened sludge with greater than 7 % solids content	Positive displacement piston or progressive cavity.	
Polymer dosing	Progressive cavity positive displacement.	
Chemical dosing	Refer chemical storage and dosing systems clauses.	

M13.3 Centrifugal pumps

M13.3.1 General

Centrifugal (radial flow, mixed flow and axial flow) pumps must be of a proven design, robust construction and efficient in operation under all conditions within the specified operating range.

The lubrication of the pumping unit bearings must be of a modern design and sufficient capacity to operate for long periods without attention.

All surfaces in contact with the pumped liquid must be protected by non-toxic primers and finish coatings. Where used in potable or recycled water applications, the primers and finish coatings must meet the requirements of AS 4020.

The pump casing must be of ample strength to withstand all possible stresses to which it may be subjected under all conditions of service.

The pump must be coupled to the drive motor. The lowest natural frequency of the combined pumping units and their concrete foundations, measured in any direction, must be at least 25% higher than the pump maximum speed. The designer must assess the natural frequency of the concrete foundations in combination with the pumping units and motors and make all necessary provisions to meet this requirement.

All pumps, except submersible for sewage applications, with their couplings, motors and other components must be capable of withstanding without damage the effects of accidental reverse rotation (the reverse runaway speed) due to reverse flow through the pump under the head equal to the pump shutoff head. Submersible pumps for sewage applications must comply with the requirements of WSAA Industry Standard for Submersible Pumps for Sewage Pumping Stations WSA 101 and Sydney Water's Supplement to WSA 101 (D0000677).

The pumps must be supplied with a guarantee and substantiating documentation that their performance is in accordance with the pump curves submitted within the tolerances specified in AS / ISO 9906. Minimum

Grade 1B tolerance factors must apply for pumps with max. shaft power input of 50 kW or larger and Grade 2B tolerance factors for pumps with max. shaft power input of below 50 kW. Unless specified otherwise, for pumps with max. shaft power input of below 10 kW, the tolerance factors given in section 4.4.2 of AS ISO 9906 may apply.

Apart from the guaranteed specified duty point(s), pump performance tests must be undertaken for a minimum of 3 duty points each side of the Best Efficiency Point (BEP), including the shut-off head and the maximum flow / minimum head point.

M13.3.2 Conditions of pumping

Prior to selecting the pumps, the designer must obtain the following pump performance curves which must be superimposed over the system curves:

- Pump output (Q/H) curve
- Pump efficiency (Q/η) curve
- Pump net positive suction head required (Q/NPSHr) curve
- Pump power (Q/P) curve.

The performance curves must cover the pump operating range from zero discharge to discharge past the minimum head. Where two or more units are required to operate in parallel, the designer must consider output (Q/H) curves for various pump combinations in parallel operation.

Whether alone or in parallel, each unit must be able to operate over the whole range of heads and flows.

The pumps must have stable and cavitation free operating characteristics over the pumping range. The pumps must be stable in operation at all heads and, in case of two or more units in parallel, under all conditions of parallel operation within the full range from the maximum head to the minimum head. Unless specified otherwise, pump shut off head must be minimum 10% (preferably 20%) above the head where its Q/H curve intersects the maximum head system curve.

Subject to the above conditions, the pump design must comply with the following:

1. The continuous rated output of the motor coupled to the pump must be at least 15% in excess of the maximum power required by the pump at 110% of the nominated duty flow rate in single operation and be non-overloading at minimum head conditions.
2. The efficiency curve must be reasonably flat over the operating range for normal conditions, with maximum efficiency developed when pumping at average head conditions.
3. The pump required net positive suction head (NPSHr) must be at least 2.0 m lower than the available net positive suction head (NPSHa) over the entire pump operating range. The available net positive suction head must be calculated for the worst possible combination of fluid temperature, vapour pressure, flow rate and intake conditions.
4. Under average flow and head conditions the pump must operate within its Preferred Operating Region (POR). Under all other operating conditions, the pump must not operate outside its Allowable Operating Region (AOR). The POR and AOR must be as specified by the pump manufacturer or, where unspecified, in accordance with ANSI/HI 9.6.3.

Variable speed pumps must be able to meet the specified duty flow and head at no more than 95% of their nominal speed. The motor must not be overloaded should it be required to operate at maximum speed.

Fixed speed pumps must be able to accommodate at least one size larger impeller than required for the specified duty flow and head. The motor must not be overloaded should the pump be fitted with the larger impeller.

One of the factors which must be used in selecting the most suitable pumping units is economy of operation. To allow a comparison of the annual operating costs of the pumping unit, prior to ordering the pumps the supplier must supply guaranteed figures for kilowatt hours per 1000 litres for the specified duty points.

M13.3.3 Nameplates

All pumps must be fitted with engraved stainless steel nameplates fastened to the pump body. For submersible pumps an identical nameplate must be provided at the top of pump sump or wet well.

Nameplate information must include as a minimum the manufacturer's name, address (or agent's address), model number, serial number, capacity, head, impeller diameter, motor power rating, equipment identification number, contract number, fully assembled pump weight and date of manufacture.

The nameplates must be permanently attached using stainless steel fixings and be clearly visible after installation.

M13.4 Horizontal centrifugal pumps

M13.4.1 General

The horizontal centrifugal pumps must be of either of the following types, as specified:

- Double suction horizontal split casing
- End suction back pull-out
- Multiple stage horizontal split casing or ring section.

Where required due to space or other constraints and if approved by Sydney Water, the pumps may be installed vertically.

M13.4.2 Construction of pumps

M13.4.2.1 General

The pumps must be supplied complete with a drive motor, flexible coupling, coupling guard and other ancillary equipment, all mounted on a rigid, heavy duty baseplate.

The single and multiple stage horizontal split casing pumps must be so designed that the top half of their casing can be dismantled and the shaft, impeller, bearings and mechanical seals easily removed without disturbing the suction and discharge pipe connections or moving the motor.

The multiple stage ring section pumps must be made up of the required number of individual stages, each comprising an impeller, guide port and chamber. The stages must be securely held together.

The end suction back pull-out pumps must be designed and constructed to meet or exceed the requirements of ISO 2858. Their complete rotating element / shaft assembly, including the shaft, impeller,

bearings and mechanical seals, must be capable of being removed from the back of the pump without disturbing the suction and discharge pipe connections.

M13.4.2.2 Casing

The casing must be designed as a double or single suction smooth profiled single or double volute, fitted with replaceable wear rings. The direction of rotation must be clearly marked on the casing.

The pump casing must be provided with substantial footings for bolting to the baseplate and lifting lugs or eye bolts for lifting purposes. The pump mounting footings must be machined parallel to the pump centreline. The lugs / eye bolts must comply with the relevant standards and SafeWork NSW requirements.

For horizontal split casing pumps, the lifting lugs or eye bolts must also allow the removal of the upper half of the casing and its inverting during maintenance.

Unless stated otherwise, the suction and discharge branches of the double suction and multiple stage pumps must be provided on opposite sides of the pump casing, with vertical flange faces. The casing must be able to accommodate larger impeller sizes for possible future upgrades.

Castings must be made in accordance with the best foundry practice and must be free from all defects. No holes or blemish must be filled with any substance, whatsoever, without acceptance by Sydney Water. The backs of all flanges must be machined, or spot faced to provide a satisfactory bearing for bolt heads and nuts.

Wear rings must be constructed so that they can be easily replaced when necessary. The method of sealing ring location must prevent skewing and axial movement and must prevent rotation of the ring in the casing.

All pockets in the casing which permit the accumulation of air must be fitted with cocks to allow all air to be released when the pumps are being primed. The cocks must be connected via vent lines to a manifold. The manifold must be fitted with a normally closed cock on one end and a plug on the other. The cock must drain to a tundish attached to the baseplate. The bottom of the tundish must be fitted with a male end threaded 3/4" BSP for connection to a plant drainage system. The plugged end of the manifold must be suitable for connection to a vacuum priming system where necessary.

M13.4.2.3 Impeller

The impeller must be of a modern design, with ample thickness and strength for the duty involved and high efficiency. The fixing of the impeller to the shaft must be by a suitable method to prevent it becoming loose or falling off the shaft under any possible operating conditions, including reversed rotation. The impellers must be fitted with replacement inlet wear rings.

M13.4.2.4 Shaft

The pump shaft must be of a robust construction to withstand maximum stresses, vibrations and whirling under all operating conditions. The shaft must be fully shrouded with sleeves throughout the pumped liquid way and seal spaces and must be stepped at each sleeve and impeller. The shaft assembly must be such as to preclude entry of water to the bearing housing and permit axial adjustment of the impeller.

The shaft and impeller must be dynamically balanced as an integral assembly. The rotating assembly should be designed so that its critical speeds are well beyond the speeds encountered during normal operation and pump starting and stopping in order to avoid excessive vibrations and material fatigue. This must also include soft starting and variable speed operation speeds. The first lateral critical speed of the

rotating element must be at least 150% higher than the maximum operating speed of the pump. The first lateral critical speed must be calculated for the maximum diameter impeller able to be fitted to the pump, without any support from wear rings.

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

M13.4.2.5 Shaft seals

(a) General

The pumps must be fitted with mechanical seals. The seals must be of an accepted design effective for their purpose and requiring a minimum of maintenance.

The seals must be of the balanced types, cartridge mounted, incorporating bellows or multiple helical springs of Hastelloy® C or chloride corrosion resistant grade stainless steel and high nitrile synthetic rubber or ethylene propylene static "O" rings. Seal faces must be lapped flat to within two helium light bands and the depth of interface roughness must not exceed 0.3 microns. The pump and seal design must be such that interface temperatures under operating conditions remain safely below the vaporisation temperature.

The seals must be fitted with transparent splash guards to protect other equipment in case of their sudden failure.

An effective seal flushing piping system must be fitted. It must provide adequate flow directly to the seal faces for cooling and for flushing of minor impurities while limiting flow to avoid erosion of the seal faces or any malfunction of the seal. The seal piping system must be made of grade 316 stainless steel tubing and must be piped from the side of the volute or a suitable point which will minimise entrainment of small solids.

(b) Supplementary Defects Liability Period

In addition, the defects liability period provided for the pumping unit, pump mechanical seals must carry a warranty guarantee of 8000 running hours.

M13.4.2.6 Coupling

The coupling must be an approved flexible type, with cone rings or flexible elements, rated to suit the maximum torque output under all load conditions.

The end suction back pull-out pumps must be fitted with spacer shaft coupling to facilitate the removal of the complete rotating element (i.e. shaft, impeller, seals and bearings) without the need to dismantle the motor or disturb the suction and discharge pipe connections.

In order to allow the removal of pump bearings and mechanical seals without the need to remove the pump top casing or motor, the coupling for larger double suction and multiple stage pumps must also be of a spacer type.

M13.4.2.7 Guards

All couplings and exposed moving parts must be adequately covered by sturdy, solid plate fixed guards acceptable to the SafeWork NSW, and meeting the requirements of the relevant part of AS 4024.

M13.4.2.8 Bearings

The bearings throughout the pumping unit must be of modern design, of ball and/or roller type and ample capacity for carrying all thrust and radial loads. All bearings must be lubricated efficiently and capable of long service without maintenance.

Larger pumps bearing housings must be either split or easily removable from the rotating element for ease of service. The bearings and mechanical seals must be removable from each shaft end by sliding out, i.e. without the need to dismantle the pump casing or motor. For that purpose, a spacer type drive coupling must be installed on the motor side and the pump shaft assembly may need special supporting arrangement.

M13.4.2.9 Baseplate

The pump, motor, coupling and coupling guard and all other ancillary equipment must be mounted on a rigid baseplate, made of cast iron or fabricated from mild steel and hot dipped galvanised or painted. The baseplate must be substantial, suitable for installation on a concrete plinth and must ensure the pump and motor are correctly aligned.

The baseplate must be fitted with a minimum of three levelling screws to allow for a minimum 20 mm height adjustment and levelling.

The baseplate must be fitted with horizontal jacking screws at the motor mounting feet locations to allow the motor to be jacked horizontally during alignment.

The mounting surfaces for the pump and motor must be machined so that the pump mounting locations are in a common plane and the motor mounting locations are in a parallel plane to the pump mounting locations. The relative dimension of the two planes must provide adequate shimming allowance to achieve final alignment of pump and motor after allowing for manufacturers' tolerances of centreline heights.

Separate pump and motor baseplates may be considered for large pumping units.

All holding down bolts must be of stainless steel and must be supplied by the Contractor. Holes drilled for holding down (anchor) bolts must not be obstructed by the equipment on the baseplate or stool.

M13.4.2.10 Bolts, studs and nuts

All bolts, nuts, studs and chemical anchors must be made of stainless steel grade 316. They must be of such size and spacing as is required to provide for the design forces with a safety factor of five and must be suitably insulated from connecting steelwork to prevent galvanic corrosion. The threads of all stainless steel fasteners must be thoroughly coated with anti-seize lubricant prior to assembly.

M13.4.2.11 Materials of manufacture

The quality of materials used in the construction of the pump must be in accordance with the table below. Material with equal or better properties for the intended application can be used in lieu of the listed materials.

Component	Material	Australian standard
Baseplate	Steel	AS 3679.1 Gr 300 AS 3679.2 Gr 300 AS 3678 Gr 300
	Cast iron	AS 1830 Gr T-250
Casing	Cast iron	AS 1830 Gr T-250
	Ductile iron	AS 1831
Casing wear rings	Stainless steel	AS 2074 Gr H3C
	Tin bronze	AS 1565 Gr C91700
Impeller	Stainless steel	ASTM A276M Gr 316
Impeller wear rings	Phosphor bronze	AS 1565 Gr C90250
	Stainless steel	AS 2074 Gr H3B
Shaft	Stainless steel	ASTM A276M Gr 431
Shaft sleeves	Phosphor bronze	AS 1565 Gr C90250
Mechanical seals: - rotating face - stationary face - seal plate and cartridge	 Tungsten or silicon carbide Tungsten or silicon carbide Stainless steel	-
Bearing housings	Cast iron	AS 1830 Gr T-250
	Ductile iron	AS 1831
Bolts, studs and washers	Stainless steel	ASTM A276M Gr 316
Nuts	Stainless steel	ASTM A276M Gr 316
Guard	Steel	AS 3679.1 Gr 300 AS 3679.2 Gr 300 AS 3678 Gr 300

The difference in hardness between casing and impeller wear rings must be not less than 50 HBW.

All other materials used in the construction of the pumping unit must be the best of their respective classes and made to appropriate Australian Standards. Where international materials standards are specified, equivalent Australian Standards must also be stated. Any difference between the international and similar Australian standards must be clearly described.

M13.4.3 Specific requirements for chopper pumps

Chopper pump must be equipped with a cutting system to facilitate cutting and passing fibrous and stringed solids present in sewage and sludge, which prevents clogging of the pump and its discharge piping.

Chopper pump must comply with the requirements of this Specification for end suction back pull-out centrifugal pumps with the following exceptions:

1. The pump must be fitted with:
   - adjustable back pull-out casing with facility for external adjustment of the clearances between the impeller and the front and rear cutters,
   - semi-open impeller with cupped and sharpened vanes and auxiliary rear pump out vanes with cutter faces,
   - stationary cutter bar at the pump inlet,
   - cutter impeller locknut that prevents solids accumulation at the pump inlet,
   - rear cutter to shred stray solids trapped in the mechanical seal area, and
   - disintegrator vane in front of the pump inlet to break down large solids (optional).
2. The pump lifting lugs and footings may be provided either on the pump casing or on a sturdy bearing housing.
3. The mechanical seal must be of a cartridge type with Viton® or equivalent O-rings and silicon carbide faces, designed to require no flushing system.
4. Mechanical seal springs must be shielded from the pumped fluid.
5. Impeller and casing replacement wear rings are not required.
6. The pumping unit must either be fitted with a spacer shaft coupling or have a provision for backing off the drive motor to facilitate the removal of the back plate and complete rotating element. The pump and motor shafts must remain aligned when coupled back together.
7. The following pump alternative materials are acceptable:
   - Impeller — Cast steel to minimum Rockwell C60 hardness
   - Shaft — Low alloy steel to AS 1444 / ASTM A434, Grade 4140 HR HT
   - Shaft sleeves — Stainless steel ASTM A564 17-4 PH, H-900
   - Cutter bar — Alloy or cast alloy steel to minimum Rockwell C60 hardness
   - Mechanical seal splash guard — Non-transparent (e.g. stainless steel to ASTM A276M Gr 316)

M13.5 Submersible centrifugal pumps

Submersible pumps must comply with the technical requirements set out in WSAA Industry Standard for Submersible Pumps for Sewage Pumping Stations WSA 101 and Sydney Water's Supplement to WSA 101 (D0000677).

Submersible pumps must consist of a single stage centrifugal pump driven by an electric motor via a common rotor/impeller shaft, forming a compact, robust and completely watertight vertical pumping unit. They must be suitable for either wet or dry well installation.

The pumps must be capable of handling unscreened and unsettled domestic sewage, occasionally containing plastic sheeting, disposable clothing, plastic backed sanitary napkins and similar solid and fibrous material.

The electric motors must comply with the requirements of Technical Specification – Electrical (CPDMS0022).

M13.5.1 Wet well installation

In wet well type installation, the submersible pumps may operate in part or totally submerged position in raw sewage, effluent or clean water. The motors must be cooled by the pumped liquid so that no external cooling is required

The wet well installed pumping units must be supplied with a discharge connection (also known as “duckfoot” bend, discharge pedestal, discharge bend, etc.), a lifting chain, double guide rails and guide rail brackets. The lifting chain and guide rails must be of a suitable length to reach the access opening at the top of the wet well or sump.

The complete pumping unit must be readily removed from the wet well / sump by means of a simple lifting device, without the necessity of either de-watering the wet well or disturbing the permanent connection to the discharge pipework, and without the need to descend into the wet well. No portion of the pump must be permanently fixed to the base of the wet well.

The wet well units must be supported off the discharge bends which must be of a rigid design to take the complete pumping unit load and provide sufficient sealing. Each submersible pump must be checked for the operation against a closed discharge (shut-off head) to prove the effectiveness of the seal between the pump and the discharge bend. Wherever possible the pump units and the discharge bends must be interchangeable.

The pump must have suitable stainless steel dual guide rails and lifting chain for withdrawal from and lowering into the pump location. When lowered down the guide rails the pump must automatically connect to the discharge bend. The guide rail arrangement must permit easy lifting of the submersible pumps in the vertical axis.

The stainless steel lifting chain must be of sufficient length to reach from the pump to the operating platform (ground) level. All holding down bolts must be of grade 316 stainless steel. Where davit type lifting facilities are specified, the pump must be fitted with wire rope and winch.

Electrical cables for each pump must be suitably protected and supplied in place so as to prevent any damages.

Unless specified otherwise, at least one of the submersible pumps must be fitted with a hydraulically operated automatic flush valve for flushing of the wet well or sump. The other pumps must have provision for the installation of a flush valve. The valve must open at each pump start for approximately thirty seconds to stir up the sludge settled in the wet well. Preferably, the valve opening / closing operation must be induced by the pump flow and pressure, thus eliminating the need for electrical components and cable.

M13.5.2 Dry well installation

In dry well type installation, the submersible pumps may be installed either vertically or horizontally. The motors must be either air cooled or provided with a cooling jacket or similar with continuous circulation of a portion of the pumped liquid or coolant.

The dry well pumping units must be supplied with a stand, stool or baseplate and a suction bend where installed vertically. The suction bend must have an inspection hole of minimum Ø 150 mm for removal of chokes from the pump suction. The baseplate must be of a short profile, robust design suitable for installation onto a massive concrete plinth. Tall fabricated pump supporting frames must not be used as they may exacerbate pump vibrations.

In vertical installation, the stand, stool or baseplate must be designed to suit the pump suction arrangement. Access to the pump suction/suction bend flanged connection must be provided from the pump side so that no work below the stool/baseplate is needed when installing or removing the unit.

M13.6 Vertical centrifugal, mixed flow and axial flow pumps

M13.6.1 General

Each pump must be of a centrifugal, mixed flow or axial flow type, fitted with a vertical shaft and rotating impeller or impellers (multistage pumps), with discharge from the pumping element coaxial with the shaft. The pumping element must be suspended by the conductor system which encloses the shaft used to transmit power to the impeller(s). The motor must be external to the flow stream.

The pumping units must be complete with the baseplate or stool, drive motor, flexible coupling, coupling guards, and other ancillary equipment as appropriate and/or specified.

M13.6.2 Discharge head assembly

The pump must be provided with a discharge head of the surface (above floor level) type.

The discharge head must be of ample strength to withstand the weight of the drive motor and pump and all other possible stresses to which it may be subjected under all conditions of service. For larger units the drive motor may be supported independently off a fabricated, skirt shaped support, or a separate building slab.

The discharge head must be provided with substantial footings for bolting to the base plate or stool and lifting lugs or eye bolts for lifting purposes.

All pockets in the discharge head which permit the accumulation of air must be connected via air vent lines to manifold(s) which will terminate in an automatic air release valve.

M13.6.3 Pump column

M13.6.3.1 Pump bowl assembly

The pump bowl assembly must be either a single or multi-stage centrifugal, mixed flow or axial flow vertical pump with discharge coaxial with the shaft. The assembly must be made up of the required number of individual stages, each comprising an impeller, guide-port and chamber. The stages must be spigotted and securely held together.

The bowl casings must be free of blowholes, sand holes and other detrimental effects. The design of the pump bowl and accessories must be such that external priming of the pumps is not necessary.

Where appropriate, the bowls must be equipped with replaceable seal rings on the suction side of the enclosed impellers.

For oil lubricated pump columns, the discharge case must have bypass parts to allow water to escape through the seal or bushing and must have a means of minimising the leakage of water into the shaft enclosing tube.

M13.6.3.2 Impeller

The impeller(s) must be of a modern design with high efficiency and ample thickness and strength, and statically balanced for the duty involved. The secure fixing of the impellers to the shaft must prevent them from becoming loose or falling off the shaft under any possible operating conditions including reversed rotation.

The impeller must be vertically adjustable by either a nut in the driver or an adjustable coupling between the pump and the driver.

M13.6.3.3 Bowl assembly shaft

The bowl assembly shaft must be supported by bearings above and below each impeller. The maximum combined shear stress must be no more than 18% of the ultimate tensile strength nor more than 30% of the elastic limit in tension of the shafting steel used.

M13.6.3.4 Line shafts

The line shafts must be manufactured in interchangeable sections having a nominal length not exceeding 3 metres. The shafts must be coupled with steel couplings and to ensure accurate alignment of the shaft they must be straight within 0.13 mm total indicator reading for a 3 m section.

Line shafts in water lubricated pump columns must be provided with a non-corrosive wearing surface at the location of each guide bearing.

M13.6.3.5 Shaft couplings

The coupling of the line shaft must be with steel couplings where the maximum combined shear stress must be no more than 12% of the ultimate tensile strength nor more than 20% greater than the elastic limit in tension of the shafting steel used.

M13.6.3.6 Line shaft bearings

For oil lubricated pump columns, the bearings which are integral tube couplings must readily allow oil to flow through to lubricate the bearings below via one or more oil grooves. They must be spaced not more than 1.5 m apart.

For water lubricated pump columns the bearings must be lubricated by the liquid pumped and must be designed for vertical turbine pump service. The bearings must be not more than 1.5 m apart and must be mounted in bearing retainers held in position in the column couplings by the butted ends of the column pipes.

M13.6.3.7 Shaft enclosing tube

The shaft-enclosing tube (oil lubricated pump column only) must be manufactured in sections not more than 1.5 m in length. The ends of the enclosing tube must be square with the axis and must butt to ensure accurate alignment. The enclosing tube must be stabilised in the column by stabilisers.

M13.6.3.8 Discharge column pipe

The friction loss of the pipe must not exceed 50 mm per metre based on the rated capacity of the pump. The pipe must be manufactured in interchangeable sections not more than 2 m nominal length and must be connected by threaded sleeve-type couplings or flanges.

Each section of pipe must have their ends faced parallel and machined with threads to allow appropriate butting.

M13.6.4 Suction pipe and strainer

The pump must be supplied with a suction bell-mouth and/or a strainer. If a strainer is supplied, its inlet area must be equal to at least three times the suction pipe area. The maximum opening must not be more than 75 per cent of the minimum opening of the water passage through the bowl or impeller.

M13.6.5 Lubrication

For oil lubricated pump column, a lubrication system consisting of a manually operated sight-feed drip lubricator and an oil reservoir constructed as an integral part of the head or as a separate auxiliary unit, must be located at the surface or below-base discharge head. Provision must be made for sealing off the thread at the tube tension nut installed in the head to allow tension to be placed on the shaft-enclosing tube.

For water lubricated column pipe, a discharge head of the surface or underground type must be provided as required with a renewable bronze bushing and a shaft packing box. The line-shaft bearings must be adequately wet down before starting the pumps by a relubricating connection in the head. It is required that provisions are made by the manufacturer to adequately pre-lubricate line-shaft bearings on installations with a setting of more than 15 m. The pre-lubrication system must operate automatically before the pump is started.

On installations with a setting of 15 m or more, a non-reverse mechanism in the motor must be provided to protect the motor and the line shaft from reverse rotation when the power is interrupted and the water empties from the discharge column.

M13.6.6 Materials of manufacture

The quality of materials used in the construction of the pump must be in accordance with the table below. Material with equal or better properties for the intended application will be considered in lieu of the listed materials.

Note: OL - Oil Lubricated Pump Column

WL - Water Lubricated Pump Column

Component	Material	Australian standard
Discharge head & base plate	Cast iron Steel	AS 1830-T220 AS 3679 Pt 1 or Pt 2 Gr 300 AS 1163 Gr C350L0 AS 3678 Gr 300
Top shaft	Steel Stainless steel	OL AS1443-K1050 WL ASTM A276M Gr 431

Component	Material	Australian standard
Line shaft	Steel Stainless steel	OL AS 1443-K1050 WL ASTM A276M Gr 431
Line shaft coupling	Steel	AS 2506-X9931/EN25
Column pipe	Steel	API.5L Gr. B
Bowl assembly shaft	Stainless steel	ASTM A276M Gr 431
Bowls	Cast iron Stainless steel	AS 1830-T220 ASTM A276M Gr 316
Impellers	Stainless steel Bronze	ASTM A276M Gr 316 AS 1565-C83600
Strainer	Stainless steel	APT.5L Gr. B
Shaft enclosing tube	Stainless steel	APT.5L Gr. B
Discharge case / tees	Cast iron	AS 1830-T220
Open line shaft bearing	Rubber (nitrile)	Duro 75
Other bearings	Rubber (nitrile) Bronze	WL Duro 75 OL AS 1565-C83600
Stuffing box - Gland and stuffing box	Cast iron Bronze	AS 1830-T220 AS 1565-C83600
Stuffing box - lubrication fittings	Steel or Cooper	
Stuffing box - studs, nuts, cap screws	Stainless steel	ASTM A276M Gr 316
Packing	Graphite impregnated	
Gaskets (seals)	Rubber	

All other materials used in the construction of the pumping unit must be of the best of their respective classes and made to appropriate Australian Standards. Where international materials standards are specified, equivalent Australian Standards must also be stated. Any difference between the international and similar Australian standards must be clearly described.

M13.7 Progressive cavity pumps

M13.7.1 General

Progressive cavity pumps must be of a single pitch helical rotor and double pitch elastomeric stator. Progressive cavity pumps must be heavy duty industrial low speed units with proven performance. They must be designed for a long, maintenance-free life. The manufacturer must provide a guaranteed life for the critical pump components - rotor, stator, flexible drive shaft or universal joint and mechanical seal. The guaranteed life must be no less than 8,000 operating hours.

The pumps must be self-priming and provide positive displacement, low shear effects and a flow proportional to the pump speed. They must have low NPSH characteristics and positive non-turbulent flow over the full range of operating conditions.

Unless specified otherwise, the pumps must be suitable for pumping macerated domestic raw sewage which may contain some grit. The materials selected must provide good abrasion resistance.

The progressive cavity pumps must have a rotor operating speed that does not exceed 70% of the manufacturer's rated maximum speed for clean water.

The pumps must be capable of withstanding pressure in the pump casing of not less that the discharge pipework hydrostatic test pressure or 160 m, whichever is the highest.

M13.7.2 Assembly

Each pump must be supplied mounted on a baseplate complete with gear drive unit, electric motor and guard. The baseplate must be fitted with lifting lugs to facilitate handling. The pump assembly must be designed for quick and easy pump dismantling and servicing.

M13.7.3 Casing

The pump body must be cradle mounted such that the suction chamber can be rotated to allow the suction port to accommodate any piping configuration. Two inspection ports must be incorporated 180 degree apart in the suction housing to provide access to internal parts. A DN25 drain plug must be provided on the bottom of the suction chamber to allow the fitting of a drain valve.

M13.7.4 Rotor

The pump rotor must be a helix constructed, machined and polished, made of abrasion resistant material.

M13.7.5 Stator

Rotor must revolve in a helix elastomeric stator consisting of nitrile rubber (e.g. Buna-N or equivalent) chemically bonded to a steel or cast iron tube. Different materials may be used, subject to Sydney Water's acceptance, if considered more suited to the product being pumped.

M13.7.6 Drive shaft

The pumps must be fitted with either a flexible shaft or universal joint drive to the rotor, as specified. The flexible shaft or universal joint must be designed for infinite life under the stated operating conditions and must be suitable for fixed and variable speed operation.

The flexible shaft must be of one-piece construction with generous fillets for fatigue resistance. The shaft may be fixed to the rotor and drive with flanged or tapered joints and locking bolts.

The universal joints must be provided with rubber boots and holding bands to protect them from penetration of the pumped liquid under all operating conditions, including maximum pressure and full vacuum. The joints and coupling rod must be wear resistant and streamlined to reduce turbulence.

All metal to metal joints must permit easy dismantling.

M13.7.7 Seals

The pumps must be fitted with a mechanical seal. The gland packed stuffing box type must not be accepted. The seal must prevent liquid from contaminating the joints, and the shields must prevent foreign objects from damaging the seal. The seals must be of a type which has been proven in service and is readily available. The seals must be capable of achieving the life stated above without the need for flushing water. The seal design must be such that interface running temperatures under operating conditions remain safely below the vaporisation temperature of the material being pumped.

M13.7.8 Bearings

All ball and roller bearings must be rated in accordance with AS 2729.

M13.7.9 Pump protection devices

The pumps 0.75kW and above must be fitted with devices that protect them against dry running conditions, excessive pressure on discharge side and excessive vacuum on suction side. All protection devices must be connected to IICATS or SCADA control system, as appropriate. If installed in pits or similar below or above ground structures which may become flooded, such structures must have level controls to stop and de-energize the pumps in case of flood.

Pumps below 0.75kW must be fitted with at least one of these protection devices and a low flow alarm derived from the signal of the flowmeter monitoring flow into or out of the pump. The flow alarm can be in the form of a current relay alarm or embedded in the analog instrument as a feature of the flowmeter. If there is a flow switch already in the line, e.g. a variable area flow meter with a float detection switch, then this instrument will provide the necessary conformance for the protection requirements of this clause. The low flow protection instrument’s signal must be wired to the pump controls direct in a fail-safe configuration (normally open terminals to be used) as well as to the SCADA for status reporting.

M13.7.9.1 Dry-run protection device

The dry run protection device must be connected to stator and must measure temperature continuously. Once the set-point temperature is reached, dry-run protection device must activate the alarm signal in IICATS / SCADA. The dry-run protection device must also be set to switch the pump off immediately.

M13.7.9.2 High pressure protection device

A diaphragm pressure switch must be connected at pump discharge to monitor the pressure. At high pressure, diaphragm switch must activate the alarm in IICATS / SCADA and switch the pump off.

M13.7.9.3 High vacuum protection device

A vacuum switch must be connected at pump suction and must activate alarm in IICATS / SCADA in low vacuum situation and switch the pump off.

M13.7.10 Pressure relief valve

All positive displacement pumps must be provided with a pressure relief valve installed on the pump discharge. Use of a pressure relief valve integrated with the pump in lieu of a separate relief valve must be approved by Sydney Water. The valve must be sized to suit the maximum flow rate and pump discharge

characteristic such that it can handle the full flow from the pump without overloading the motor. The relief valve must be of a type suitable for the material being pumped, e.g. raw sewage.

M13.7.11 Noise

Pump noise level must not exceed that specified in this Specification. The noise figure must be the total of the noise contributions of the pump, gearbox and motor including an allowance for noise generated by the use of a variable speed drive.

If an acoustic enclosure is required to meet the required occupational or environmental noise levels, this must be provided by the pump supplier. Acoustic enclosures must be designed to provide adequate ventilation and have removable panels for inspection. The acoustic enclosures must be fabricated from galvanised or painted steel sheeting and the insulation enclosed in perforated sheeting. Shafts guards must be separate to any acoustic enclosure

M13.7.12 Materials of manufacture

The pumps must be constructed of materials at least equal in strength, corrosion resistance and wear resistance as appropriate as follows:

Component	Material
Pump casing	Cast iron grade 220 or higher
Rotor	Stainless steel grade 316 with tungsten carbide coating (eg. Duracoat® 3000 or equivalent)
Stator	Steel or cast iron with nitrile rubber (Buna-N or equivalent)
Drive (flexible) shaft	Stainless steel of suitable proven grade
Universal joint rod, pins and bands	Stainless steel of suitable proven grade
Bearing housing	Cast iron grade 220 or higher
Baseplate	Mild steel, hot dip galvanised or painted
Guard	Mild steel, hot dip galvanised or painted
Fasteners	Stainless steel grade 316

M13.7.13 Electric motors

Motor rated power must be at least 15% greater than the pump shaft input power over the whole pump operating range. The motor rating must be sufficient to ensure that the motor will not overload when the pump is discharging through the pressure relief valve at all speeds down to the minimum allowed as specified by the pump supplier.

Motors for the progressive cavity pumps must be capable of a minimum 20 evenly spaced starts per hour.

Positive temperature co-efficient thermistor protection of motors must be provided for all motors 5.5 kW and larger. Motor anti-condensation heaters must be provided for all motors 22 kW and larger.

The motor terminal boxes on the pumps must be oriented to suit the installation layout. Separate terminal boxes must be provided for power cables and thermistors and heaters. Each terminal box for temperature detectors or heaters must be identified and fitted with an external warning label to caution against damage during testing and, in the case of heaters, to caution against contact with live connections.

M13.7.14 Spare parts

The Contractor must provide one set of spare parts for each pump size supplied. The spare parts must include the following as a minimum:

- Stator
- Rotor
- Flexible shaft or universal joint
- Mechanical seal
- Gasket kit.

M13.8 Installation of pumping units

The installation of the pumping units and accessories must be carried out by qualified mechanical engineering tradespeople, strictly in accordance with the information and instructions supplied by the manufacturer and Clause M43 of this Specification. Proper precautions must be taken to prevent any damage or deterioration to items of equipment prior to putting into service. The pumping unit and parts of equipment must be installed free of any undue stresses, strains or vibrations and be accessible for maintenance. Connecting pipework must be independently supported so that their weight is not transferred onto the pump flanges.

The setting out details for the pumping units, equipment and pipework must be shown on drawings. Any additional information, if required, must be obtained from the pump manufacturer.

M14. Flame arresters

Flame arresters must be designed for digester gas service (biogas) and must be self-draining with provision to drain away any water in the gas.

The design of the flame arrester must be such that it provides easy access to clean and/or replace the entire core arrester element without damaging the body, plates or sealing parts.

The core flame arrester element must be manufactured from 316 stainless steel.

Flame arrester housing/body and core element extensible frame must be manufactured using low copper aluminium (Aluminium 356 T6).

M15. Vacuum system

M15.1 General

Vacuum systems must comprise vacuum pumps, vacuum pipework and ancillary equipment. The vacuum pumps must be either of an oil recirculating rotary vane type or a liquid (water) ring type, as specified.

The oil recirculating rotary vane vacuum pumps must be of a modular, rugged design, single stage, air cooled and direct driven. Each pump must be fitted with an oil mist eliminator with min. 99.9% oil removal efficiency, exhaust pressure gauge, anti-suckback valve, exhaust filter, wire mesh inlet screen, vibration isolators, oil level sight glass and oil filter.

The liquid (water) ring type vacuum pumps must be driven with close coupled motors and complete with water break tank with float valve, liquid/air separator, vacuum pressure switch, base plate and all ancillary equipment.

The whole of the manufacture of the vacuum system must be carried out in a workmanlike manner by first class labour and in accordance with best practice.

The vacuum system must be provided as a factory tested system complete with electric starting equipment, controls and instrumentation for automatic and manual operation.

The vacuum pumps must have ample capacity and be of a standard and proven design, robust construction and efficient in operation under all conditions within the specified operating range. The service liquid (oil or water) must be separated from air in the liquid/air separator and reused. The vacuum pumps must be reasonably quiet in operation in order to comply with the noise requirements stated in this Specification.

Where used for pump priming, the vacuum system must draw water into the main pumps prior to those pumps being operated. Each vacuum pump must be connected to one pumping unit and operate in conjunction with that unit. The vacuum system must be fitted with suitable vacuum priming valves, solenoid valves, isolation valves and level switches. The vacuum lines must be interconnected via a manually operated valve.

Where used for vacuum sewerage the vacuum system must comprise of minimum one duty and one standby vacuum pumps, each sized for the design capacity, vacuum/sewage collection tank, solenoid and isolation valves, pressure and level sensors and other ancillary equipment. The design and installation of the vacuum sewerage system must comply with WSAA Vacuum Sewerage Code WSA 06.

For the system to work efficiently it is essential that all pipework, connections, vessels, valves etc. are free of any leaks. The tightness of the vacuum lines must be tested in accordance with relevant Australian and industry standards.

M15.2 Requirements of vacuum system

The vacuum system is required either to ensure that the pump suction pipework and casing are always primed with water and there is no possibility of air being pumped, or that adequate vacuum is maintained in the vacuum/sewage collection tank to enable transportation of sewage from the hydraulically most disadvantageous point to the vacuum pumping station.

The vacuum pumps must operate in a duty-standby arrangement with automatic changeover in the event of failure of the duty pump.

Each vacuum pump would be sized to draw water or sewage into the pipelines at the required flowrate.

The operation of the vacuum pump must be controlled by a vacuum switch positioned on the vacuum receiver or vacuum/sewage collecting tank. The vacuum pump must start when the vacuum reaches the cut-in pressure and stop when the vacuum reaches cut-out pressure.

The pipework from the main pumps to the vacuum receiver must incorporate an air eliminator at least 100 mm above the top of the pipe connections. The vacuum receiver must have a minimum volume of 500 litres. The vacuum/sewage collecting tank must be sized to limit the number of vacuum and main sewage pumps starts below the maximum allowable number specified by their supplier.

The whole system must be resistant to the corrosion associated with water and sewage pumping stations. All surfaces in contact with the potable water must be protected by non-toxic primers and finish coatings suitable for potable water application and in accordance with WSA 201.

The vacuum pumps must be provided assembled on a galvanised or painted steel frame fitted with anti-vibration mounts.

All flanges must be circular and comply with AS 4087 with min. pressure class PN16.

M15.3 Nameplates

All vacuum pumps must be fitted with engraved stainless steel nameplates fastened to the pump discharge head assembly.

Nameplate information must include as a minimum the manufacturer's name, address (or agent's address), model number, serial number, capacity, head, equipment identification number, contract number and date of manufacture.

The nameplates must be permanently attached to the pump (using stainless steel fixings) and be clearly visible after installation.

M15.4 Valves

Each vacuum pump must be fitted with delivery isolation valves and non-return valves on the suction line.

M16. Pipework

M16.1 General

This Specification covers pipework within Sydney Water facilities, such as pumping stations and treatment plants. Refer to Technical Specification – Civil (BMIS0209) for pipe networks.

All pipework and associated fittings must conform to the appropriate Australian Standards, WSAA Codes of Practice, Industry Standards and Product Specifications and, where applicable, Sydney Water's standard specifications.

M16.2 Scope

The term "Pipework" must include, but is not necessarily limited to, the following, as applicable:

a) pipes, valves, fittings, joints and other appurtenances

b) compliance to the required regulatory approvals, notification, etc

c) trench excavation

d) supply and compaction of embedment material

e) laying of pipelines

f) inspection prior to backfilling

g) backfilling and compaction of trenches

h) restoration of surfaces

i) testing and commissioning of all pipelines

j) defects rectification

k) cleaning and disinfection of potable water pipelines

l) corrosion protection systems

m) insulation

n) connections to proposed mechanical equipment, including flexible connections, dismantling joints etc

o) connections to existing and proposed structures

p) pipe supports, anchorage and/or thrust blocks

q) provisions for expansion, contraction and vibration

r) temporary diversion pipework required to construct the works

s) pipe systems to penetrate structural elements

t) labelling of pipework and valves

u) backflow prevention devices, as required by Australian Standards.

M16.3 Pipework design

All metallic piping systems, including pipes, fittings, lining, coating, joints and seals, except water mains and pipework covered by WSA 03, must be designed for a minimum 100 year design life. Plastic piping systems must have a design life of minimum 50 years.

Sufficient connections, flanges, dismantling joints, flange adapters or flexible couplings must be provided, to enable valve or equipment removal for replacement and maintenance and for servicing and maintenance of the pipeline itself.

Pipework subject to blockages must be fitted with adequate facilities such as access holes or hand holes fitted with blank flanges or flanged pipe bends, which can be easily removed for cleaning. Additionally, pipework used for applications including grit, digested sludge and thickened sludge must utilise long radius bends (≥ 1.5 x DN). 90^{O} elbows must not be used.

The high points of all pipe routes must have provision for venting entrapped air. Likewise, adequate provisions for complete emptying of the pipework must be incorporated at low points.

Where pipework is exposed or subject to temperature variations, the design must include expansion loops or other Sydney Water's accepted devices to take account of thermal expansion.

Pipework must be arranged in such a way that access to all parts of the plant is not impeded. This means that pipe runs must preferably be along walls or at a height of 2 m or more above floor level, or in pipe trenches and pits in the floor. Where installed at heights less than 2 m above floor level, e.g. in water pumping stations, adequate stairs or ladders and platforms must be provided to provide access over the pipes and to valves and other appurtenances. Other options must be subject to Sydney Water's acceptance.

Pipes must be designed and constructed to withstand all imposed loads including, but not limited to trench/embankment fill, external hydrostatic loads, internal pressure, superimposed dead loads and superimposed live loads (e.g. vehicular traffic). Wherever possible all pipework must be graded to have a constant slope, with no high / low points.

Maximum velocity of biogas in any new main digester pipework and manifolds up to the condensate/main sediment traps must not exceed 3.7 m/s under normal duty flows to minimise the risk of liquid and solid carry-over resulting in damage to instrumentation and equipment. Maximum velocity in biogas pipework offtakes downstream of the condensate/main sediment traps that are connected to waste gas burners, heaters and cogenerators must not exceed 10m/s unless required by the OEM receiving equipment for post biogas compressors.

Pipework carrying chemicals must be designed and installed in accordance with the requirements of clause M37 of this Specification.

M16.4 Pipe material schedule and codes

M16.4.1 General

Pipe materials must be as specified herein. Unless indicated otherwise, fittings materials and class must be the same as the adjacent pipe.

Pipe materials must be selected to suit the process application, design pressure, the fluid and associated properties being conveyed and its location, environment and installation (i.e. above ground, below ground, submerged etc.).

M16.4.2 Pipework schedule for wastewater treatment and water filtration plants

The minimum requirements in regard to pipe materials and grades to be used in wastewater treatment and water filtration plants are given in Tables A and B. Material with equal or better properties for the intended application can be used in lieu of the listed materials.

Table A: Piping system schedule for wastewater treatment and water filtration plants

Pipe service		Pipe material code					
		Exposed			Buried / Embedded / Encased		
		Up to 50 mm	65 mm to 80 mm	100 mm and larger	Up to 50 mm	65 mm to 80 mm	100 mm and larger
AER	Aeration Pipework	A2/B1	B4	B4/C4	A2/B4	B4	B4/C4
AA	Agitation Air	B1	B4	B4/C4	A2	B4	B4/C4
AL	Alum	D10	D10	-	D7/D10	D7/D10	-
AH	Ammonia Hydroxide	D10	D10	-	D7/D10	D7/D10	-
AS	Anti-Scalant	D10	D10	-	D7/D10	D7/D10	-
BC	Biocide	D10	D10	-	D7/D10	D7/D10	-
BD	Backwash Discharge	-	B4/B5/D1	B4/B5/C2	-	B4/B5/D1/ D7	B4/B5/C1/ D1/D7/E1/ E2
BS	Backwash Supply	-	D1	B4/B5/C2	-	B4/B5/D1/ D7	B4/B5/C1/ D1/D7
CIP	Clean in Place Fluid	D1/D10	D1/D10	D1/D10	D1/D7/ D10	D1/D7/ D10	D1/D7/ D10
CA	Compressed Air (700 kPa) (Note 1)	A2/B1/B4/ B8/D7	B3/B4	B4	A2/B4/B8/ D7	B4/D7	B4
CE	Chlorine Ejector Water	A2/D1	A2/D1	B2/D1	A1/D1	A1/D1	C1/D1
CG	Chlorine Gas	B3/D1	-	-	-	-	-
CLS	Chlorine Solution	D1/D10	D1/D10	-	D1/D10	D1/D10	-
CLV	Chlorine Gas under Vacuum	D1	-	-	-	-	-
ACA	Citric Acid (Aqueous)	D10	D10	-	D7/D10	D7/D10	-
DS	Digested Sludge	-	B4	B4/C2	-	B4 /D7	B4/C2/D7
DG	Digester Gas	-	B4	B4	-	B4	B4
DW	Domestic (Potable) Water	A2/B1/D1/ B8	A2/B1/D1	C2/D1	A1/D1/D7	A1/D1/D7	C1/D1/D7

Pipe service		Pipe material code					
		Exposed			Buried / Embedded / Encased		
		Up to 50 mm	65 mm to 80 mm	100 mm and larger	Up to 50 mm	65 mm to 80 mm	100 mm and larger
FC	Ferric/Ferrous Chloride (iron salts)	D10	D10	D10	D7/D10	D7/D10	D7/D10
FLT	Filtrate (U/F Filtrate)	D1	D1	B4/B5/D1	D1/D7	D1/D7	C1/D1/D7
FM	Fire Main	A2/B8	A2/B4/B5	B2/B4/B5/ C2	A1	A1	B4/C1
GR	Grit	-	B4	B4	-	B4	B4
HA	Hydrochloric Acid	D6/D10	-	-	D6/D7/ D10	-	-
IW	Industrial Water	A2/B1/D1/ B8	A2 /B1/D1	C2/D1	A1/D1	A1/D1/D2	C1/D1
MA	Medical Air	A2/B4/B8	-	-	-	-	-
MN	Methanol	B4	B4	-	B4	B4	-
ML	Mixed Liquor	-	B4	B4	-	B4/D1/D7	B4/D1/D7
OSP	Off Spec Permeate	B4/B5/D1	B4/B5/D1	B4/B5/C6/ D1	-	-	-
POL	Polyelectrolyte	D1/D10	D1/D10	-	D1/D7/ D10	D1/D7/ D10	-
PD	Pumped Drainage Return	-	-	C2	-	-	C1/D7
RS	Raw Sludge	-	B4/D10	B4/D10	-	B4/D7/ D10	B4/D7/ D10
RE	Reclaimed Effluent	A2/B4/B8/ D10	A2/B4/B8/ D10	A2/B4/B8/ C2/D10	A1/B4/D7/ D10	A1/B4/D7/ D10	B4/C1/D7/ D10
SE	Secondary Effluent	D10	D10	C2/E1/ D10	D7/D10	D7/D10	C1/E1/D7/ D10
SEW	Sewage	-	D7/D10	C2/D8/ D10	-	D7/D10	C1/D1/D8 /D7/D10
SA	Scour Air	A2/B1/B4	A2/B4	B4	A2	A2/B4	B4
SB	Sodium Bisulphite	D6	D6	-	D7	D7	-
SC	Scum	-	D10	B2/D10	-	D7/D10	C1/D7/ D10
SHC	Sodium Hypochlorite	D10	D10	-	D10	D10	-
SHX	Sodium Hydroxide	B6/D6/ D10	B6/D6/ D10	-	B6/D7/ D10	B6/D7/ D10	-
SN	Subnatant	A2/D10	A2/D10	A2/D10	A1/D7/ D10	A1/D7/ D10	C1/D7/ D10

Pipe service		Pipe material code					
		Exposed			Buried / Embedded / Encased		
		Up to 50 mm	65 mm to 80 mm	100 mm and larger	Up to 50 mm	65 mm to 80 mm	100 mm and larger
SUL	Sulphuric Acid (Notes 2 & 3)	D10/B4/ B7	D10/B4/ B7	-	B4/D10	B4/D10	-
SW	Stormwater	-	D2/D5	D2/D5	-	-	C1/D2/D5 /D7
TE	Tertiary Effluent	-	D1	C2/D1/E1	-	D1	C1/D1/D7 /E1
TS	Thickened Sludge	-	B4	B4		B4/D1/D7	B4/D1/D7
V	Vent (Note 4)	-	-	-	-	-	-
RAS/ WAS	Return Activated Sludge / Waste Activated Sludge	-	B4/D10	B4/D10	-	B4/D1/D7/ D10	B4/D1/D7/ D10

Notes:

1. A2 Copper must not be used for compressed air pipes above 40 mm diameter.
2. B4 (grade 316 stainless steel) and B7 (Carbon Steel) only suitable for Sulphuric Acid of concentration > 98%.
3. PTFE mixing tees are to be used at the location where sulphuric acid is diluted with water.
4. For “Exposed” pipework, vents will generally be of the same material as the pipes that they vent. Special cases may require detailed design when they arise. Vents are not applicable to “Buried/Embedded/Encased” pipework.
5. Also Refer M37 for pipe material to be used for chemicals not listed in Table A.

Table B: Piping material schedule for water and wastewater treatment plants

Code	Pipe
A1	Copper, AS 1432, Type B, annealed tempered.
A2	Copper, AS 1432, Type B, as drawn tempered.
B1	Mild Steel, to AS 1074, medium, galvanised.
B2	Mild Steel, to AS 1579, welded and or flanged. Hot dip galvanised and/or cement lined where indicated.
B3	Mild Steel schedule pipe, to AS 4041. Flanged or welded, hot dip galvanised.
B4	Stainless Steel, grade 316, seam welded, Schedule pipe to suit application (Schedule 10 minimum).
B5	Stainless Steel, grade 316, spiral welded, minimum thickness = 2 mm
B6	Mild Steel schedule 40 welded or flanged for T≤ 45 °C; Stainless steel Grade 304 L or 316 L Schedule 40 for T> 45 °C;
B7	Carbon Steel Schedule pipe, to AS 4041. Flanged or welded, no internal surface treatment.
B8	Stainless Steel tube, grade 316, to AS 4041 or grade 316 stainless steel press fit to PN16 pressure class up to sizes including DN50.

Code	Pipe
C1	Ductile iron, rubber ring joint to AS 2280. Pressure Class Pipe & Fittings (WSA PS 200 and WSA PS 201,) to suit application. External coatings as per Sydney Water EPS500. Internal cement lining type (GP, SR or CaC) to be selected for the application.
C2	Ductile iron flanged to AS 2280. Flange Class Pipe & Fittings (WSA PS 200 and WSA PS 201) to suit application. External coatings as per Sydney Water EPS500. Internal cement lining type (GP, SR or CaC) to be selected for the application.
C3	Not used.
C4	Ductile iron flanged joint to AS 2280. Flange Class Pipe & Fittings (WSA PS 200 and WSA PS 201) to suit application. External coatings as per Sydney Water EPS500. Epoxy lined internally to WSA 201 coating system CER.
D1	UPVC, AS 1477, Class 18.
D2	UPVC rainwater pipe, AS 1273.
D3	Plastic ABS, AS 3518 (existing installations only).
D4	GRP polyester based, AS 2634 & AS 3571, Class to suit application.
D5	UPVC AS 1254, storm water pipes.
D6	PVC-C to ASTM D1784, Class 23447-B
D7	Polyethylene series 1 to AS 4130
D8	UPVC to AS 1260, grade SN10 for DN100 and SN8 for >DN100
D10	PVC-U to ASTM D1785 Schedule 80
E1	Reinforced concrete pipe to AS 4058 or FRC pipe to AS 4139. Rubber ring/Elastomeric joints.
E2	Reinforced concrete pipe to AS 4058 or FRC pipe to AS 4139.
E3	Reinforced concrete pipe to AS 4058 PVC lined.

M16.4.3 Specific requirements for pipework in pumping stations

Only metallic pipes and fittings must be used in water, sewage and recycled water pumping stations, including:

a) Ductile iron

b) Stainless steel

c) Mild steel

d) Copper and bronze (minor pipes and fittings only).

For pump applications in wastewater treatment and water filtration plants, plastic pipes and fittings may be used, provided the contractor can demonstrate that design prevents direct connection of plastic pipework to the pump. This is to avoid any vibration being transmitted to plastic pipework and fittings, which may result in pipework fatigue and failure. The detail design must be subject to Sydney Water's 's acceptance.

Unless accepted otherwise by Sydney Water, minimum design pressure for pumping stations pipework must be PN16.

Ductile iron and stainless steel are the preferred pipework material for water and sewage pumping stations. Subject to Sydney Water's acceptance, mild steel pipework may be used for special fittings and sizes beyond the range covered by other materials.

Ductile iron and mild steel pipework for sewage and water pumping stations must be internally cement mortar lined and externally coated in accordance with WSA 201 system EUH for ductile iron, and WSA 201 system FPE for mild steel.

If partially or occasionally empty, the ductile iron and mild steel pipework for sewage pumping stations must be internally calcium aluminate cement mortar lined.

Alternatively, and subject to Sydney Water's acceptance, the ductile iron pipework for sewage and water pumping stations may be internally lined and externally coated in accordance with WSA 201 system EUH or FBE.

Stainless steel pipes, if used in water and sewage pumping stations, must be factory fabricated and pressure tested. Site welding is not allowed, except for tack welding where field fit is required. Stainless steel must be grade 316 or other grades with Pitting Resistance Equivalent Number (PREN) of 23.1 or greater, factory pickled and passivated in accordance with ASTM A380. Stainless steel pressure pipes must be min. Schedule 40S. If a lower pipe schedule is accepted by Sydney Water, the pipe wall thickness must be adequate for the structural loads and design pressure, but not less than 6 mm. Stainless steel pipes do not require internal or external protective coatings. Stainless steel non-pressure pipes, eg. inlet drop tubes in sewage pumping stations, may be Schedule 10S.

Non-metallic pipes can only be used for vent lines, provided that they are buried, i.e. protected from the elements and vandalism. Exposed vent lines must also be metallic. This, however, doesn't apply to fibreglass vent shafts.

M16.4.4 PVC-M, PVC-O and PVC-U pipes and fittings for pressure applications

Modified (PVC-M), Oriented (PVC-O) and Unplasticised (PVC-U) Polyvinylchloride pipes and fittings for pressure applications must be manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS-209, WSA PS-210 or WSA PS-211, as applicable. Ductile iron fittings, if used with PVC pipes, must comply with WSA PS-212. The minimum pressure class of PVC pipes and fittings must be PN16. Pipe material classification for PVC-O pipes must not be less than 450. All PVC pipe must be joined by elastomeric ring joints or solvent cement welded joints as required.

For PVC-U pipework for chemical systems and for solvent cement joints refer to M37. PVC pipework must be installed in accordance with AS 2032.

M16.4.5 PVC-U pipes and fittings for drains, waste and vents

Unplasticised Polyvinyl Chloride (PVC-U) pipes and fittings for sewerage service must be manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS-230.

Pipework installation must be carried out in accordance with AS 3500 and the manufacturer's specification and requirements. Method of jointing must be rubber ring or solvent cement.

All PVC-U pipework and valves exposed to sunlight and external weather must be externally painted to ACL coating system as specified in WSA 201.

M16.4.6 PVC-C pipes, fittings and valves

All Poly Vinyl Chloride post-chlorinated (PVC-C) pipes, fittings and valves must meet the requirements of Class 23447-B, as defined in ASTM Specification D1784.

As the working temperature increases, pressure rating for pipe, fittings and valves must be reduced in accordance with table below. Maximum working temperature must not exceed 80 °C.

Temperature °C	PN16	PN10
0	16	10
20	16	10
30	16	10
40	14.5	9
50	12	7.5
60	9	5.6
70	6	3.8
80	3	2.0

Pipework jointing and installation must be carried out in accordance with the manufacturer's specification and requirements. Method of jointing for PVC-C pipe must be solvent cement.

All PVC-C pipework must be installed in accordance with AS 2032.

All PVC-C pipework and valves exposed to sunlight and external weather must be externally painted to ACL coating system as specified in WSA 201.

M16.4.7 PVC-U pipes, fittings and valves to ASTM D1785 schedule 80

Where used, PVC-U ASTM D1785 schedule 80 pipe, fittings and valve body material must meet the requirements of ASTM Class 12454-B (PVC Type 1 Grey) as defined in ASTM Specification D1785.

As the working temperature increases, pressure rating for pipe, fittings and valves must be reduced in accordance with manufacturer requirements. Maximum working temperature must not exceed 60 °C.

Method of joining must be solvent cement in accordance with pipe manufacturer’s recommendation to suit the application. Pipework jointing and installation must be carried out in accordance with the manufacturer's specification and requirements.

All PVC-U ASTM D1785 schedule 80 pipework must be installed in accordance with AS 2032.

For PVC-U pipework for chemical systems and for solvent cement joints refer to Clause M37 of this Specification. PVC pipework must be installed in accordance with AS 2032.

All PVC-U pipework exposed to sunlight and external weather must be painted to ACL coating system as specified in WSA 201.

M16.4.8 PE Pipes and fittings for pressure applications

PE pipes and fittings for pressure applications must be high density polyethylene with minimum required strength of 10 MPa (HDPE 100). The pipes and fittings must be manufactured, tested and supplied in

accordance with WSAA Product Specifications WSA PS-207 and WSA PS-208. Fabricated PE fittings for pressure applications must comply with WSA PS-216.

As the working temperature increases, pressure rating for pipes and fittings must be reduced in accordance with table below. Maximum working temperature must not exceed 80 °C.

Temperature °C	PN16
0	16
20	16
30	14.5
40	13
50	11
60	10
80	8

Pipework installation, in particular the requirements for supporting exposed pipe and for penetrating structures, must be carried out in accordance with AS 2033 and the manufacturer's specification and requirements.

The minimum pressure class of PE pipes and fittings must be PN16 and dimensions must be Series 1. PE pipes and fittings must be joined by butt fusion or electro fusion welding in accordance with WSAA Polyethylene Code WSA 01.

M16.4.9 Copper and bronze pipes and fittings

Seamless copper tube must comply with AS 1432 type B.

All soldered, threaded, compression and press fit (crimped) and similar copper and bronze fittings and connectors must comply with AS 3688. Press fit O-rings must be EPDM or FKM for higher temperature services. Threaded, compression and press fit fittings must not be used on sizes larger than DN50. Pipes over DN50 must have brass or gunmetal flanges. All flanges must be silver soldered to the pipes. Compression and press fit joints must not be used near pumps and other machinery where vibrations are present.

Installation, commissioning and testing of cooper pipes and fittings must comply with AS 4809.

Wherever a copper pipe is connected to a steel or cast iron pipe, insulating dielectric unions of an acceptable type must be installed. Wherever copper pipe is supported from hangers, it must be suitably insulated from the hangers.

All above ground copper pipes must be protected against corrosion.

M16.4.10 Steel pipes and fittings

All steel pipes and fittings for water and wastewater applications must be manufactured, tested, supplied and installed in accordance with WSAA Product Specification WSA PS-203 and WSA PS-204 and AS 4041. For compressed air applications carbon steel pressure pipes to AS 4041 must be used.

Pipes and fittings must be cement mortar or calcium aluminate mortar lined internally in accordance with WSA 201 system CML or CAC, as specified. Other internal lining systems are subject to Sydney Water’s

acceptance. The internal ends of cement and calcium aluminate lined pipes <DN750 having “ball and spigot” or “slip-in” joints and not cement lined must have a factory applied thermally sprayed coating system TSZ as specified in WSA 201.

The pipework must be externally coated system EUH, FBE or FPE, as required.

All buried steel pipes and fittings must be provided with an external protective coating of fusion bonded polyethylene in accordance with AS 4321.

Above ground steel pipes and fittings must be externally protected using WSA 201 system PUR-A, EHB-A or Sydney Water’s accepted equivalent.

Where specified, fully welded steel pipelines must be provided with cathodic protection and lagging.

M16.4.11 Stainless steel pipes and fittings

Unless otherwise specified, all stainless steel pipes and fittings must be manufactured from grade 316L or grade 316 stainless steel pipes, complying with ANSI/ASME B36.19M and B16.9, respectively.

Spiral wound stainless steel pipes, if used, must be fabricated from grade 316 stainless steel, manufactured in accordance with the requirements set out in AS 4041 for class 3 piping or other agreed manufacturers standards.

All instrumentation tubing must be manufactured from grade 316 stainless steel seamless tube and fittings suitable for use with compression and press fit (crimped) fittings. Press fit O-rings must be EPDM or FKM for higher temperature services.

Other stainless steel grades with PREN of 23.1 or greater may be used subject to Sydney Water’s acceptance.

All welds between stainless steel components must be in accordance with AS 4041.

All stainless steel welding must be carried out using approved welding techniques and appropriate procedures. Welds must be chemically cleaned, pickled and fully passivated in the factory in accordance with ASTM A380.

All threaded, compression and press fit and similar stainless steel fittings and connectors must comply with AS 3688, must not be used on sizes larger than DN50 and have a minimum pressure class of PN16. Compression and press fit joints must not be used in pumping stations and near pumps and other machinery where vibrations are present.

Braided stainless steel pipes and fittings, if used, must have minimum pressure class PN16 and be of a corrugated metal, double braided type.

M16.4.12 Ductile iron pipes and fittings

All ductile iron pipes and fittings must be manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS-200 and WSA PS-201, AS/NZS 2280 and AS 1646. The pipes and fittings must be internally cement mortar lined in accordance with WSA 201 system CML, calcium aluminate cement mortar lined to system CAC, thermally bonded to system FBE or epoxy coated to system EUH, as required. Flanged pipes and fittings must be Flange Class pipe. Spigot and socket pipes and fittings must be PN35.

Bare ductile iron pipes and fittings cast into concrete must be power-tool cleaned to AS 1627 Class 2. Pipes and fittings with clean and sound factory applied coating do not need additional surface preparation prior to concrete casting.

M16.4.13 ABS piping

ABS piping and fittings must not be used for new installations. Where existing installations require cut ins grade 316 stainless steel stub flanges must be used.

M16.4.14 GRP pipes and fittings

Glass reinforced plastic (GRP) pressure pipes and fittings for water and wastewater applications must be manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS-205 and WSA PS-205S, as applicable.

M16.5 Connections of pipes, valves and fittings

M16.5.1 Expansion joints

Where pipework is exposed to weather conditions or subjected to significant temperature variations, the installation must include expansion loops, joints or other Sydney Water's accepted devices to take account of thermal expansion.

Expansion joints must be installed as recommended by the manufacturer to accommodate movement due to the thermal, but without releasing pipelines pressure forces. Where releasing of pressure forces is unavoidable, the pipework must be adequately anchored. Expansion joints must be made of suitable metallic material. Rubber expansion joints must not be used for this purpose.

M16.5.2 Flanges

M16.5.2.1 General

Flanges must be circular and conform in dimensions and drilling to AS 4087 and minimum pressure class PN16.

Where the sizes and pressure classes are not covered in AS 4087, flanges must conform to AS 4331.1, AS 2129 or a relevant international standard, as agreed with Sydney Water. In the case of exceptions, mating pipe flanges must be drilled to suit the specified drilling of the adjoining valve or equipment.

Flanges on all steel and ductile iron pipes must be fully fixed to the pipes.

Flanges on GRP, PVC and PE pipes may be stub flanges with loose metal backing rings, or full face up to DN100. Unless accepted otherwise by Sydney Water, backing rings must be grade 316 stainless steel. Full face flanges complying with relevant Australian Standards. Flanged GRP and PVC pipework, however, may only be used in water and wastewater treatment plants. They are not permitted in networks.

All flanges must be integral with or positively attached to the pipes and fittings. Grip type flanges and joints, including those with set screws around flange neck that "bite" into the pipe material or similar must not be used. Grip connections are only acceptable for blower discharge pipework.

M16.5.2.2 Stainless steel flanges

The flanges must be slip-on plate flanges to ASTM A240 or ASTM A182. The flanges must be of the required pressure class, drilled in accordance with the relevant standard and welded in accordance with AS 4041, figure 3.24.4.8 (H) Type 6 or 6A.

Where flange joints are used on stainless steel pipes, they may be joined using stainless steel stubs and stainless steel backing rings in accordance with AS 4041, figure 3.24.4.8 (I) Type 7.

M16.5.2.3 Ductile iron flanges

Flanges for ductile iron pipes and fittings must be integrally cast or fabricated and attached to the ductile iron pipe by screwing with mating threads filled with suitable epoxy resin.

Flange contact surfaces must be raised face.

Flange faces are to be coated with an approved soluble lacquer.

M16.5.2.4 Steel flanges

Unless specified otherwise, all steel flanges must be slip-on, welded on both sides as per AS 4041.

M16.5.2.5 Bolts and nuts

All flanges must be assembled square and true prior to bolting.

Bolts must be tightened in a diametrically opposite sequence as per DTC-1145. Each bolt must be initially tightened in sequence to 20 % of required torque, then the sequence repeated to give 50% and finally 100%. The required tightening torques must be determined by the designer taking into consideration factors such as the type and material of the flange gaskets, material of bolts and nuts, surface finish of their threads including lubricants if used, type and material of nut washers, bolt sizes etc.

M16.5.3 Flange gaskets and o-rings

All flange gaskets and O-rings must be manufactured, tested and supplied in accordance with WSA Product Specification WSA PS-312 and WSAA Industry Standard WSA 109.

The gasket type, material and thickness must be suitable for the flange size and pressure class, contact with the fluid being conveyed, the operating conditions and environment.

Pipes and fittings must be in their correct position, alignment and grade before the joints are made and no springing of joints must be permitted.

M16.5.4 Pipe threads

Unless otherwise specified, all pipe threads must conform in dimension and limits of size to AS 1722 taper jointing thread.

All bolt threads must be coated with a nickel based anti-seize compound prior to assembly.

M16.5.5 Dismantling joints

All dismantling joints must be thrust type with flanges for the required pressure class, but not less than PN16, and complying with AS 4087. Where the sizes and/or pressure classes are not covered in AS 4087, dismantling joint flanges must conform to AS 4331.2, AS 2129 or relevant international standards as agreed with Sydney Water.

Non-thrust type dismantling joints, unrestrained couplings, grip type flanges or joints must not be used in pumping stations and valve chambers.

Dismantling joints must be manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS-284 and marked in accordance with this Specification, except that as a minimum the markings must include the manufacturer's name or mark, nominal size and pressure class.

M16.5.6 Flexible rubber couplings

Flexible rubber couplings must have integral duck and rubber flanges. They must have individual solid steel ring reinforcement with a carcass of highest grade woven acceptable synthetic fibre. Couplings must be single arch and must be equipped with galvanised steel split flange retaining rings. Couplings must be selected to match pipeline and/or equipment connections size and meet the operating conditions. They must have filled arches on sludge pipelines.

Flexible rubber couplings installed adjacent to a wafer type or other through bolted type valves or fittings must be equipped with a steel spacer flange to prevent distortion of the rubber coupling flange. Control units, consisting of at least two bolts must be provided where necessary to limit extension of the coupling.

M16.5.7 Mechanical pipe couplings

Unless specified otherwise, mechanical pipe couplings not intended to take thrust must be metallic type recommended by the manufacturer for the intended service.

M16.5.8 Victaulic couplings

Victaulic couplings must be installed so that a minimum of 3 mm gap is left between adjacent pipe ends to allow for expansion. The seals must be selected for the service required. Victaulic couplings on mild steel pipe may be of the rolled grooved type, or Sydney Water's accepted equivalent.

Victaulic couplings must not be used for permanent installations for pumping stations.

M16.5.9 Anti-vibration bellows

Suitable anti-vibration bellows must be used where required to reduce transmission of vibrations from operating machines, e.g. diesel or gas pumps, onto the adjoining pipework. The bellows must be of a thrust-bearing type, made of a suitable grade stainless steel resistant to fatigue due to vibrations and operating conditions. Where installed, the bellows must be fitted with compression lugs for ease of removal and installation. Rubber bellows or flexible rubber couplings must not be used for this purpose.

M16.6 Painting and labelling

All pipework is to be painted or coloured and permanently labelled as outlined below:

a) Labelling is the primary means of identification. Pipework colouring is a secondary means of identification.

b) All pipework must be labelled in accordance with AS 1345. This does not apply to the inner pipe where a double containment piping system is used.

c) All pipework is to be labelled at regular intervals as per AS 1345

d) The direction of flow must be indicated by an arrowhead at the end of the pipeline marker as per AS 1345.

e) Pipework colours used to assist in identifying pipework contents must be as per Tables C and D below. The introduction of the new colour scheme should avoid having two different colour schemes in one location. It is recommended to keep the existing colour scheme unless the entire pipework in that location is repainted/colour banded/replaced. Repainting, colour banding or replacement of existing pipes to suit the new colour scheme must be decided on assessment of risks by the plant operators/manager on a case-by-case basis.

f) The colour identification system can be implemented by either pipework pigmentation during manufacture, painting in accordance with WSA 201 or colour banding at regular intervals as per AS 1345.

g) SS pipework to be colour banded only (i.e. not painted).

h) Chemical pipework - All chemical carrying pipes must be fully coloured/painted. This does not apply to the inner pipe where a double containment piping system is used.

i) All other pipe material must be colour banded.

j) Refer to Sydney Water Technical Specification - Electrical (CPDMS0022) for electrical and communication conduits.

k) Buried PVC and other non-metallic pipes must have metal tape placed in the trench above the pipe to allow for detection.

Table C: Colour scheme for pipework

Pipeline content	Colour AS 2700
Chemicals	
Acids	P11 Magenta (deep purple)
Alkalis	G25 Olive
Oxidising agents including chlorine gas	Y14 Golden yellow
Reducing agents and other hazardous chemicals	R25 Rose pink
Polymer solutions and non-hazardous chemicals	N52 Mid grey
Water	
Potable water	B24 Harbour blue (dark blue)
Recycled water	P23 Lilac (bright purple)
Clean water (raw, backwash, cooling, heating, stormwater, RE, IW)	G21 Jade
Dirty water (sewage, wastewater, centrate, sludge, process drainage, DOOF WWTP FE)	Black
Fire services	R13 Signal red
Oils, flammable and combustible liquids	X53 Golden tan (brown)
Gases	Y44 Sand
Air (compressed, medical, scour)	B25 Aqua (light blue)
Steam	N24 Silver grey

Notes:

1. Refer to list of common pipework contents in Table D below.
2. Clean water is categorised as suitable for skin contact (but not ingestion), Dirty water is categorised as not suitable for skin contact.

Table D: Common pipework contents

Pipeline content *	Content type	Colour AS 2700
Acetic acid (glacial)	Acid	P11 Magenta
Aluminum sulphate	Acid	P11 Magenta
Citric acid	Acid	P11 Magenta
Ferric chloride	Acid	P11 Magenta
Ferric sulphate	Acid	P11 Magenta
Ferrous chloride	Acid	P11 Magenta
Hydrochloric acid	Acid	P11 Magenta
Hydrofluorosilicic acid and sodium silicofluoride (bulk fluoride powder)	Acid	P11 Magenta
Sulphuric acid	Acid	P11 Magenta
Ammonium hydroxide (ammonia solution)	Alkali	G25 Olive
Lime (slurry or hydrated)	Alkali	G25 Olive
Magnesium hydroxide (bulk slurry)	Alkali	G25 Olive
Soda Ash	Alkali	G25 Olive
Sodium hydroxide	Alkali	G25 Olive
Calcium Nitrate	Oxidiser	Y14 Golden yellow
Chlorine (liquified Cl_2 gas)	Oxidising agent	Y14 Golden yellow
Potassium permanganate	Oxidising agent	Y14 Golden yellow
Sodium hypochlorite	Oxidising agent	Y14 Golden yellow
Sodium bisulphite	Reducing agent	R25 Rose pink
Polyacrylamide polymers	Polymer solution	N52 Mid grey
PolyDADMAC polymers	Polymer solution	N52 Mid grey
Salt /Brine	Non-hazardous	N52 Mid grey
Sugar	Non-hazardous	N52 Mid grey
Raw water	Clean water	G21 Jade
Filtered water	Clean water	G21 Jade
Industrial water (IW)	Clean water	G21 Jade
Reclaimed Effluent (RE)	Clean water	G21 Jade
Filter backwash water	Clean water	G21 Jade
Supernatant return (WFPs)	Clean water	G21 Jade
Cooling water	Clean water	G21 Jade

Pipeline content *	Content type	Colour AS 2700
Stormwater	Clean Water	G21 Jade
Sewage	Dirty Water	Black
DOOF WWTP Filtered Effluent (FE)	Dirty Water	Black
Grit	Dirty Water	Black
Raw Sludge	Dirty Water	Black
Digested Sludge	Dirty Water	Black
WFP Sludges	Dirty Water	Black
RAS	Dirty Water	Black
WAS	Dirty Water	Black
Centrate	Dirty Water	Black
Supernatant (WWTPs)	Dirty Water	Black
Process Drainage	Dirty Water	Black
Digester gas	Flammable	X53 Golden tan
Ethanol	Combustible liquid	X53 Golden tan
Methanol	Combustible liquid	X53 Golden tan
Foul Air	Gas	Y44 Sand

Note: * Pipeline contents that are not listed in Table D must comply with the pipe colouring system corresponding to content type in Table C above.

M16.7 In-Line strainers

In-line strainers must be installed upstream of small, high speed (e.g. booster) water pumps and pressure reducing valves for protection from debris and objects accidentally left in the pipework.

Strainers must be ductile iron or grade 316 stainless steel body, double flanged to AS 4087 and min. pressure class PN16. The screen must be grade 316 stainless steel wire mesh or perforated sheet metal with a maximum aperture of 2 mm for sizes up to DN 150 or 3 mm for sizes larger than DN150, with low headloss coefficient.

Strainers for treatment plants can also be made from uPVC.

The strainer must be fitted with a lid or blank flange that can be removed safely by one person to allow screen cleaning. Where the lid / flange weight exceeds 16 kg, a support or lifting device must be provided.

Unless specified otherwise, the strainers must be either of a ‘Wye’ or ‘Tee’ design.

The strainer must be installed above ground or in an underground pit with adequate clearance to remove the lid / flange and the screen. A sump must be provided to allow drainage of the strainer to a suitable discharge point. All ‘Tee’ strainers must have the drain connection fitted with a manual ball valve and piping directed towards the sump.

M16.8 Pressure gauges

Pressure gauges must comply with the requirements of AS 1349.

Pressure gauges must be industrial Bourdon tube gauges complete with glycerine filled diaphragm seals for applications where particles may block the Bourdon tube. The gauges must be glycerine filled to dampen any potential pulsations.

The scale of the gauge must be such that the nominal reading is at the middle of the scale.

Gauges must have a nominal diameter of 100 mm and must be fitted with a DN15 BSP threaded shank and an isolating ball valve.

M16.9 Pipes and fittings installation

M16.9.1 General

All pipes must be installed as per relevant Australian Standards and as follows.

Pipes and fittings must be in their correct position, grade and alignment before joints are made as no springing of joints must be allowed. In spigot and socket joints, each spigot must be driven well home into the socket of the preceding pipe, and the spigot must be truly concentric with the socket.

Buried ductile iron pipes must have anti-corrosion protective sleeving in accordance with WSAA Product Specification WSA PS-320 and AS 3680. The need for sleeving for thermally sprayed metallic zinc or zinc-aluminium alloy with polymeric topcoat coating system must be assessed in accordance with Sydney Water's Procedure - Soil Assessment for Installation of Ductile Iron Pipes without Sleeving.

Unprotected steel pipes must have anti-corrosion protective sleeving in accordance with WSAA Product Specification WSA PS-335.

M16.9.2 Pipe supports

Piping must be properly supported on racks or by anchor brackets, saddle or concrete supports. In no case must support spacing exceed that recommended by the pipe manufacturer to adequately support the pipework for the service intended.

Hangers, supports or pipe racks must be provided in each direction and at each change in direction. All hangers, racks, saddles and supports must be of standard manufacture for that purpose.

The support brackets must be manufactured from hot-dip-galvanised or painted structural mild steel or grade 316 stainless steel or of a suitable proprietary item like "Unistrut", which must be hot-dipped galvanised or painted mild steel or grade 316 stainless steel and cut to appropriate length. Exposed ends of "Unistrut" or similar brackets must be fitted with end caps.

All pipes must be attached to the brackets with suitable saddles, which must be either mild steel or grade 316 stainless steel.

Pipe supports in the floor trench drain in the building must be of stainless steel construction.

All pipework with joints not designed to withstand tensile forces tending to separate the joint when the pipeline is subjected to an internal gas or liquid pressure must be fitted with thrust and anchor blocks at all intersections, branches, changes of direction, valves and dead ends.

Unrestrained couplings and joints must not be used within pumping stations, valve chambers, above ground and other similar or accessible locations.

M16.10 Testing and commissioning

All pipework that conveys liquids (water, sewage, recycled water, reclaimed effluent, industrial water and chemicals) must be hydrostatically tested when fully installed as per Sydney Water's Specification – Commissioning, transitioning assets into operation (D0001440). New works in existing sewage systems may use sewage as test media if accepted by Sydney Water. Compressed air or vacuum must not be permitted as test media, except for aeration pipework.

All pressure pipework in pumping stations, including machinery rooms, dry wells and wet wells, with the exception of joints between the submersible pump pedestal and the pipe, must be hydrostatically tested in-situ. Test pressures must be documented in detailed design drawings.

Pipes conveying compressed air must be tested for leaks. The test media must be water. Test procedure must be produced prior to testing and accepted by Sydney Water.

Temporary supports if required to conduct the tests must be removed in full and the site made good after the test. Temporary supports must not be welded to any part of pipe(s) under test.

M16.11 Anchorage of pipework

Pipe anchorages must be provided to absorb static and dynamic thrusts from pipe fittings and valves.

Buried pipe anchorage must, generally, comply with WSAA Water Supply Code of Australia WSA 03 – Sydney Water's Edition, drawing no. WAT-1205. All pipe anchors must be designed to withstand the highest pressures the piping system may be subjected to, including maximum hydrostatic test pressures and water hammer.

All buried pipe joined with rubber ring couplings or other joints incapable of containing tension must incorporate concrete thrust and anchor blocks at all valves, tees, bends, dead ends and where otherwise required to resist movement.

M16.12 Pipework drainage

The pipework must be fitted with a required number of adequately sized manual drains at all low points to enable full emptying of each pipe section within no more than 30 minutes. The drains must be minimum DN25 and each must be fitted with two isolation valves for double isolation. The drains must discharge into the drain system.

Automatic drain valves must be provided at all low points of compressed air lines with an integral strainer or approved equivalent. The discharge must be directed towards the drain.

M16.13 Air valves vents

Manual air vents must be installed at the high points of all pipework containing any pressure, which cannot be vented through service connections or vent cocks furnished with equipment.

Manual air vents must be installed at the high points of all liquid lines. Automatic air valves must be provided at locations subject to frequent air accumulation.

M16.14 Pipework penetrating structures

Pipework penetrating structural elements must be in accordance with relevant standards, must ensure no leakage through the penetration and must make adequate allowances for differential movement.

The Contractor must ensure that pipework penetrating structural elements from soil include flexible pipe joints that allow articulation. As a guide, one flexible pipe joint must be within 300 mm of the structure and the second flexible pipe joint must be within 2 - 3 times the pipe external diameter. The Contractor must fully design the articulated pipe joint system.

Puddle flanges must be provided around metallic pipes that penetrate reinforced concrete walls. The puddle flange must be located centrally in the wall with a continuous reinforcement mat on both sides of the flange between it and the concrete surface.

Plastic pipe penetrations through concrete structures must be sealed with hydrophilic rubber seal Hydrotite® or equivalent. The pipe external surfaces must be roughened and/or coated with sand to form a better bond with concrete.

Where allowance for longitudinal movement, such as thermal expansion is required, any pipe penetrating a concrete structural element must pass through a 316 stainless steel sleeve. The sleeve must be cast into the concrete structural element by means of a puddle flange. No loads must be transferred from the pipe to the sleeve. The annulus between the pipe and the sleeve must be sealed with an approved flexible and watertight product, such as Link-seal® or equivalent.

M16.15 Identification of buried pipework

All non-metallic pipes buried underground must be provided along their complete buried length with a continuous trace wire tape so that they can be identified with a pipe locater. Both ends of the trace wire must be accessible from the surface for that purpose.

M17. Lifting facilities

M17.1 General

Where specified, suitable permanent lifting facilities, such as jib cranes, monorail cranes, gantry cranes or other must be provided. The lifting facilities will be used for the maintenance of mechanical and electrical equipment and may be utilised in the initial installation of equipment and construction of the plant.

The lifting facilities must be designed, manufactured, installed and tested to the best modern practice and in accordance with the relevant Australian Standards, SafeWork NSW and other statutory requirements.

The capacity of the lifting facilities must be at least 20% greater than the heaviest load to be installed within the plant, including the usually pre-assembled items, such as complete pumping units and similar assemblies installed on a common base frame.

Hoisting, lowering, cross travel, longitudinal travel or slew of the crane must be either manually or electrically operated, as specified.

Lifting facilities must be designed to allow the load to be moved and positioned with minimum effort. This should be achieved in one lift, with no need to detach and re-attach and/or temporary support of the load in the process.

Loading bays must be provided for vehicular access for direct loading and offloading by the lifting equipment.

The lifting facilities with rated capacity greater than 2000 kg or vertical lift of more than 2 m must be provided with electrically operated hoisting.

The lifting facilities with rated capacity greater than 2000 kg must also be provided with electrically operated long and cross travels or slew, as appropriate.

Where specified, frequently used lifting facilities with rated capacity equal to or less than 2000 kg and/or vertical lift equal to or less than 2 m must also be electrically operated.

The electrically operated cranes must be controlled by a hard wired push-button type pendant control station. The pendant must house all the required equipment and push buttons to provide required two speed control in each direction. Battery operated control stations are not acceptable.

All structural welding on the crane must be in accordance with AS/NZS 1554.1, weld category SP.

All safety requirements must comply with AS 1418, AS 4991, AS 3000, AS 2550 and SafeWork NSW. All maintainable parts of the lifting facilities must be provided with suitable access for maintenance.

Where installed over or in contact with potable water, all paint, labels or other objects that may come in contact with water or become free from the lifting equipment or associated infrastructure must meet the requirements of AS 4020.

The lifting facility must have the following markings in black lettering, visible to the crane operator from the operating level:

- Rated capacity in tonnes
- Class/classification numbers

- Serial No.
- Travel directional sign (North, South, East and West).

M17.2 Jib cranes

Where specified, equipment such as submersible mixers, stop boards, penstocks, gates, submersible pumps etc. must be provided with a permanently installed jib crane.

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, as specified.

The reach and slew of the boom must be suitable for raising and lowering the equipment from its installed position to a designated platform or floor area or onto a truck where it can be readily inspected and serviced or taken away.

The jib crane and hoist or winch must be clearly labelled for the rated capacity.

M17.3 Monorail cranes

Monorail cranes must include a monorail beam, trolley and hoist and lifting chain or wire rope.

The monorail beam must be manufactured from structural steel and be hot dipped galvanised or painted after fabrication. The monorail beam must have trolley stops on both ends which must be bolted to the beam.

The monorail beam, trolley and hoist must be clearly labelled for the rated capacity.

Monorail cranes must be approved by SafeWork NSW and be complete with structural certification for both, the crane and its support structures. The Contactor must be responsible for the certification of the structures that support new lifting equipment.

Where existing structures are modified to carry monorail crane, the appropriate structural certifications must be obtained for the required modifications.

M17.4 Overhead travelling cranes

Overhead travelling gantry cranes complete with supporting beams and rails, bridge, trolley, hoist, lifting chain or wire rope, service platform and access ladder with self-closing gate must be designed, manufactured, factory tested, delivered, installed, site tested, commissioned and registered in accordance with relevant parts of AS 1418 and SafeWork Australia.

The Group Classification of the cranes must be A1 and the Group Classification of the crane mechanism M2 (as per AS 5246 Part 1).

The crane long travel rails must be fixed true and securely to the crane beams. End stops must be provided on both the longitudinal and cross travel. Electrically operated cranes must also be fitted with limit switches to limit the motion of the crane bridge and trolley prior to hitting the end stops.

Provision must be made for lubrication of all working parts and lubrication points must be located such that they are readily accessible.

The design, construction and materials of the service platform(s) and access ladder(s) must comply in every respect with the requirements of AS 1657, AS 1418 and SafeWork NSW.

The rated capacity of the crane, span, minimum hook height and other relevant characteristics must be adequate to lift the heaviest part installed in the plant and place it on the centre of the tray of a truck parked in the loading bay in one lift.

Crane operating envelope must cover all installed mechanical and electrical equipment within the plant. The direction of cardinal points (i.e. North, South, East and West) must be clearly marked on the bottom of the crane in an approved manner and be visible to the crane operator at all times.

The crane must have the following information engraved on a stainless steel nameplate visible to the crane operator from the service platform:

- Serial No.
- Manufacturer's name
- Date of manufacture
- Standard to which designed and manufactured.

M17.5 Crane hoists

Cranes must be provided either with a wire rope or chain hoist.

The hoist must have sufficient vertical lift to lift the equipment free of all possible obstructions from the floor and place it on a designated platform or truck.

The lift height of the hoist must be from fully lowered, hook at the floor level, to fully raised at 600 mm below the monorail beam, crane bridge or boom.

Where specified, hoist must have true vertical lift. Otherwise, the hook drift must not exceed 20 mm per metre lift.

The hoist brake must be fail-safe under power failure. The brake mechanisms must be protected against rain and dust ingress.

The hoist steel wire rope must be in accordance with AS 3569 and must be hot dipped galvanized. Where exposed to sewage or in aggressive environments the wire rope must be made from a suitable grade of stainless steel.

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

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

Hoist lifting chains must comply with AS 2321 and be hot dipped galvanized. In corrosive environment or where specified the lifting chains must be manufactured from stainless steel and comply with AS 4797.

Adequate chain buckets attached to the trolleys or hoists must be installed to collect the hoist chains. The buckets must be self-draining and not accumulate water.

A suitable label must be attached near the rope drum or chain bucket, giving the gross length and particulars of the rope or chain for replacement purposes.

Wire rope and chain must have a minimum factor of safety of ten.

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

All gears and sprockets must be of high strength hardened and machined steel with sealed grease packed ball or roller bearings on the load shaft. Chains must be guided onto all sprockets to ensure that under all operating conditions they will not jam.

The bottom block must be fully guarded. The hook must be drop forged steel. It must 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 must be coated in accordance with WSA 201.

The hoist and equipment must be suitable for continuous exposure to the weather and direct sunlight.

M17.6 Electric hoist

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

The electric hoist must be fitted with upper and lower limit switches.

M17.7 Crane electrical requirements

M17.7.1 General

Except where the specification requires a higher standard, all work must be carried out in accordance with the latest edition of AS/NZS 3000 (SAA Wiring Rules), AS/NZS 3008.1.1, and Technical Specification – Electrical (CPDMS0022).

The electricity supply to operate electric cranes must be 400 V, 3 phase, 4 wire, 50 Hz alternating current.

Electric operated cranes must include an insulated, sliding contact power feed system and collectors (a catenary power feed system or travelling cables on pulleys) and travel limit switches.

A 3 phase isolating switch must be installed adjacent to the unit bottom of the crane access platform ladder. "Danger" notices must be installed on the crane and any other required "Danger" signs remote from the crane.

A Certificate of Compliance of Electrical Work (CCEW) and all associated documentation must be completed as per the requirements in Sydney Water’s Technical Specification – Electrical (CPDMS0022). A copy of the submission must be provided to Sydney Water at the time of submission as well as a part of the O&M Manuals. Main Supply Isolator

A main supply isolator, capable of being padlocked in the open position must be supplied and installed adjacent to the unit. This isolator must be rated such that it is capable of interrupting the locked rotor current of the largest motor plus the full load current of all other motors on the crane.

A sign reading "Main Switch for Crane - Isolate Before Servicing", must be provided for installation adjacent to the isolator. The sign must be a minimum of 600 mm wide by 500 mm high.

M17.7.2 Motors

All motors must be 400 V, 3 phase, 50 Hz alternating current, reversing, horizontal mounted squirrel cage type in accordance with AS 1359 and AS 60034. Each motor must be tested by the manufacturer at their works and certified test sheets must be supplied before the motors are delivered.

The motors must be designed for crane duty and be not less than one hour rated. The motors must be class F insulation with maximum temperature of 130 °C during operation.

An earthing stud must be fitted to the frame of each motor.

A lifting eye or lug must be fitted to the frame of each motor.

The power factor of the motor at full load must be not less than 0.85.

The continuous rated output of each motor must be at least 15% in excess of the maximum power required by the driven unit under all specified operating conditions.

If the motors are double wound with delta windings on one or both speeds, then one "corner" of each delta winding must be broken, and the extra connection bought out to a fourth terminal with a removable link within the terminal box. A fourth contact in the starter must take the place of the removable link and open the delta of the non-energised winding.

All motor bearings must be self-lubricating ball and/or roller types of standard design, except that in motors exceeding 15 kW a roller bearing must be fitted at the driving end.

To avoid damage to bearings (work hardening or "Brinelling") due to vibration during transport suitable precautions must be taken to protect them.

Characteristics of all motors must be such that acceleration and deceleration is smooth and gradual, to reduce the possibility of load swing.

At creep speed the hoisting motion must be capable of being maintained (irrespective of the size of the load on the hook within rated capacity) for one minute continuously in both the "up" and "down" directions.

M17.7.3 Brakes

The crane must be fitted with brakes of an approved design. The brakes must be capable of sustaining a load 25% greater than the test load when the hoisting motor is not energised. The brake fitted to each motion must be operated by a solenoid thruster, must be smooth operating and of ample size to perform efficiently the operation for which they have been designed, without overheating. All brakes must be fail-safe under power failure.

M17.7.4 Protection and control equipment

Control of all motions and the master cut-out contactor must be by means of a pendant type control station. Push buttons must 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.

The crane protection panel and control equipment must include:

- Master cut-out triple pole contactor arranged for operation from the control station
- Protection panels fitted with the necessary triple pole motor contactors, overloads, fuses, etc. mounted in an approved position on the crane, easily accessible for servicing, and to the requirements of the Lifts and Scaffolds Regulations of the SafeWork NSW.
- Fuses in each active conductor to the control circuits
- A triple pole self-resetting time lag overload relay adjustable as to time and current and to operate in the control circuit to the main contactor. The overload relays must be of the normally closed, circuit opening type.
- If the offered hoisting motor is a two-speed motor, protection against the simultaneous closing of "low" and "high" speed contactors must be provided by means of electrical and mechanical interlocks.

The panels must be housed in an enclosure with easy access to equipment and mounted in a position accepted by Sydney Water. It is preferred that the control and protective panel(s) be hinged. The dustproofing medium must be sponge rubber or neoprene, held in place by continuous metal retainers in addition to any adhesive.

The contactors incorporated in the control equipment must comply with utilisation category AC4, Class 1 of AS 1029, Part 1.

M17.7.5 Motion limits

a) General

Limit switches must be heavy duty industrial type and must be installed on the crane to limit the hoisting and long and cross travel motions.

Any additional motion limiting devices, where required, must be provided to obviate physical damage to the crane or an object, or structure adjacent to the crane, due to movement of the crane, part of the crane, or a load being handled by the crane past its designed range of movement.

b) Working Limit Switch

Working Limit Switches must be provided for the hoisting motions, cross travel and long travel. When operated these switches must cause the power supply to the motor it controls to be interrupted and the brake to be applied, but it must not prevent reversal of motion. The limit switches must be self-resetting

when the motion returns to the non-limited section of its range. These limit switches may operate in the directional contactor circuit.

c) Final Limit Switch

A Final Limit Switch must be provided for limiting the hoisting motion. When operated this switch must cause the power supply to the motor to be interrupted and the brake to be applied. The final limit switch must 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, must not be readily accessible to the crane operator.

However, any additional motion limiting devices, where required, must be provided to obviate physical damage to the crane or an object or structure adjacent to the crane, due to movement of the crane, part of the crane, or a load being handled by the crane past its designed range of movement.

M17.7.6 Lighting

Suitable lighting must be provided on the crane structure for illumination of the hook and load. All light fittings must have anti-vibration mountings.

Illumination must be suitable for maintenance work and must be to AS 1670.

M17.7.7 Cables

Cables must be PVC insulated of approved manufacture and conforming to SAA Wiring Rules AS/NZS 3000 and AS/NZS 3008 enclosed to accord with the specified rating.

Wiring for power circuits must be carried out using 600/1000 volt grade PVC insulated multi stranded cables, with minimum conductor size 2.5 mm² (7/0.67).

Wiring for control circuits must be carried out using 600/1000 volt grade PVC insulated multi-stranded cables, with minimum conductor size 1.5 mm² (7/0.50).

All cables to and from the crane assembly must be run in heavy gauge steel galvanised or painted conduits. Not more than two power circuits must be enclosed in any one conduit.

The pendant control station must be suspended in manner that will protect the electrical cables against strain.

M17.7.8 Catenary power feed system

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

The catenary system must be located so as to be accessible for maintenance.

The catenary system must be installed level, true and correctly aligned with the travel of the crane and must be of adequate length to allow operation of the crane over the full range of travel.

Trolleys must be of sufficient length to prevent the impact shock between trolleys being absorbed by the catenary cable while the catenary system is being compressed.

Catenary cables must be 600/1000 V grade, double insulated, multi-stranded, with minimum size 2.5 mm² (50/0.25) for power circuits, and 1.5 mm² (30/0.25) for control circuits.

M17.8 Prior to manufacture

The following drawings are required to be submitted by the manufacturer prior to fabrication:

- Crane General Arrangement (fully dimensioned) showing location of crane protection and control panel, motors, cables, main supply isolator, insulated conductor feed system, limit switches etc.
- General Arrangement, (fully dimensioned) of the crane protection and control panel, listing all details and showing the location of all components and general constructional features
- Equipment List, containing a full description of all components and listing the Manufacturer, Catalogue Number, rating and quantity of each item
- Single line and control circuit diagrams of the system, showing normal current ratings, etc.

Where drawings submitted require modification, a further three copies of the modified drawings must be submitted. This procedure must continue until Sydney Water accepts the drawings. All work must be in accordance with the final drawings.

M17.9 Installation and testing

The crane must be installed and tested under the crane manufacturer's supervision.

Each crane must be load tested to its safe working load. The beams and trolleys must be tested for their full range of travel.

The installation of the crane must be inspected and passed by the electricity supply authority and SafeWork NSW.

All certificates, complete with two sets of maintenance manuals and user operational instructions must be retained.

A maintenance schedule for the installed lifting facilities is also required.

M18. Ventilation

M18.1 General

Unless otherwise specified, ventilation ductwork, fittings and appurtenances must be designed, supplied and installed in accordance with AS 4254.1 and AS 4254.2 or SMACNA “HVAC Duct Construction Standards, Metal and Flexible”. Where conflicting requirements arise from the use of the above standards, requirements in the Australian Standard must have precedence.

All ventilation ductwork, enclosures and covered areas must have suitably spaced and located intake points which allow an even collection of foul or hot air from each enclosed area or piece of equipment. Intake points must have manual dampers to allow full and proper balancing of the ventilation system.

All ductwork must be grade 316 stainless steel, FRP or PVC (subject to a Performance Solution being in place for FRP and PVC where required). Fans, dampers and other ventilation equipment must be grade 316 stainless steel. Spiral weld stainless steel must not be used for ductwork containing Hydrogen Sulphide.

M18.2 Fans and accessories

M18.2.1 Ventilation fans

Fans must be 3 phase, 400 V. Temporary or wall mounted fans which are plug and socket connected may be single phase, 240 V. Fixed fans must be industrial quality, direct driven, axial or centrifugal type, and made from grade 316 stainless steel. The fans must be selected to achieve the lowest practicable absorbed power at the nominated operating conditions. Grade 316 stainless steel safety guard must be provided on the unducted entry.

Where fans are connected to common ductwork they must have grade 316 stainless steel non-return dampers to prevent backflow of air. Where available, all fan accessories (e.g. supporting fixtures, flexible connections, anti-vibration mounts, silencers, etc.) must be from the original fan manufacturer. Flexible connections must be lead impregnated polyester material or equivalent.

Fan motors must have non-overloading power characteristics. Fans and motors must be selected such that they are capable of increasing the "as built" system flow rate by 10%. Terminal boxes external to fan casings and wired to fan motors must be provided.

Fan bearings must be oil or grease lubricated. Fan motors must be provided with grease packed ball or ball-and-roller bearings. Dust seals must be provided for all bearings.

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

M18.2.2 Installation

Fans and accessories must 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 must be provided to prevent transmission of vibration to ductwork. Where necessary, expansion pieces between fans and flexible connections must be provided.

M18.3 Construction of ductwork

M18.3.1 Flexible and rigid ductwork

All flexible and rigid ductwork, fittings, hangers, supports and duct insulation must be selected, fabricated, supplied, tested and installed in accordance with AS 4254.1, AS 4254.2 and/or SMACNA "HVAC Duct Construction Standards, Metal and Flexible", with precedence given to the requirements in the Australian Standard. The ductwork must be sized, designed, acoustically insulated and installed to reduce noise travelling along or being generated by the ducts.

The Building Code of Australia 2019, Specification C1.10 Fire hazard properties, part 5 requires rigid and flexible air-handling ductwork in a Class 2 to 9 building to comply with the fire hazard properties set out in AS 4254 parts 1 and 2. AS 4254.2 Section 2.1.2 requires air-handling ductwork to achieve a Spread-of-Flame index not greater than 0 and a Smoke-Development index not greater than 3 tested as per AS/NZ 1530.3. FRP and PVC ductwork do not meet the AS 4254.2 requirement, specifically for the Smoke-Development index. This compliance does not apply to outdoor ductwork.

The potential hazard associated is the risk of fire and smoke spread between separate compartments from the non-compliant ductwork and the impact that this may have on the evacuation of occupants.

The use of these products internally in buildings could be justified through a fire engineering Performance Solution. There is no requirement under NSW legislation to bring already certified buildings up to current code (other than in the case of a fire order from Council or where major building refurbishment is being undertaken and the Certifying Authority deems it necessary to upgrade).

The following acceptance criteria are the minimum required under a Performance Solution to demonstrate that the use of FRP or PVC ductwork will not lead to significant fire or smoke spread between separate compartments, and that this would not impact the egress of occupants within the facilities.

The Fire Safety measures related to a Performance Solution include the following:

- Plant spaces with this type of ductwork are to be kept free of combustible storage
- All ventilation air ductwork is operated under negative pressure and discharged to outside treatment facilities
- Adequate evacuation signage is provided in the plant spaces meaning that on alarm, evacuees would be expected to be able to reach the fire exits provided. These exits lead either directly to outside, or into a fire isolated stair.
- Occupants of the facilities are aware of the evacuation plan, and any visitors within the facility area are accompanied by a staff member.

If any facility requires a Performance Solution as part of a formal approvals process (e.g. a construction certificate, complying development certificate or the like), then a site-specific Performance Solution must be prepared for submission to the approval authorities.

M18.3.2 FRP ductwork

M18.3.2.1 General

The FRP ductwork must be manufactured in accordance with ASME RTP-1.

All FRP duct sections must have an identification label laminated to the exterior surface, which must indicate manufacturer's name, address, model number, serial number, resin name and number, resin manufacturer, curing agent temperature and date of manufacture.

The FRP duct system must provide for expansion and contraction due to temperature changes without damage to the covers.

All edges must have a smooth finish (not rough or sharp) for safety in handling. All cut surfaces must be resin edge sealed to prevent wicking.

The performance parameters for the ductwork are as follows:

- Temperature: +10 °C to 100 °C
- Positive Pressure: 200 mm water column + 8
- Negative Pressure: 100 mm water column - 4
- Flow medium and velocity: contaminated air at 10 m/s maximum

Ductwork must be designed and constructed in accordance with ASME/ANSI RTP1-1989.

Ductwork must be airtight and must not vibrate or pulsate when the system is in operation. Joints must be substantially airtight. Ductwork must not come in contact with any of the ceiling construction or any other equipment in the ceiling cavity.

Calculations for wall thickness must be based on the structural fibreglass reinforced wall only. Long term deflection must not exceed one per cent of duct diameter or duct width for rectangular ducts. Round FRP ductwork must be used and must be designed using a safety factor of 10 to 1 for pressure and 5 to 1 for vacuum service. Round duct must be designed by manufacturer to resist specified loadings.

Supports for ducts, including foundations must be aesthetically designed. Drawings must be submitted to Sydney Water for acceptance.

Duct insulation requirements must be as per AS 4254.1 and AS 4254.2.

M18.3.2.2 Materials and fabrication

FRP ductwork must be fabricated of contact moulded or filament wound construction, or a combination of these methods, to meet design criteria.

The resin must be a vinyl ester and must be resistant to the contaminants in the air produced by the treatment of sewage. The resin must be a brominated vinyl ester or equivalent resin system with suitable additives to achieve the same level of fire retardancy where site specific hazard identification determines fire retardancy is required (e.g. passes close to a fire risk such as remanent bush land, private dwellings or other high risk areas including ammonia etc. or the contents are flammable and would pose a risk to other structures). Derakins 510A as manufactured by Dow Chemical, Hetron 992 FR as manufactured by Ashland Chemical, or Dion VR 9300 FR as manufactured by Reichold Chemical or approved equivalent must be used. Surfacing veil must be apertured and non-hydrophilic polyester.

The corrosion barrier resin must be a vinyl ester Hetron 922 or approved equivalent and must be resistant to the contaminants in the air produced by the treatment of sewage.

The resin used in the structural layer must be Iso polyester or vinyl ester (preferred) dependant on project specific requirements. Where nominated by project requirements (e.g. in bushland settings subject to bushfires) the structural resin may also need fire resistant equal to UL94 V0.

The corrosion barrier must comprise a C Glass veil (unless the service conditions need a synthetic veil as determined by the resin manufacturer and compatible with the fire resistance requirements), backed up by a minimum of 900 gsm of chopped glass. This must comprise of two layers of 450 gsm CSM mat (or equivalent) or applied by a calibrated automated chopper gun system. The glass ratio must be between 20% and 30%, the minimum overall corrosion barrier must be no less than 2.5 mm.

Where ducts pass into, or through other vessels or are subject to the duct contents being present on the external surface, then a second corrosion barrier of the same specification must be applied externally to the duct.

Where duct is exposed to the normal atmosphere the final layer of the duct must comprise a C veil only. The duct must be coated in a pigmented, paraffinated flow coat with UV inhibitors. The addition of UV inhibitors must be compatible with the flowcoat and must be sufficient to give a design life equal to that of the vessel. The external flowcoat where required must exhibit the same fire resistance or better than the structural resin system.

No sand or bulking fillers are permitted except for thixotropic or air release additives. Any additives must not degrade the fire, chemical or UV resistance of the ducts.

All fittings such as elbows, laterals, trees, and reducers must be fabricated of the same resin and reinforcement and equal or superior in strength to the adjacent duct section and must have the same internal dimensions as the adjacent duct. Non-flanged duct joints must be butt wrapped or bell and spigot joints. Bell and spigot joints must be sealed with a standard butt joint overlay as per PS 15-69. The interior opening between the bell and spigot must be sealed with a resin paste so that no glass fibres are exposed and all voids are filled. Field cut duct ends and exposed glass fibres must be resin coated prior to joint assembly to maintain a continuous interior corrosion barrier. All exterior surfaces of joints must be coated with a paraffinized resin-rich gel coat with W inhibitors.

Total width of overlay for butt-wrap joints must be not less than 150 mm for diameters from 150 mm up to and including 750 mm for diameters of 1000 mm and larger overlay must be not less than 250 mm.

Standard elbow centreline radius must be equal to one and half times the duct diameter (1.5 x). Short radius bends are not acceptable.

Standard elbows up to 600 mm diameter must be smooth radius moulded elbows. Standard elbows 750 mm diameter and greater may be mitred sections as specified below. 0 to 44 degree elbows must contain one mitred joint and two sections. 45 to 80 degree elbows must have a minimum of two mitred joints and three sections. Elbows greater than 80 degrees must have a minimum of four mitred joints and five sections.

Fittings must be factory manufactured to meet the specified design criteria and in accordance with approved submittals. Reinforcing ribs must be factory installed as required to meet the specified deflection requirements and to provide a system free from pulsing, warpage, sagging and undue vibration.

Forming vanes must be provided in all mitred rectangular elbows. Rectangular elbow turning vanes must be of FRP construction, solid or double wall construction with an airfoil shaped profile.

Round duct and fitting reinforcing must be factory located and installed to avoid duct hangers, support saddles, bracing, branch take offs and entries, and plenum connections. Routine field cutting and field relocations of factory installed reinforcing is not acceptable. All stiffener rings must be moulded into the duct wall.

Out-of-roundness of duct must be limited to plus or minus 3 mm or plus or minus one per cent of duct inside diameter, whichever is greater for duct sizes 150 mm diameter and greater.

All unflanged ducts must be square on the ends in relation to the duct axis within plus or minus 3 mm up to and including 600 mm diameter and rectangular duct up to 1830 mm perimeter; and plus or minus 5 mm for all diameters greater than 600 mm.

The tolerance on angles of all fittings must be ±1^{O}, up to and including 600 mm diameter and ±0.5^{O} for 750 mm diameter and above.

Flange faces must be perpendicular to the axis of the duct within 0.5^{O}. Flange faces must be flat to within plus or minus 0.8 mm, up to and including 450 mm diameter and flat within plus or minus 1.6 mm for 500 mm diameter and larger.

All connections to expansion joints, butterfly dampers, fire dampers, tanks, or other equipment must be flanged. All ductwork flanges to be connected flat face to flat face or raised face to raised face only, including connection to valves, pipes, etc. Flat face to flat face is preferred. Connection of flat face to raised face flanges is not acceptable. Where raised face to raised face connection is required a stub flange with stainless steel backing ring must be used. Gaskets must be chlorobutyl. Flanges must be hand laid up to thickness specified in PS 15-69 except that minimum thickness must be 20 mm. Each flange face must be ground flat, and a new 2.5 mm corrosion barrier must be applied. The flange must be anchored to a waxed table to ensure the flatness tolerance outlined above. The face must be textured for use with full face chlorobutyl gaskets, 3.0 mm minimum thickness. Flange drilling must be as per PS 15-69. All bolt holes must be back spot faced for a washer seat. All flange bolts must be torqued to values as recommended by manufacturer.

M18.3.3 Ductwork ancillaries

Flexible connectors must be installed at inlet and outlet of each fan and in the duct runs where required for expansion, contraction and movement. Expansion or contraction flexible connections must be designed to allow 25 mm movement. Working lengths or "live" length must be as designed by the manufacturer to allow up to 25 mm of movement. Ends must be flanged, with flanges matching duct connection flanges. Corners on rectangular expansion joints must be moulded and free of patches or splices.

The flexible connections must be suitable for outdoor service and temperature ranges from 10 °C to 100 °C and pressure to 35 kN/m². Specially fabricated split grade 316 stainless steel retaining back-up bars must be supplied to prevent damage to the flanges when grade 316 stainless steel bolts are tightened.

The thickness of transition pieces must be designed using a safety factory of 10 for pressure and 5 for vacuum service with the pressure classification listed herein.

Custom flanges must be designed as required to connect to fans, dampers and ductwork. Flange sizes must match approved equipment dimensions.

Bolted access doors of adequate size must be installed wherever access may be required for service, maintenance and adjustment. Access doors must be of the same material as the duct. Doors must be

equipped with gaskets and bolted. Access door fasteners and hardware must be grade 316 stainless steel. FRP inspection ports must also be provided as required.

Access doors and inspection ports must be provided at the following locations (minimum requirement):

a) Plenums - Access door

b) Duct mounted dampers - Inspection port

c) In ductwork greater than DN 600 (or of equivalent cross section) located at sufficient intervals (maximum 30m) to allow an internal inspection of the entire length of the ductwork - Inspection port with a minimum 500 mm clear opening for pipe crawler camera/drone access.

d) Turning vanes - Inspection port

e) Spares - 2 additional inspection ports and 1 additional access manway for each odour treatment unit installed at wastewater treatment plants (all costs must be deemed included as part of the Ductwork Costs)

f) For ducts less than 300 mm diameter blind ends and swept Tee “rodding points” must be fitted every 25 m or closer for complex duct geometry such that access is still maintained for remote cameras or cleaning hoses.

M18.3.4 Ductwork Installation

M18.3.4.1 General

Where the duct is supported by another structure, all necessary allowances and provisions must be made in the installation of the ducts for the structural conditions of the supporting structure. Ducts must be transformed or divided as may be required. Wherever ducts are divided, the cross-sectional area must be maintained. All such changes must be approved and installed as directed by Sydney Water.

During installation, the open ends of ducts must be closed to prevent debris and dirt from entering. Work must be installed in accordance with the overall approved progress schedule and in co-operation with all other trades so there will be no delay to other trades.

All ductwork, fans, outlets and other parts of the ductwork systems must be maintained in a clean condition during installation.

Complete ductwork systems must be cleaned prior to testing and air balancing. Cheese cloth must be secured over all openings of the ductwork system for entrapment of dirt during the cleaning operation.

Changes in direction and offsets must be made in a gradual manner to facilitate streamlined flow of air. All elbows must have a centreline radius of not less than 1½ times the width of the duct in the plane of the elbow. For rectangular ductwork with greater than 450 long side where full radius elbows cannot be installed or abrupt elbows are shown, provide abrupt elbows equipped with shop-installed hollow, fibreglass or grade 316 stainless steel airfoil turning vanes. An access door must be installed at each abrupt elbow, so located for easy access to turning vanes.

Whenever a fire-rated wall or floor is penetrated the space around the duct must be fitted with an approved type of fireproof material.

At fire-rated walls, grade 316 stainless steel sheet metal escutcheon plates must be installed on both faces of the wall in order to close the gap between the structure and the sides of the insulated or bare duct.

Ducts must be sloped to shed water. All FRP ducts must have a camber and there must be no stagnation of water when the covers are in place.

Where ducts connect to or terminate at masonry openings or along the edges of floors where concrete curbs are not being provided, there must be placed around the ductwork a continuous 63 mm wide by 63 mm by 4.7 mm angle of the same material as the duct which must be bolted to the construction and made airtight to same by applying caulking compound on the angle before it is drawn down tight to construction.

Plenums connected to concrete curbs must be fastened with 75 mm by 75 mm by 6 mm thick continuous angle of the same material as the duct. This angle must sit on a continuous bead of caulking compound and be anchored to the curb at 400 mm centres. The duct must terminate at the curb and be fastened to the angle. A continuous bead of caulking compound must seal the plenum to the curb.

Installation of all ductwork must be neat and provide access to duct work components, which require inspection, entry, maintenance and repairs. Where possible duct runs are to be adjacent and parallel to each other and to building and plant elements. All ductwork must be designed to prevent accumulation of materials and ensure all sections can be easily cleaned. Installed ductwork must not prevent access to other equipment in the plant.

M18.3.4.2 Ductwork supports and hangers

Suitable supports must be provided for all duct work to ensure that the duct work does not sag or bend. All hanger materials must be grade 316 stainless steel. Spacing of hangers on horizontal ducts must be in accordance with table below.

Duct Size A (m^2)	Spacing (mm)	Min. Wall Thickness (mm)
0.008	2800	3
0.018	3000	3
0.030	3100	3
0.050	3300	3
0.070	3400	3
0.125	3500	3
0.160	3600	3
0.196	3700	3
0.283	4300	5
0.442	4600	5
0.636	4800	5
0.785	5500	6
1.130	6000	6

Perforated band iron or wire for supporting ducts must not be permitted. Ducts must not be supported from non-structural building elements, any equipment items, furring, hung ceilings or from another duct or pipe. C-clamp type hangers must be supplied with a retainer strap.

Ductwork must be properly anchored and supported from the building or the purpose made structure as required and/or as deemed necessary. Support anchoring for horizontal ducts must be 3 m c/c maximum spacing. Each anchor must consist of two semi-circular stainless steel bands around the duct bolted together vertically and horizontally. The structural supports or wall attachment must be grade 316 stainless steel. All fittings, expansion joints and similar items must be supported within 450 mm of the joint or as deemed necessary.

Concrete pedestals, grade 316 stainless steel hangers, angles and straps must be furnished to support the ducts installed for the corrosive gases extraction systems. Anchors, inserts or clamps must be used to secure hangers to walkway roofs, underpass or overpass structures and must be of grade 316 stainless steel. The support system must be designed to accommodate dead weight and dynamic analysis, including system thermal effects, pressure thrusts. All supports must adequately secure the duct against excessive dislocation due to thermal expansion and construction.

M18.3.5 Vibration of ductwork

Where vibration occurs in the ductwork while the system is in operation, such additional members as are necessary to overcome this vibration must be installed. All ductwork, where vibration occurs must be neatly and securely isolated at points of contact with the building.

The ductwork at a manually operated damper must be reinforced to properly support the damper and prevent vibration.

M18.3.6 Maximum duct air velocities

Duct velocities must be limited to the following values:

- Main Duct 10 m/s
- Branch Ducts 8 m/s
- Exhaust Grills 6 m/s

M18.3.7 Ductwork acoustic

Where necessary the ductwork must be lagged to ensure the noise levels comply with the requirements of this Specification.

M18.4 Dampers

Dampers must be supplied as necessary to fully balance the air flow rates from all parts of the system and to allow automatic isolation of non-working parts of the system.

Dampers must be manufactured in grade 316 stainless steel of rugged construction and must be free of rattles, fluttering or slack movement, and capable of adjustment over the necessary range without excessive self-generated noise or the need for special tools. The dampers must be of heavy duty construction designed to withstand 2 to 3 times the designed air flow and static pressure. Suitable access is to be

provided to all dampers. The dampers must meet the following requirements, Internal / external seams and body / flange joints are to be fully welded

- Pressure tested for leaks prior to installation
- Faulty welds (pinholes), runny (fast), or blop (slow) or cold lap welds/joints are to be ground out and re-welded
- Installed damper/s with faulty welds must be removed and repaired on floor. Repaired damper/s must be retested before installation.
- All welds and surrounding metal affected by welding process must be cleaned and passivated
- Application of sealant to incomplete welds or faulty welds is not an acceptable practice.

M18.4.1 Volume control dampers

Blades must be without sharp edges and sufficiently rigid to eliminate movement when locked. Blades minimum thickness must be 1.6 mm.

Damper bearings must be oil impregnated sintered bronze ball bearings or engineering plastic sleeve bearings. Where the operating temperature is expected to exceed 50 °C, nylon must not be used. Access for lubrication of bearings must be provided.

Spindles must be grade 316 stainless steel, securely fixed to damper blades with minimum diameter as follows:

- Blade diameter ≤ 600 mm 10 mm
- Blade diameter > 600 mm 12 mm

The damper must be capable of being adjusted and locked in the following blade positions: "Open", "10° to open", "20° to open", "30° to open" and "Closed". The positions must be clearly and permanently labelled.

M18.4.2 Non-return dampers

All non-return dampers assemblies must be counterweighted so that they:

a) Offer minimum resistance to air flow

b) Close by gravity.

Where available, non-return dampers must be manufactured and supplied by the original fan manufacturer.

M18.5 Access panels

M18.5.1 General

Personnel access panels (doors) must have minimum clear openings of 750 mm x 700 mm.

Unless otherwise specified, hand access panels must have a minimum clear opening of 200 mm x 300 mm.

The panels must be double thick, deep formed, constructed and insulated to match the duct. Cold bridging must be minimised. Panel frames must be rigid, securely attached to the duct, with no part of the panel or frame protruding into the airstream.

The seals must be silicone rubber mechanically fixed to either the panel or the frame to ensure an airtight seal when latched in the closed position. For fire rated seals, use woven ceramic fibre material. Latches must be Wedge type sash latches and there must be a minimum of two.

M18.5.2 Access for cleaning

Any areas of duct work in which accumulation of materials of any kind is possible must be provided with suitably located local access for cleaning and/or drainage. Duct work must be designed so that any liquid which comes into the ducts can be easily and automatically drained so that there are no build-ups of liquid within the duct work. Access must be provided to the duct work for cleaning through sealed access doors.

M18.6 Air balancing

M18.6.1 General

Air handling systems or parts thereof must be air balanced to give flow rates within ± 10% of designated air quantities, subject to the following:

a) Air must be distributed to minimise duct velocities

b) Air resistance at fans must be minimised, and the fans must be adjusted to run at lowest fan speeds and power consumption.

Balancing points must be provided in ducts in sufficient number to facilitate the proper testing and commissioning of the air collection system, but in any case, at least one for each branch duct and each main duct. All balancing points must be located in readily accessible positions in straight duct, at least seven “hydraulic diameters” downstream from any bend or air control device.

Where the required distance (seven “hydraulic diameters”) cannot be achieved, the design must allow for straightening vanes or diffusing grid to achieve stable flow conditions at the balancing point. All balancing points must be easily accessible for measurement.

M18.6.2 Procedure

Air balancing must commence after air handling systems installation is complete. The air handling units must be cleaned before balancing.

Where there are inter-related air handling systems, all systems must be operated concurrently.

Final position of dampers must be marked upon completion of balancing.

M18.6.3 Reports

The following must be included on the air balance data sheets:

a) Static pressure differentials

b) Air quantities through each sub-system or branch ducting after balancing

c) Fan capacity and fan speed.

The final operating point must be shown on the fan characteristic curve.

M18.7 Vibration

M18.7.1 General

All rotating equipment including fans and motors, must be statically and dynamically balanced and installed on bases designed to accommodate vibration isolators.

M18.7.2 Equipment requiring vibration isolation mountings

Except for external equipment which is not connected to the structure of any building, all rotating or reciprocating equipment must be supported on mountings as follows:

a) For static deflections ≤ 15 mm: Single or double deflection neoprene in-shear mountings incorporating steel top and base plates and a tapped hole for bolting to equipment.

b) For static deflections > 15 mm: Spring mountings.

M18.7.3 Selection of vibration isolation mountings

Mountings must be selected to achieve 95% isolation efficiency at the normal operating speeds of the equipment.

M18.7.4 Spring mountings

Free-standing laterally stable springs with at least 12 mm clearance between springs and other members, such as bolts and housing, must be used. The following must be provided:

a) Ratio of mean coil diameter to compressed length at the designated minimum static deflection: > 0.8:1

b) Minimum travel to solid of at least 150% of the designated minimum static deflection

c) Levelling bolts and lock nuts

d) 5 mm neoprene acoustic isolation pads between base plate and support

e) Vertical resilient limit stops to prevent spring extension when unloaded, serve as blocking during installation, and which remain out of contact during normal operation

f) Springs snubbing to prevent bounce at start-up.

Alternatively, spring mountings as recommended by the original equipment manufacturers will be acceptable.

M18.7.5 Installation

Vibration isolation mounting supports must be set and adjusted to give adequate clearance for free movement of the supports.

M18.8 Ventilation air inlet and exhaust louvres

Weatherproof and bird proof ventilation air inlet louvres and air exhaust louvres must be installed in any rooms with ventilation fans installed. The maximum velocity of air flow through the inlet louvres must not

exceed 2 m/s. The air velocity through the exhaust louvres must comply with industry best practice and must not be excessive to cause undue noise. All external fixings must be vandal proof.

M18.9 Ventilation requirements for water pumping stations

Specific ventilation requirements for water pumping stations are set out in Sydney Water's Design Specification for Water Pumping Stations D0002071.

M18.10 Ventilation of small and booster water pumping stations

Ventilation requirements for small and booster water pumping stations must be similar to those for larger water pumping stations. The fans may be installed directly onto the walls of the pumping stations at high level and no ductwork and dampers are required. Refer to Sydney Water's Design Specification for Water Pumping Stations D0002071 and Sydney Water's Edition of WSA 03.

M18.11 Ventilation of sewage pumping stations dry wells

Ventilation of sewage pumping stations dry wells must comply with Sydney Water's Design Specification for Sewage Pumping Stations Dry Well Ventilation (D0001896).

M18.12 Ventilation rates for treatment plants

Ventilation rates for treatment plants must be in accordance with NFPA 820 for protection against fire and explosion hazards and AS 1668.2 to ensure acceptable air quality for underground galleries, passageway areas, staff and utility rooms. Where ventilation of odour and foul air occurs alongside ventilation for working underground in confined spaces, these must be managed simultaneously. The requirements for both ACP0004 and NFPA 820 must be met.

M19. Odour and septicity control for sewage pumping stations and sewer network

M19.1 Odour control

Sewage pumping stations wet wells, emergency storage tanks, inlet maintenance holes and sewerage networks must be provided with natural ventilation system in accordance with Sydney Water's Editions of WSAA Codes WSA 04 and WSA 02. Where required, mechanical ventilation and odour control facilities must also be provided. Odour control facilities must comply with Sydney Water's Technical Standard ACP0004 Odour Control Unit Standard Specification and latest IICATS standards for odour control unit (OCU).

M19.2 Septicity control

Septicity control for sewage pumping stations and sewer network must comply with Sydney Water Technical Standard ACP0002 Chemical Dosing Unit Standard Specification.

M20. Gearboxes

Valve and penstock gearboxes must comply with relevant valve gearboxes sections of this Specification.

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

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

Gear housings must 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 must be provided to permit inspection of the gears without disassembly of the gear reducer. Lifting lugs must be provided to facilitate safe lifting of the gearbox.

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

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

The gearboxes must have the following markings, unless specified otherwise in the relevant standards:

- Manufacturer's name
- Model and series number
- Year of manufacture
- Gear ratio
- Maximum allowable gearbox input torque.

The information must be shown on an engraved stainless steel nameplate. This nameplate must be permanently attached with a suitable adhesive. The plate must be in a location that must be clearly visible after installation.

The lettering must be as large as practicable but not less than 6 mm nor larger than 25 mm high.

M21. Drives and couplings

M21.1 Couplings

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

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

Pulleys and couplings must be balanced before the keyway is cut to eliminate vibration caused by lack of balancing. Then the whole assemblies complete with key must be finely balanced after assembly.

M21.2 Vee belts, wedge belts and toothed belts drives

Vee-belt wedge-belt drives must comply with AS 2784 (Endless Wedge belt and V belt drives). All drives must be designed with a minimum service factor of 2 based on motor rated power. Belts must be standard commercial items readily available locally and normally kept in stock. Pulleys and sprockets must be keyed onto the shafts using a taper type locking bush.

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

M21.3 Chain drives

Chains must be standard roller chains comprising steel links, hardened steel pins and rollers. Chains must comply with AS 1532 "Short pitch transmission precision roller chains and chain wheels" and must have a minimum pitch of 19 mm.

Sprockets must 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 must be provided in an easily accessible location.

M22. Penstocks

M22.1 General

This Specification, in conjunction with the codes listed hereunder, sets out the requirements for the manufacture, testing, supply and installation of cast iron and fabricated stainless steel wall and channel mounted penstocks for waterworks purposes.

Cast iron penstocks must be designed, fabricated, tested and installed in accordance with the requirements of ANSI/AWWA C560.

Fabricated stainless steel penstocks must be designed, fabricated, tested and installed in accordance with the requirements of ANSI/AWWA C561.

Where the requirements of this Specification conflict with ANSI/AWWA C560 or ANSI/AWWA C561, this Specification must prevail.

All penstock components made from cast iron or steel must be coated in accordance with WSA 201. No coating of stainless steel penstocks and components made from aluminium and copper based alloys is required.

Unless specified otherwise, all penstocks must be of a rising spindle configuration and designed for both seating and unseating heads, i.e. bi-directional.

All penstocks, including hand wheel at the gear box where fitted, must close in anti-clockwise direction.

Penstocks must be designed to resist all stresses which may occur during installation and operation, including overflow and 1% AEP events.

The minimum thickness of penstock gates and frames must be 6mm. All welding of fabricated stainless steel components must be continuous and comply with AS/NZS 1554.6. No welding of cast iron parts is allowed.

All manually operated penstocks must open and close with a maximum force of no more than 160 N applied on the operating element. The “cracking” torques and forces required to be applied for approximately ½ to 1 turn to off-seat or on-seat the penstock under maximum differential head conditions must not be higher than as stated by the Contractor and agreed to by Sydney Water.

For penstocks operated by removable key, their spindles must be provided with removable caps. The spindle cap and key must meet the requirements of AS 2638.1.

M22.2 Materials of construction

Penstocks must be constructed from the materials detailed below. The stated material grades represent the basic or minimum requirements, and materials of equivalent or superior quality may be acceptable subject to Sydney Water’s acceptance.

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

Copper alloy components subject to immersion must be dezincification resistant complying with AS 2345.

Seals must be manufactured from an elastomeric material that is not adversely affected by the fluid, temperature or environmental conditions to which they may be subjected to in service. Seals must comply with AS 1646.

Where in contact with potable or recycled water, all materials, lubricants and painting must comply with AS 4020.

M22.2.1 Cast iron penstocks

Frame:	Cast or ductile iron
Gate:	Cast or ductile iron
Yoke:	Cast or ductile iron, steel or grade 316 or 316L stainless steel
Spindle pedestal:	Cast or ductile iron or grade 316 stainless steel
Bolts and nuts:	Grade 316 stainless steel
Seating (wear) faces:	Bronze or grade 316 stainless steel
Guides:	Cast or ductile iron
Spindle lift (thrust) nut:	Gunmetal, aluminium bronze or manganese bronze
Gate top and side seals:	Neoprene, polyurethane, EPDM or plasticised PVC
Gate bottom seal:	Neoprene, polyurethane, EPDM or plasticised PVC
Gear housing:	Cast or ductile iron
Gears and gearboxes:	Refer to gate valve gearboxes clause of this Specification
Handwheel:	Cast or ductile iron
Spindle, spindle couplings and spindle brackets:	Grade 316 or 431 stainless steel
Spindle protection tube:	Clear polycarbonate or grade 316 stainless steel
Spindle bracket bushes:	Gunmetal, aluminium bronze or manganese bronze

M22.2.2 Fabricated stainless steel penstocks

In general, the materials listed below must be suitable for water and sewage applications.

Frame:	Grade 316 or 316L stainless steel
Gate:	Grade 316 or 316L stainless steel
Spindle pedestal:	Grade 316 or 316Lstainless steel
Yoke:	Grade 316 or 316L stainless steel
Bolts and nuts:	Grade 316 stainless steel
Seating (wear) faces:	UV-stabilised UHMWPE (Ultra High Molecular Weight Polyethylene)
Guides:	Grade 316 or 316L stainless steel

Spindle lift (thrust) nut:	Gunmetal, aluminium bronze or manganese bronze
Gate top and side seals:	Neoprene, polyurethane, EPDM or plasticised PVC
Gate bottom seal:	Neoprene, polyurethane, EPDM or plasticised PVC
Gear housing:	Cast or ductile iron
Gears and gearboxes:	Refer to gate valve gearboxes clause of this Specification
Handwheel:	Cast or ductile iron or grade 316 stainless steel
Limit nut:	Gunmetal, aluminium bronze or manganese bronze
Spindle, spindle couplings and spindle brackets:	Grade 316 or 431 stainless steel
Spindle protection tube:	Clear polycarbonate or grade 316 stainless steel
Spindle bracket bushes:	UV-stabilised UHMWPE, gunmetal, aluminium bronze or manganese bronze

Grade 316L stainless steel must be used in lieu of grade 316 wherever thickness of components exceeds 6 mm.

M22.3 Gate

Penstock gates must be designed to withstand all stresses resulting from the specified operating conditions with a safety factor as specified in the relevant standard.

The gates must be of a flush-bottom closure type, unless specified otherwise, and must clear the flow in the fully open position.

Penstocks must be designed so that the gate can be completely removed from the frame. For that reason, the penstock gate must be provided with a means of lifting it out of the frame for maintenance purposes or under emergency conditions. Means must be provided for emergency lifting of the gate by a crane from surface connections. The lifting attachments must be easily accessible for capture by lifting hooks. Where eyebolts are provided, they must comply with AS 2317.

M22.4 Frame

Penstock frames must be designed to withstand all stresses resulting from the specified operating conditions with a safety factor as specified in the relevant standard.

The frame must incorporate a guide rail to facilitate sliding of the gate over the length of its operating travel. Guide rail length must extend to engage at least two-thirds of the gate height in the fully open position. The guide rail must be designed for self-cleaning with minimal clogging.

The frame must be either the wall or channel mounted, as specified. Wall mounted frames must be sealed against the wall using compressed elastomeric seals appropriate to the working environment. Grout must only be used against unlined concrete wall surfaces. Channel mounted penstock frames must not be embedded in concrete. Channel benching must be shaped to allow penstock installation and future removal.

Frame must be fixed to concrete structure with grade 316 stainless steel masonry anchors. Mounting bolt size/pattern must be designed to cater for any thrust that may be exerted on the frame from force applied

when the actuator reaches stall torque. When the gate is off-seating the loads on the mount bolts must not exceed the manufactures specified pull-out load and tensile strength when a force of design head hydrostatic pressure is applied. The frame must not be subjected to undue forces during it installation which may cause its deformation or permanent damage.

M22.5 Sealing and seating faces

Penstock seals must be fixed on the gate so that they can be easily removed with the gate for maintenance.

Side and top seals must remain engaged under either on-seating or off-seating heads.

The bottom seat must be designed so as to eliminate grit traps.

Penstock guides must be fitted with replaceable low friction and wear-resistant wear strips.

M22.6 Spindle

Penstock spindles must be designed to withstand all stresses resulting from the specified operating conditions with a safety factor as specified in the relevant standard.

Penstock spindles must be made of a solid stainless steel bar or a stainless steel pipe with adequate strength to withstand all perceivable loads. They must utilise an ACME type single start thread machined to smooth finish on the bearing surface. Alternatively, a metric trapezoidal screw thread may be used instead.

Spindle brackets must be provided where recommended by the manufacturer. The brackets must be adjustable and spaced in accordance with the manufacturer’s recommendations. The bushings must incorporate grease lubrication points except where they are of the self-lubricating type.

Hand wheels (where fitted) must be installed between 900 and 1200 mm above the standing surface.

Penstocks with rising spindles must be fitted with stainless steel or transparent polycarbonate protection tube. A position indicator must be provided where non-transparent protection tube is used.

Limit nuts or collars must be provided on rising spindles and set such that excessive force applied by the operator will not buckle the spindle.

Spindle couplings, where required, must be provided where overall spindle lengths exceed 6 m or where necessary to couple to actuators. Couplings must be designed to transmit the loads from one section of the spindle to the other.

The penstock spindle must be fitted with a keyed locking mechanism to prevent its unintentional operation when either in closed or open position.

M22.7 Yoke

Self-contained penstocks must be provided with a yoke. Yoke must be designed to withstand the thrust of the actuator for maximum static head conditions.

The actuator mounting and guide contact surfaces must be accurately formed to ensure proper spindle alignment.

The yoke must be designed to allow removal of the gate from the frame.

M22.8 Pedestal

Pedestals and their mounting brackets must be of sufficient cross-section to withstand all thrusts resulting from the specified operating conditions. Mounting brackets must be fixed to the yoke or concrete structure. Fixing to metal flooring is not permitted.

M22.9 Actuators

Electric actuators requirements must be as per Sydney Water Technical Specification – Electrical (CPDMS0022).

Pneumatic actuators must comply with the Pneumatic Valve Actuators clause of this Specification.

All actuators must be push button operated and have a manual override.

Actuators must be installed on pedestals and, where specified, within vandal and weatherproof enclosures.

For a manually-operated penstock, the gearbox input shaft must terminate horizontally in a keyed shaft. The shaft must extend sufficiently to allow for operation by a portable actuator. A hand wheel suitable for mounting on the shaft must be supplied loose.

Penstocks installed on sewage pumping stations inlet sewer lines and in dividing walls must be fitted with electric actuators.

M22.10 Installation

All penstocks must be installed strictly in accordance with manufacturers' installation instructions.

M22.11 Inspection and testing

Shop and field inspection and testing of penstocks must be in accordance with the relevant ANSI/AWWA standards. Functional tests must include penstock operation from fully open to fully closed position and vice versa over a minimum of five cycles. Unless specified otherwise, testing must also include leakage test for both, seating and unseating. The maximum allowable leakage rates for shop and field tests must be as specified hereunder.

Test certificates must be provided for each penstock for the tests conducted both at the manufacturer's works and at site.

M22.12 Maximum leakage rates

The leakage rate for cast iron penstocks must not exceed 1.2 litres per minute per metre length of the seal length for seating and 2.4 litres per minute per metre length of the seal perimeter length for unseating heads.

The leakage rate for seating or unseating design heads for fabricated stainless steel penstocks must not exceed 0.2 litres per minute per metre length of the seal perimeter length.

Leakage tests must be conducted with clean water at ambient temperature.

M22.13 Required data

Prior to the commencement of fabrication, the manufacturer must provide certified drawings and material specification of the equipment to be supplied for Sydney Water's review and acceptance. The drawings must show the principal dimensions, general construction and be sufficiently detailed to enable Sydney Water to determine if the proposed equipment meets this Specification.

M22.14 Marking

Each penstock must have the following information provided on a nameplate permanently located where it can be readily viewed after installation:

a) Manufacturer's name or mark

b) Model number

c) Serial number

d) Aperture dimensions (width x height)

e) A direction of flow arrow if penstock is unidirectional

f) Maximum input operating torque (Nm)

g) Year of manufacture

h) Maximum static head (m).

M23. Stop boards

Stop boards must be of a proven design and comply with all Occupational Health and Safety requirements. Stop boards must be fabricated from 316 stainless steel or marine grade aluminium.

Design and materials used in the manufacture of the stop boards must be suitable for a minimum 25 year design life.

The stop boards must be fitted with a keyed locking mechanism to prevent their unintentional operation when either in closed or open position.

Stop board seals must be neoprene or UHMW polyethylene. Sliding friction must be taken into account when calculating lifting loads. No metal-to-metal sliding contact must be permissible. Direct bolting of plastics or neoprene must not be permitted.

Stop boards must be bi-directional or clearly marked to indicate the water flow (pressure) side.

Stop boards must have lifting handles and lifting lugs. The lifting lugs must be rated to allow for removal under maximum differential pressure conditions.

Stop boards must be designed to be safely lifted and fully removed or installed by one operator. Where stop boards cannot be safely manually handled by one operator, suitable lifting and handling device(s) must be used.

Guide members for stop boards must be designed to facilitate ease of installation and removal of the stop boards. Frame components must provide seating or sealing faces for the stop boards as appropriate, on the sides top and bottom.

For all new works, the frames must be embedded into the channel structure and must be flush with the channel sides.

For new stop gates/boards to be retrofitted into existing works, subject to Sydney Water’s acceptance, some channel flow obstruction by side and bottom frames may be allowed.

All stainless steel welds must be factory pickled and passivated in accordance with ASTM A380. All parts in sliding contact must be of dissimilar corrosion resistant materials.

For uni-directional stop boards, the edge of the bottom of the stop boards must be chamfered to provide a narrow bearing area on the seal.

Storage racks must be provided for stop boards when not in use in a position for easy access and out of normal access routes. The storage must be designed to protect the boards’ seals from sunlight and physical damage.

Stop boards must be designed to resist all stresses which may occur during installation and operation, including overflow and 1% AEP events.

The total maximum leakage rate for stop boards must not exceed 0.5 litre per minute per metre length of the seal perimeter length. The seal length calculation must not include the seals between the individual slide gate or stop board elements.

Leakage tests must be conducted with clean water at ambient temperature.

M24. Weirs

Weirs must be fabricated from stainless steel grade 316 plates and must be a minimum of 6 mm thick.

The plates must be supplied with slots for bolting the plates to the concrete wall or weir trough. Unless specified otherwise, the minimum range of adjustment that must be provided is ± 50 mm in the vertical direction. The distance between the slots must be determined by the designer as required to support the weir plate, but not greater than 600 mm.

The weir plates must be supplied and installed complete with a suitable backing material to prevent any flow between the plate and the material to which they are fixed. The weirs must be levelled to within ± 1 mm.

M25. Screening equipment

M25.1 General

This section covers the technical requirements for the supply of band screens, step screens and their appurtenances associated with the plant.

All screens supplied must be of a standard and proven design.

M25.1.1 Covers

The screen must be fully enclosed to prevent leakage and retain odour and aerosols within the channel system. Removable covers must be provided for servicing and inspection. Covers must be stainless steel grade 316. The covers must be hinged, lightweight and easily removable for maintenance access. Suitably sized and spaced air intake nozzles must be provided in the covers to allow an even collection of foul air from the sluice channels and screw conveyors.

M25.1.2 Inspection cover

A hinged and lockable type access opening cover must be provided for inspection and blockage clearance. As a safety measure limit switches must be installed on all hinged access cover to prevent the screen operation in an automatic mode when the access covers are opened.

M25.1.3 Lifting devices

The lifting devices supplied and installed must have the capacity to lift the screen for maintenance. A monorail or gantry (preferred) crane must be installed for below ground/covered area installations to suit for maintenance of the screen. Above ground/uncovered area installations must use a permanent or mobile crane for maintenance. The monorail/gantry crane must be designed to have a maximum load to swing the screen with a wet load wedged in the screen. Mobile cranes must also be used for replacement or removal for major overhaul of the screens from below ground / covered areas. Access road and outrigger placement must be considered where mobile cranes are used.

M25.1.4 Manual bypass bar screen

The manual raking height must not exceed 1.2 m from the operator platform level to avoid safety related manual handling issues.

M25.2 Band screens

M25.2.1 General

Coarse single stage screens must have 5mm or lager aperture size. Two stage screening for MBR applications must have coarse screening followed by 2mm aperture fine screening.

The screens must be perforated plate, self-cleaning and capable of capturing solids as per performance requirements. Wedge wire type not acceptable. The effective aperture area must be measured as the area of aperture (area of holes/slots) of the immersed area of perforated or slotted screen panel that can pass flow and immediately presented to the flow at the normal screen operating water level.

Grid velocities (i.e. through the throat of the screen opening) must be kept below 1.1 m/s for coarse screens, and below 0.5m/s for fine screens at the nominated blinding factor/s (minimum 50% for coarse screen aperture 5mm and above and 60% for 2mm fine screen aperture) to avoid pinning through the opening.

Consider using 20mm or 30mm bar screens in front of coarse screens where rocks can damage the coarse screens.

The design of the screens and associated components such as bearings, instruments and drives must consider the maximum possible sewage level in the channels. The screens must be able to operate and must be structurally designed to withstand the maximum possible differential hydrostatic head, and any possible impact from any solid object able to be passed at the maximum inlet velocity that may be present in the upstream approach channel.

Head loss profiles must be included for both average and peak flows at the nominated blinding factor/s (minimum 50% for coarse screen aperture 5mm and above and 60% for 2mm fine screen aperture)). Where a smaller aperture screen is nominated a blinding factor greater than the nominated minimum must be adopted subject to Sydney Water approval.

Screenings must be removed from the panel using spray wash headers incorporating nozzles that can be easily replaced or removed for cleaning. A reliable source of high-pressure wash water is required to clean the screens. Reclaimed effluent is to be used as the primary source of wash water and sluice water. A review of available reclaimed effluent quality, quantity, availability and pressure must be carried out for wash water and sluice water requirements.

An allowance for backup water is required in the event the primary water supply becomes unavailable e.g. if the reclaimed effluent fails, then supply backup with industrial or potable water. Strainers must be provided in the supply line to the nozzles as agreed with Sydney Water to minimise nozzles blockages. Strainers must be Y or basket type for potable water, mixed media and membrane filtered water and must be fitted with a 15mm manual blowdown valve directed to a suitable drain. Autocleaning style strainers must be provided for all other water types such as clarified secondary effluent and filtered primary effluent. The blowdown from autocleaning style strainers shall also be directed to a suitable drain that has been designed to manage high impurity loads.

The removed screenings must be transferred via a sluice launder or screw conveyor to the screenings wash press units and the sluicing system must be designed to carry peak screening and wash water flow rates.

The drive mechanism and associated moving parts must be mounted above the channel and must be readily accessible for maintenance purposes. Only the mainframe and screen panels must be submerged in sewage.

Any moving parts below the water level subject to wear/frequent maintenance due to solids such as grit is not acceptable.

The screens must be removable from the channels as a unit without disassembly or interruption to the flow. Lifting lugs are to be provided for this purpose. Screens must be removable in a safe manner, without the need for personnel to enter the channels or enter any hazardous location.

The weight/mass of the equipment to be lifted must be permanently marked. This may include a percentage for blinding.

The screenings system must be fully automatic in operation and must operate continuously unattended. Failure detection must be provided for all items of equipment and automatic shutdown of the plant or individual items of equipment must be provided for as specified.

M25.2.2 Screen control

The screens must have at least two of the following operating modes:

a) Differential Control: Based on head loss through the screen. There must be at least three level settings, LOW, MID and HIGH. For the LOW setting, the screens for any channel in operation will remain idle (unless completing a cleaning cycle). When the Operating Differential Level rises above the Low Differential setpoint for a period, the screens will perform a cleaning cycle, running at low speed. When the Operating Differential Level is above the Mid Differential setpoint, but below the High Differential setpoint for a period the duty band screens operate simultaneously and continuously at medium speed. Similarly, when the Operating Differential Level is above the High Differential setpoint for a period the duty band screens operate simultaneously and continuously at high speed. The HIGH setting must be approximately 200 mm below the bypass weir level. The three level settings must be Operator Adjustable Parameters at the PMI.

b) Level Control: Based on a continuous upstream or downstream water level requirement. The duty band screens must operate simultaneously and continuously at variable speed to maintain the required water level. Standby band screens must be brought online as needed to maintain the required water level.

c) Timer Control: Based on the time of day and the parameters must be Operator Adjustable at the PMI.

A VSD must be supplied for the screen drive motor to enable the belt speed to be adjusted according to the head loss and/or water level.

M25.2.3 Construction

The screens assembly including the framework and enclosure and all other wetted components must be fabricated from grade 316 stainless steel or other accepted corrosion resistant materials (e.g. Band screen panels may also be manufactured from HDPE, Polypropylene, UHMWPE, guide links/wear strips UHMWPE, Gaskets EPDM, etc.). Fixings must be grade 316 stainless steel. Any items not of grade 316 stainless steel material must be identified in the tender documents.

The screen design must be such that individual panels can be removed and replaced without having to dismantle the whole screen.

M25.2.4 Drive assembly

Overload and/or damage protection to be provided through an electronic shear pin. During commissioning the operation of the protection mechanism must be checked and demonstrated.

M25.3 Step screens

This section covers the general technical requirements for supply and installation of step screens. Sydney Water is moving towards screens that provide a high capture rate, typically > 70%. Existing step screens

may be replaced at the end of design life with either band screens, or other high capture screens, based on site assessment.

M25.3.1 General

The screens must be bar filter type, self-cleaning and capable of capturing solids as per performance requirements. The effective area of the fine screen through the channel must not be less than 45% of the channel width.

Screenings must be removed from the face of the screen through the interaction of the relative motion between the bars and the shape of the bars and the slope of the screen face.

The screenings must be lifted to a height to allow them to be discharged on to the succeeding equipment (screenings conveyor) then to the screenings washing/de-watering units.

The fine screen must be of the Step type fine screen consisting of interlaced bar racks. The bar racks must be mounted together so that every second bar is stationary, and the adjacent bars are movable.

The drive mechanism and associated moving parts (excluding movable bars) must be mounted above the channel and must be readily accessible for maintenance purposes. Only the mainframe and screen bars must be submerged in sewage.

The frame must incorporate a pivoted mounting that allows raising of the bottom of the screen from the channel.

The screen must have a grit flap and anti-blocking feature on the channel floor. The space between the bottom of the screen and channel invert must not exceed 3 mm.

The screen must include side frames with pivoting mechanism, step racking, bar racks, discharge chute, drive unit, electrical control devices and enclosure.

The screenings system must be fully automatic in operation and must operate continuously unattended. Failure detection must be provided for all items of equipment and automatic shutdown of the plant or individual items of equipment must be provided for as specified.

The design of the screen and its appurtenances, such as bearings and electrical devices, must consider the maximum possible sewage level in the channel under the worst conditions.

M25.3.2 Screen control

The screens must have two Process Operating Modes:

a) Level Control: Based on a continuous upstream water level sensor. There must be at least three level settings, LOW, MID and HIGH. For the two lower settings, the frequency of step initiation and the number of steps after each initiation must be Operator Adjustable Parameters at the PMI. When the depth reaches the HIGH setting, the screen must step continuously. The HIGH setting must be approximately 200 mm below the bypass weir level. The three level settings must be Operator Adjustable Parameters at the PMI.

b) Timer Control: Based on the time of day initiation of screen stepping. There must be at least three separate settings of Operator Adjustable Parameters at the PMI, for the frequency of step initiation and the number of steps after each initiation.

For both Process Operating Modes, there must be a lag timer, to delay stepping of the follow screen by an adjustable time, after the lead screen has parked.

There must be a float switch, set approximately 50 mm above the HIGH setting, to initiate continuous stepping, if continuous stepping has not already been initiated by either of the Process Operating Modes.

The screen must have an easily adjusted park switch on the gearbox output shaft to allow accurate parking of the moving screen steps, in line with the fixed screen steps and to count the number of steps. The park switch will be an inductive proximity switch type or limit switch type. Accurate parking position must be demonstrated during commissioning.

The screen must include an electronic shear pin to protect the screen from over torque.

M25.3.3 Construction

The entire screen assembly including the screen bars, framework and enclosure and all other wetted components must be fabricated from grade 316 stainless steel. The width and thickness of the bars must be such as to provide ample strength to fulfil the necessary duties. The clear spacing between bars must be 3 to 6 mm. This spacing must be maintained by intermediate spacers which are made from a replaceable bearing material.

The screen design must be such that individual bar element can be removed and replaced without having to dismantle the whole screen.

The construction of the side frames and bar racks assembly must permit the assembly to be readily removed. The fine screen frame must be supported at the top of the channel and be able to rotate completely from the pivot and drop into the channel with no anchor bolts or attachments to the channel floor.

M25.3.4 Drive assembly

The screen must be driven through a reduction gearbox by an electric motor. Mechanical torque protection or a proven electronic method will be provided to protect the screen element and transmission components against overload and/or damage. During commissioning the electronic shear pin operation must be checked and demonstrated.

M25.3.5 Safety relief flap gate

A step screen discharge chute must be provided with a safety relief flap gate. In the event of discharge chute blockage, the flab will open and prevent compacting the discharge chute and overloading the step screen. An interlock must be provided to stop the step screen operation when the emergency flap gate opens.

M25.4 Screenings wash press

M25.4.1 General

The screenings wash press is part of the screenings handling facility. It must be sized to effectively convey, wash and dewater the maximum volume of screenings expected for the range of flows without blockage or failure. A substantial increase in sluice water must be accommodated in the hydraulic design of the screening wash press when band screens have been specified in preference to step screens. An allowance

for backup water is required in the event the main water supply becomes unavailable e.g. If the reclaimed effluent fails, then supply backup with industrial or potable water.

The screenings wash press must be an integral unit where screenings must be washed, dewatered, and compacted.

The screenings wash press must be a shafted screw type complete with troughs, covers, drive units, supports and anchor bolts.

The screw conveyor trough must have a drainage pan with slots for draining of the washed organic liquid. It must have replaceable brushes on the screw flights.

The screenings wash press must be supplied complete with:

a) Purpose designed wash zone

b) Dewatering compaction zone

c) Discharge press pipe

d) Drain connections for organic return

e) Inspection hatches

f) Wash and flush solenoid valves

g) Drive unit.

The screenings wash press must consist of two zones:

a) In the first zone: the screenings are washed

b) In the second zone: the washed screenings are dewatered and compacted.

The screw must be designed so that clogging and build-up on the flights must not occur.

The screw must have provision for movement and support bearing at the drive end which must be capable of taking the thrust load.

The shafted screw flights must be sized to suit the maximum screenings discharge rates.

The trough must have a minimum two drain holes with a drainpipe.

The screw wash press must have a suitable piped drain to drain water to a drain system, which discharges upstream of the operating screen.

M25.4.2 Screenings wash press control

The operation of the screenings wash press must be designed and supplied to be interlocked with the operation of the surrounding equipment and to prevent unwanted spillage of conveyed material when equipment is not operating.

M25.4.3 Screenings wash press feed hopper

The feed hoppers must be designed to receive and discharge material without blockage. The feed hoppers must be integral parts of the screenings wash press and must be manufactured from grade 316 stainless steel.

M25.4.4 Screenings wash press supports

The screenings wash press must be supported at each end and at intermediate location where applicable.

All support steelwork must be fabricated from grade 316 stainless steel.

External support steelwork must be fabricated from structural steel and be hot dipped galvanised or painted after fabrication.

Connections between grade 316 stainless steel and galvanised steelwork must be bolted using insulation between dissimilar metals.

Welding between grade 316 stainless steel and carbonised steel is not permitted.

M25.4.5 Screenings wash press drive

The screw conveyor drive must be by an electric motor with a directly mounted speed reduction unit. The motor must be mounted in an accessible location.

The drive unit must be fitted with an electronic shear pin to prevent excessive loading or seizure.

M25.4.6 Material of construction

The material construction of the screenings wash press must conform to the following:

a) The external double trough must be grade 316 stainless steel, with minimum 5 mm thickness

b) The internal double trough must be grade 316 stainless steel, with minimum 3 mm thickness

c) The inspection & access lids must be grade 316 stainless steel, with minimum 2 mm thickness

d) The spiral must be high tensile micro-alloy steel

e) The press pipe must be grade 316 stainless steel

f) The chute and feed hopper must be grade 316 stainless steel, with minimum 2 mm thickness

g) The support legs and brackets must be grade 316 stainless steel.

M25.4.7 Washing and flushing

The washing and flushing RE pipework to the screenings wash press must each include the following:

a) Isolation valve

b) A strainer, which must incorporate a flush out valve and which must be readily dismantled for cleaning, without having to remove the strainer from the pipework

c) Separate flow switches on the pipes to the washing and flushing zone. Each flow switch must be a low flow switch, which must initiate an alarm during a low flow or no flow condition in the RE supply to the respective zone.

d) Separate solenoid valves must be installed in the lines to the washing and flushing. Each solenoid valve must open and close under the control system for the screenings facility to direct the RE supply to the respective zone.

The washwater and flush water supply to the screenings wash press must be failsafe.

The screw wash press and its solenoid valves must operate intermittently under the control system for the screenings handling facility.

M25.5 Screenings washing/dewatering unit

This section covers the general technical requirements for a screenings washing/dewatering unit to enhance the product from the screenings wash press.

M25.5.1 General

The screenings washing/dewatering unit must be of a proven proprietary design preferably with operation in Sydney Water plants.

The screenings washing/dewatering unit must be capable of further enhancing the washing and dewatering of the screenings wash press to achieve dryness in excess of 35% and residual organics of 5% - 7%.

The screenings washing/dewatering unit must be sized to effectively convey the maximum volume of washed dewatered screenings from the discharge of the screw wash press to the discharge point without blockage or failure.

The screenings washing/dewatering unit must be designed for use with the screenings wash press unit and must be of the counter pressure screw (CPS) unit type.

The screenings washing/dewatering unit must be supplied complete with:

a) Drive Unit

b) Integrated fully shaft screw with cutter

c) Adjustable support

d) Discharge elbow connection.

M25.5.2 Control

The screenings washing/dewatering unit must operate intermittently, under the control system for the screenings facility.

The operation of the screenings washing/dewatering must be designed and supplied to be interlocked with the operation of surrounding equipment and to prevent unwanted spillage of conveyed material when equipment is not operating.

M25.5.3 Feed connection to screenings washing/dewatering unit

The screenings washing/dewatering unit must be connected to the screenings wash press with an appropriately designed elbow and pipe connection. The elbow and pipe connection must be manufactured from grade 316 stainless steel.

M25.5.4 Supports for screenings washing/dewatering unit

All support steelwork must be fabricated from grade 316 stainless steel.

Further external support steelwork, if required, must be fabricated from structural steel and be hot dipped galvanised or painted after fabrication.

Connections between grade 316 stainless steel and galvanised steelwork must be bolted using insulation between dissimilar metals.

Welding between grade 316 stainless steel and carbonised steel is not permitted.

M25.5.5 Screenings washing/dewatering unit drive

The screenings washing/dewatering drive must be by an electronic motor with a directly mounted speed reduction unit.

The drive unit must be controlled by the electronic shear pin fitted on the screenings wash press to prevent excessive loading or seizure.

The operation of the screenings washing/dewatering unit must not generate excessive noise and must preferably have a noise level not exceeding 75 dB(A) at 1 metre free field.

M25.5.6 Material of construction

The material of construction of the screenings washing/dewatering unit must conform to the following:

a) The cylindrical trough frame must be grade 316 stainless steel

b) The shafted screw spiral must be of high tensile micro-alloy steel

c) The support must be grade 316 stainless steel

d) The discharge chute must be grade 316 stainless steel.

M25.5.7 Washing and rinsing

The screenings washing/dewatering unit must preferably be designed to minimise the use of RE water for washing and flushing.

M26. Grit removal system

M26.1 General

The grit removal system must be capable of capturing grit as per performance requirements.

The grit removal system must consist of a flat bottom circular concrete tank having tangential inlets and outlets, 360 degrees rotation, and a turn down ratio of 10:1. The vortex flow must be maintained within a range of 1.1 m/s at peak flow and 0.5 m/s at minimum flow. Grit capture rates to be as follows:

a) >95% of 300 µm

b) >85% of 200 µm

c) >65% of 150 µm.

The plants that have down-stream processes, such as Thermal Hydrolysis (THP), which limits the amount of incoming grit, the capture rate for the grit system must be > 95% for 150 µm particles.

Removed accumulated grit must be collected in the pit centrally located in the tank. A Grit pump must remove the accumulated grit from the centrally located hopper.
The vortex type grit removal system must include:

a) Inlet channel to produce the Coanda effect

b) Rotating paddle mechanism to provide spiral sewage flow to keep organic matter in suspension and allow settling of the grit into the chamber

c) Centrifugal pumps for the removal of settled grit from the arrester

d) Classifier for further dewatering of grit

e) All interconnecting pipework, solenoid valves and fittings

f) All limit switches, mechanical overload devices, interlocks, etc. necessary for the correct functioning of the equipment.

The system must:

a) Be a proprietary system with a proven performance record

b) Consist of a circular concrete tank with tangential inlet and radial outlet

c) Have vortex flow maintained by a rotating paddle with accumulated grit removed from the pit by means of a pump

d) Handle the range of flows discharged from the inlet works

e) Be designed to prevent blockage or damage by paper, rags, etc

f) Avoid 90-degree bends and eliminate unnecessary elbows

g) Use dedicated suction and discharge lines.

The discharge line from the grit removal pump must deposit the flow into a screw type grit washer classifier which elevates the grit laden slurry, allowing water to drain back into the tank, and discharge the dewatered grit into a mobile storage bin.

M26.2 Operation

The paddle mechanism must operate continuously, while the grit pumps and classifiers operate intermittently on a predetermined cycle. The cycle and period of operation must be determined at the time of commissioning to optimise grit removal from the chamber.

The equipment must be designed to handle the range of flows at a minimum loss of head and must operate under widely varying flow conditions without requiring adjustments.

M26.3 Paddle mechanism

The paddle mechanism must comprise two or more rotating paddles attached to a central paddle drive which revolves around a drive tube. The paddle must be self-cleaning whereby it removes fibrous material by the incorporation of a "swept back" design.

Paddles must be designed to create upward thrusts in the centre of the tanks to cause sewage to spiral on a horizontal axis as it revolves. The paddle velocity must be appropriate to detain organics in suspension and settle grit at the base of the hopper.

The paddle drive tube must be supported axially through a main ball bearing slewing ring or turn table bearing which must be protected against submergence.

The bearing must have a design life in excess of 100,000 hours.

The paddle drive tube must be rotated through a large gear head, grease packed and with a direct mounted high efficiency gear reduction unit.

The paddle drive unit must be mounted in a substantial cast iron gearbox with a base plate for bridge mounting above the tank.

M26.4 Grit removal pump and pipework

One centrifugal pump must be installed for each grit tank. The pump may be mounted above the tank with vacuum priming or remote mounted flooded suction type. The suction pipe and grit discharge pipe must be a minimum of 100 mm diameter. The suction pipe must be grade 316 stainless steel. Vertical, direct coupled type centrifugal pumps only must be installed (i.e. no horizontal, belt driven types).

Grit pumps must include:

a) Ni hardened impeller and volute

b) Solid stainless steel shaft

c) Heavy duty bearings

d) Mechanical seal

e) Recessed impeller.

Additionally, the top mounted vertical pump must:

a) Include a sensor to detect if pump is primed

b) Have suction piping less than 5 m in length.

The grit pump must discharge into the classifier.

Pipework carrying grit slurries must satisfy the following criteria:

a) Fluid velocities must be in the range 1 to 2.5 m/s

b) All bends must be long radius type, moulded elbows are not acceptable

c) Except for flushing connections, the use of tees must be avoided. But where this is not possible, they must be “wye” type tees are permissible.

d) Long vertical should be avoided

e) Tapping points on the underside of pipes is not permitted.

M26.5 Grit pump/water sparge assembly

A grit pump/water sparge assembly shall be furnished to facilitate grit removal. The assembly shall consist of water (reclaimed) sparge and grit pump. The water sparge shall agitate the grit and then be pumped by the grit pump to the grit washing classifier. The water sparge is fed from the reclaimed effluent main and shall be activated by a solenoid valve. The grit pump shall have a recessed torque impeller specifically designed for grit handling. The system shall also have the facility to backflush the grit pump suction line with reclaimed effluent.

M26.6 Grit washer classifier

This section covers the general technical requirements for Grit Washer Classifier.

The grit washer classifier shall be of a proven proprietary design washing classifier capable of washing and dewatering the pumped grit from the grit tank to achieve dryness in excess of 90% and residual organics less than 5%.

The classifier shall be of the inclined Archimedean screw type or similar used for separation of grit from organics. The classifier shall be fabricated from stainless steel and shall comprise of an inclined screw housed within an inclined trough and inlet hopper.

The grit washer classifier shall be mounted on a free standing frame bolted to a concrete plinth. The grit washer classifier shall have a successful grit operating record in sewage plants.

Interconnecting pipework and valves shall be provided to enable grit laden slurry to discharge from the grit pump to the classifier and provide overflow and drainage from the classifier back into the inlet works.

M27. Rectangular clarifier/primary sedimentation tank equipment

This section covers the general technical requirements for the mechanical equipment for rectangular clarifier or primary sedimentation tanks.

The rectangular clarifiers shall be provided with all baffle plates, longitudinal and cross sludge scrapers, scum scrapers, effluent launders, scum baffles, drive units, launder weirs etc. and manufactured of suitable materials for operation under submerged conditions in sewage.

Clarifier tanks shall be constructed conforming to the performance requirements of this Specification.

M27.1 Scraper - chain and flight type

M27.1.1 Longitudinal sludge scrapers

The longitudinal sludge scrapers shall be non-metallic chain, sprockets and flight type, complete with chain, flights, attachment links, wear shoes, wall brackets, return rails, floor rails and wear strips.

The longitudinal sludge scrapers shall comprise a chain and flight assembly, which:

a) Scrapes sludge to a sludge trough or sludge hopper in the tank floor

b) Skims scum to a trough at the end of the tank.

Alternatively, the scum skimmer and the sludge scrapper shall be two separate units.

M27.1.2 Cross sludge scrapers

The cross sludge scrapers must be non-metallic chain, sprockets and flight type complete with chain, flights, attachment links, wear shoes, floor rails and wear strips.

The cross sludge scraper mechanism must comprise a chain and flight assembly, which scrapes sludge to the sludge hopper.

M27.1.3 Scraper/collector chain

The scraper chain must be non-metallic having a six-inch pitch and specifically designed for sludge scraper usage. The chain must have a minimum rated working load of not less than 14 kN based on strength, fatigue and wear consideration. The chain must have an ultimate breaking strength of 29 kN minimum. In addition, the collector chain must be designed to withstand a working load of up to 200% of the full load running torque of driving motor. Chain links must be manufactured from thermoplastic polyester resin. The links must be integrally moulded with the barrel and both side bars formed in one piece to ensure squareness and strength of the links. Maximum elongation of the chains at rated working load must not exceed 0.1% at its rated working load.

Connecting pins must be non-metallic, moulded in one piece, from acetal resin. Pins must have a moulded T-head, which must seat and lock inside the moulded chain link to prevent pin rotation. The pin must positively lock when chain is assembled.

M27.1.4 Scraper/collector flights assembly

M27.1.4.1 Scraper/collector flights

The longitudinal and cross collector scraper flights must be minimum height of 190 and 150 nominal sizes, respectively. Flights must be of heavy-duty channel shape or box type or an H section with wear shoes, designed to offer maximum rigidity with less than 6 mm deflection in worst operating condition. Standard design of "C" channel flights, angle type flights, buoyant flights are not considered suitable. and must not be used. The flights must be specifically designed for sludge scraper service. Each flight must have a scraper lip on the leading edge, plastic filler blocks for bolting to the flight attachments to match the flight attachment links. The lip must be of a material, which will not degrade or wear significantly during contact with the tank floor. Cut or exposed edges of fibreglass material must be coated with an epoxy resin to prevent ingress of moisture into the fibreglass structure.

M27.1.4.2 Flight attachment links

Rigid, non-metallic flight attachment links must be manufactured from the same material, and must have the same load rating, as the collector chain links. The attachment links must extend the full depth of the flight and be integrally moulded in one piece to assure flight attachment.

M27.1.4.3 Flight wear shoes

The carrying wear shoes must run on floor rails. Return wear shoes must run on angle tracks.

Wear shoes must be reversible providing two useable wearing surfaces. Wear shoes must be 20 mm thick high grade polyethylene Cast Nylon-6 material manufactured in compliance with ASTM D789 and must be fastened to the flights. The main purpose of these wear shoes assembly is to protect from rubbing against the tank bottom. Four pieces of wear shoes must be fixed in each scraper flight (two pieces of carrying wear shoes and two pieces of return wear shoes).

M27.1.5 Return rails

The return rail must be lightweight and supported from the tank wall with support bracket. The return rail must be capable of supporting all combination chain and flight materials. Return rails must be of 304 grade stainless steel or a standard fibreglass reinforced plastic angle section (minimum 50 x 75 x 6 mm thick) manufactured in compliance with ASTM 4020-81 of sufficient strength to carry the conveyor distributed load. All return track hardware must be 316 stainless steel. Return rails must be supported at regular intervals to suit the rail strength and applied load.

Return rails must be of sufficient strength to withstand the impact loads expected to result from the worst case tensioning of the collector system.

Return rails must be supported by wall bracket. Wall bracket assemblies must be of solid type construction and of Cast Nylon-6 material. Rail support shoes must be nominally 12 mm thick and of Cast Nylon-6 material.

M27.1.6 Floor rail

The scraper chain and flight must be supported on the floor rail, which must be embedded in floor of the sedimentation tank. The floor rails must be of UHMW polyethylene manufactured to ASTM 4020-81. All

connection hardware must be grade 316 stainless steel. The floor rails must be slotted to provide lateral guidance to the flights and also feature an allowance of thermal expansion and wear indicator.

M27.1.7 Wear strips

Floor and return rail wear strips must be 10 mm thick Dotmar UHMW - PE Polystone 7000 SR Black.

Floor wear strips must be mounted directly to tank concrete floors with chemical anchor bolts spaced at a maximum of 1.2 m.

Return rail wear strips must be attached to return rails with slotted pan head machine screws, each with a flat washer, split lock washer and hex head nut at maximum of approximately 1.2 m centres.

M27.1.8 Collector sprockets and shafts

M27.1.8.1 Head drive shaft assembly

Head drive shaft assembly must be complete with drive sprockets, chain tensioner, idler sprockets, drive chain, electric motors, guards and loss of motion sensors.

The main longitudinal and cross scraper drive shafts must be manufactured from stainless steel or high strength glass fibre reinforced polyester resin.

M27.1.8.2 Head shaft drive sprockets

Drive sprockets must be fastened to the drive shaft, which operates the chain sprockets. The sprockets must have chain saver rims and must be of a solid type construction. All sprockets must be compatible with non-metallic chain and the drive shafts.

M27.1.8.3 Idler stub shaft assemblies

Stub shafts must be of solid one-piece construction from Cast Nylon-6 material mounting to wall.

Stub shaft bearings must be of solid type construction and of UHMW - PE material. Bearings must be secured to stub shafts by non-metallic keys. Stub shafts must have Cast Nylon-7 sprocket retainer plates.

M27.1.8.4 Idler sprockets

The scraper chain idler sprockets must be of solid type construction. Sprockets must be 100% Cast Nylon-6.

M27.1.9 Protection devices for longitudinal and cross sludge scrapers

The longitudinal and cross sludge scraper must be provided with the following protection devices:

a) A proximity type switch to detect on SCADA loss of motion of the longitudinal and cross scrapers (e.g. broken chain or shaft key)

b) An electronic torque limiter or an electronic shear pin to detect on SCADA high torque on the drive system (e.g. from a lump of concrete on the floor of the sludge trough)

c) A travel and alignment sensing system must be provided to continuously keep track of normal operation.

Protection devices must be operative in either field or remote equipment mode selection.

M27.1.10 Loss of motion and travel and alignment sensing system

The travel and alignment sensing system must keep plant personnel alerted to flight misalignment or loss of motion before a failure can occur.

The travel and alignment sensing system must be located on downstream end of the return scraper chain to detect failure of movement and or misalignment of the flights. The system must made up of two idler sprockets, which follow the scraper chains. Metallic "targets" attached to the sprockets must be sensed by proximity switches which report to a control panel. If the chain becomes misaligned, the control panel must recognize a difference in the phase of the sprockets, raise an alarm and disconnect power from the drive.

If the panel recognizes a loss of motion from any of the proximity switches, the power must be disconnected from the drive and an alarm raised. Equivalent or better alternative proprietary travel and alignment sensing systems are acceptable.

All sensors installed under water must have IP68 rating.

M27.1.11 Drives

Longitudinal and cross scraper must be driven by separate drive unit complete with speed reducer (i.e. one drive per tank). The base plate must be bolted directly to the operating platform bridge. Each drive must have ample power for starting and operating the cross scraper mechanism under normal operating conditions without overloading.

A chain tightener must be provided to take up any unnecessary slack in the drive chain. The chain tensioner must be mounted in a readily accessible place for easy maintenance.

The drive sprockets and chain tightener sprockets must be plastic.

A chain tightener must be provided to take up any unnecessary slack in the drive chain.

M27.1.11.1 Drive motor

The longitudinal sludge collector drive units must be equipped with a variable speed drive (VSD) featuring an integrated overload protection, soft start and over torque setting. The VSD must allow the operators to adjust the scraper speed to an optimum level.

The motor for each cross sludge scraper drive must be a fixed speed motor with ample power for starting and operating the collector mechanisms under normal operating conditions without overloading. An electronic shear pin must be provided to protect the cross sludge scraper mechanism.

Machine drives must be selected to be conservatively rated under all conditions of loading possible in the course of normal operation of the plant. Normal operation includes jamming by foreign matter for mechanical handling equipment.

The electrical over torque limiter (or shear pin) must be set at 20% more than maximum sludge load. The electrical over torque limiter must fail before the mechanical shear pin (or mechanical torque limiter).

M27.1.11.2 Mechanical torque limiter

The drive unit must be provided with a torque limiting type gearbox to protect the sludge scraper assembly from overloading. The torque limiter must be set to the maximum allowable torque required to drive the

sludge scraper. This must protect all mechanical components of the scraper system and minimize the damage due to possible overloads.

As an alternative to over torque limit type gearbox slipping clutch type mechanical shear pins must be provided on drive chain sprockets assembly with load rated for 30% more than maximum sludge load.

The mechanical shear pin must be designed to safeguard and prevent failure from slipping or breaking or damaging of the following equipment:

- Flight and attachment links
- Collector chain
- Drive chain.

Proximity switches must be installed for detection of Collector Drive failure.

M27.1.11.3 Drive chain

The drive chains that are submerged in water must be of heavy duty, non-metallic glass reinforced.

The drive chain must have a load rated 50 % more than maximum sludge loads. Chain must have a minimum working load of 7 kN. The ultimate breaking strength of drive chain must be 25% lower than the breaking strength of collector chain.

M27.1.12 Scum troughs

The scum troughs at each end of each clarifier must receive the scum collected from the scum skimmers and discharge scum into scum pumping station.

The scum trough must have rotating painted, hot dip galvanised or painted steel pipes with slot openings at the top and running across the entire width of the tank.

The collector pipe must operate automatically to turn and immerse the slot below the top water level to let the scum flow into the collector pipe for scum harvesting.

When scum is decanted from the tank, appropriate indication must be given on the SCADA.

M27.1.12.1 Collecting pipe

The collecting pipe must have an opening at the top and run across the entire width of the tank. The collecting pipe must be a rotating type and collect the floating scum when it is rotated through up to 90º. The troughs must be fitted with a motorised or pneumatically operated system to tilt the open top pipe through 90º angles. When the operation is completed, the scum trough will return to its parked position.

When the pipe opening is at the top position the scum trough acts as a baffle to trap the scum. The pipe must be grade 316 stainless steel with minimum of 305 mm diameter and 8 mm thickness. The opening must be 60º slots along the pipe.

M27.1.12.2 Collar

Each scum collection pipe must be supplied with two collars. The collar must be made of grade 316 stainless steel pipe plate to support the scum collection pipe on either end.

M27.1.12.3 Seal

Greased bearings are not preferred, but where used the collar must be supplied with rubber ring seal to minimise friction and to avoid leakage.

M27.1.12.4 Effluent launder

Effluent launders must be provided at the end of the clarifier for removal of clarified effluent. The material of the effluent launder must be either concrete or grade 316L stainless steel. An adjustable weir must be provided as an integral part of the launder. The weirs must have at least 20 mm of adjustment up and 20 mm down.

The weir plate must have minimum 3 mm thickness and 100 mm (minimum) deep grade 316L stainless steel plate. The weir section must be V notched and fastened to the launder wall for vertical adjustment.

M27.1.13 Materials

The scum throughs must be made from the following materials:

Scraper flights	ASTM 3917-80	Fibreglass reinforced polyester
Drive chain	ANSI-B29.16	Reinforced nylon resin NH78 pattern
Scraper chain	ANSI-B29.13	Thermoplastic polyester resin NCS 720 pattern
Flight attachment links	ANSI-B29.13	Thermoplastic polyester resin NCS 720 pattern
Flight wear shoes	ASTM D789	Cast nylon 6
Floor rail and wear strip	ASTM 4020-81	UHMW-PE (Ultra high molecular weight polyethylene - Virgin Grade) or stainless steel grade 316
Wall brackets	ASTM D789	Cast Nylon 6
Return rails	ASTM 3917-80	Fibreglass reinforced polyester or stainless steel gr. 316
Wear strips	ASTM 4020-81	UHMW-PE
Head shaft drive sprockets	ASTM D789	Cast Nylon 6
Idler sprockets	ASTM D789	Cast Nylon 6

M27.2 Scraper - Travelling bridge type

M27.2.1 General

The travelling bridge collector must be a complete bridge assembly supported on AS 1085 Rails. The bridge assembly must consist of a travelling bridge with walkway, bridge drive, sludge removal system, support rail and anchorage parts and electrical control panel with necessary controls for the operation of the mechanism. The drive train must be designed to withstand maximum horizontal loads placed on the bridge and sludge removal system. All parts of each mechanism must be proportioned for stresses that may occur during fabrication, installation and operation.

The sludge collector must meet following operational conditions:

1. The collector must have enough capacity that channelling of over lying liquid through sludge will not result
2. The mechanism must be sufficiently rugged to transport and remove sludge up to 4% TSR that could accumulate in settling tank during periods of mechanical breakdown or power failure.

M27.2.2 Bridge construction

The bridge must be designed to span the entire width of the tank. Bridge construction must be as per requirements in Sydney Water's Technical Specification – Civil (CPDMS0023). The walkway must be covered with floor plate/ grating and must be in accordance with AS 1657.

M27.2.3 Bridge Drive

The drive assembly must consist of variable speed drive, gear reducer, drive chain, and drive and driven sprockets. All gearing must be fully enclosed in an oil tight housing with the gears running in oil. Bearing must be anti-friction type. Drive chain must be roller chain type. The motor must comply with IP 56 standards.

Drive shaft must be of sufficient size to adequately and safely withstand all loads of starting and operating. The drive shaft must be supported by multiple, grease-lubricated bearings.

M27.2.4 Scraper sludge removal, blades and supports

The scraper blade assembly must be positioned and guided by two or more rigid structural steel support assemblies attached to the bridge. The scraper assembly must retract above the water surface for maintenance and inspection.

M27.2.5 Power supply system

The following systems must be used.

M27.2.5.1 Power supply stretch cable system

A stretch cable system must be provided with number of pulleys, which support the electrical cable used to power the collector. The electrical cable must be looped in coils with each coil being attached to a separate pulley.

M27.2.5.2 Power supply trolley track system

A trolley track system, which allows the electrical cable to uncoil and retract as the bridge moves, must be provided.

M27.2.5.3 Power supply cable reel system.

A cable reel system capable of unwinding and rewinding the power cable while maintaining a constant tension on the cable must be provided. A strain relief device must be provided to protect the fixed end of the cable.

M27.2.6 Scraper sludge removal cross collector

A cross collector must be Helical screw type or chain and flight type.

M27.2.6.1 Helical screw type cross collector

A screw cross collector consisting of a drive unit with an overload alarm, vertical drive shaft, underwater gearbox, helical screw, bearings and anchors must be provided. The drive unit must consist of a motor and gear reducer connected to a vertical drive shaft through a flexible coupling.

Under water gearbox must be pressure lubricated and must have bearings and seals designed for submerged operation. Grease lubrication lines must be provided from each submerged bearing to an accessible location.

The motor must comply with IP 56 standards.

M27.2.6.2 Chain and flight type cross collector

The chain and flight type cross collector must comply with standards specified in this Specification.

M27.3 Sludge blanket detector

The sludge blanket level detector must be used in each clarifier sludge trough or hopper to detect the level of sludge blanket and for control of the sludge withdrawal.

M27.4 Drainage

Provision must be made to drain clarifiers via the sludge withdrawal system.

M27.5 Safety

Each clarifier must have at least one rescue float and lifeline. Double barrier protection must be provided in all hydraulic connections to the clarifier.

M27.6 Sprays

Sprays must be installed within the clarifier tanks to assist in moving the scum and prevent scum build up on the clarifier wall.

M27.7 Pre-commissioning

M27.7.1 Load test

The entire sludge collector mechanism must be load-tested. The test must verify the operation of mechanical and electrical torque limiter (or shear pin). Initially electrical torque limiter (or shear pin) must be set above the mechanical torque limiter settings to verify the mechanical torque limiter. Methodology must be submitted illustrating how the torque must be applied prior to the test taking place.

M27.7.2 Operational test

The mechanism must be operated in a dry tank for a minimum of 6 continuous hours before the system integrated commissioning. There must be no binding, jerking, or unusual motion exhibited during this run in period. Motor amperage must be checked at least hourly for any unusual or higher than normal figures. After the unit has successfully passed this initial test, flow must be introduced into the tank and the same 6 hour observation test run.

M28. Circular clarifiers/sedimentation tank

This section covers the general technical requirements for circular clarifier or sedimentation tank.

M28.1 General

The circular clarifier/sedimentation tank must be equipped with an influent well, feed well, sludge collector, skimmers, scum baffles, drive units, launders weirs etc, and manufactured of suitable materials for operation under submerged conditions in sewage.

Minimum side water depth must be 4 metres.

M28.2 Clarifier inlets

The inlet arrangement must be designed to dissipate influent velocities, distribute flows evenly, prevent short-circuiting and minimise density currents. The feed well must be supported outside the centre cage to diffuse the liquid into the tank without disturbance. Baffled openings must be provided near the water surface to allow scum to exit the feed well. The feed well must be made of 5 mm thick steel plate with necessary alignment angles. A double concentric feed-well must be used for energy dissipation and final flocculation.

M28.3 Sludge scraper assembly

Sludge scraper blade must be arranged to effectively sweep the whole of the tank floor and induce sufficient motion of the settled sludge to ensure its efficient passage by gravity into the central sludge collection well.

Each scraper blade assembly must be supported from the rotating bridge and fabricated in stainless steel grade 316. Support chains incorporating stainless steel turnbuckles and rods for adjustment of tension and the support of the scraper blades must be provided. Provision must be made for the blade to be lifted off for inspection, adjustment and replacement.

Scraper blades must be provided with adjustable neoprene squeegee projecting 40 mm below the bottom of the blade and secured by stainless steel bolts, nuts and washers in grade 316. Each squeegee must have a minimum thickness of 6 mm and have 40 mm vertical adjustment.

M28.3.1 Central column wiper seal band clamps

All bands used to tighten wiper seals to the central column of a clarifier must be fabricated from stainless steel grade 316.

M28.4 Skimmer

The clarifier must have a skimming mechanism to sweep the surface of clarifiers, automatically removing scum and floating material to a scum box at the periphery of the tank.

Skimmer blade must be a minimum thickness of 5 mm.

M28.5 Effluent launder

A rectangular effluent launder must be provided around the perimeter of the tank. The material of the effluent launder must be either concrete or grade 316L stainless steel. The launders must be an integral part of the clarifier wall.

M28.6 Weirs

An adjustable weir must be provided around the periphery of the tank at the water surface for removal of clarified effluent. The weirs must have at least 20 mm of adjustment up and 20 mm down.

The weir plate must consist of minimum 4 mm thickness and 200 mm deep grade 316 L stainless steel plate. The weir section must be curved and fastened to the launder wall with special anchor bolts and hexagonal nuts for vertical adjustment.

Installed weir plates must be sealed against the effluent launder wall with a continuous strip of non-degradable neoprene having a minimum width 100 mm. The neoprene strip must be compressed between the wall and the weir plates as the plates are fixed. The neoprene strip must be located centrally about the bolts.

The weirs must be set to within plus or minus 2 mm of their design level.

M28.7 Scum baffle

Peripheral scum baffles must be a minimum thickness of 5 mm and must have no less than 230 mm immersion and 150 mm freeboard. The baffle section must be curved and fastened to the wall.

M28.8 Scum box

A stainless steel grade 316 spray bar with corrosion resistant replaceable nozzles producing flared sprays must be installed along the scum box. The spray bars must be mechanically activated and isolated by the bridge traversing the boxes at each cycle of rotation to wash the residual scum effectively from the scum box. A typical arrangement could include a level operated ball valve and a flow control valve.

Scum box provided must be the maximum possible size box that can fit in the clarifier to avoid scum recirculating in the clarifier.

The scum box must be made of 5 mm (minimum) stainless steel plate and serve as an integral section of the tanks scum baffle.

The scum box must incorporate a ramp entry with a mechanical activated flushing trap type device which must be activated by the bridge traversing the box at each cycle of rotation.

M28.9 Bridge support column

The bridge structure must be supported at the tank centre by a robust support column with pivot bearings. The support column must be designed to rigidly support the bridge structure with due allowance for all anticipated loads. The support column must be bolted to the floor of the tank. The bridge support column must be fabricated from grade 316L stainless steel.

Access walkway(s) must be provided to any bearing equipment installed on the centre support column.

All bearing assemblies requiring lubrication must have the lubricating points piped to locations accessible from the access walkway or bearing assemblies must be sealed for life with seals that prevent the ingress of dirt or water.

M28.10 Walkways

Access walkways with handrails must be provided around the perimeter of the circular tanks to facilitate hose down operations and maintenance. A bridge walkway of minimum width 900 mm must be provided. Walkways must have slip-resistant surfaces. The 900 mm wide walkway and platform with handrails must be supported by the influent column at the centre and the tank wall at the outer ends.

M28.11 Centre drive platform

A centre drive platform must be provided with centre driven rakes and fixed half diameter bridge for access to the centre and to drive components. It must be provided with necessary support and connection to the walkway.

M28.12 Clarifier bridge motion sensors

Every clarifier must have one motion sensor installed to detect that the outside edge of each clarifier bridge is rotating.

M28.13 Clarifier bridge drive VSD

The drive units must be periphery or centre drive. The drive units must be equipped with a VSD featuring an integrated overload protection, soft start and over torque setting. The VSD must allow the operators to adjust the scraper speed to an optimum level. The over torque limit must be set to the maximum sludge loads.

Motor and gearbox must be direct coupled. The drive unit must be suitable for mounting outdoors in a sewage environment.

The wheels must remain in contact with the clarifier wall, on course with smooth operation, i.e. no start/stop motion.

Machine drives must be selected to be conservatively rated under all conditions of loading possible in the course of normal operation of the plant. Normal operation includes jamming by foreign matter for mechanical handling equipment.

The electrical over torque limiter (or shear pin) must be set at 20% more than maximum sludge load.

M28.14 Sludge blanket detector

The sludge blanket level detector must be used in each primary and secondary clarifier to detect the level of sludge blanket and control the speed of the sludge withdrawal.

M28.15 Drainage

Provision must be made to drain clarifiers via the sludge withdrawal system.

M28.16 Safety

Each clarifier must have at least one rescue float and lifeline. Double barrier protection must be provided in all hydraulic connections to the clarifier.

M28.17 Sprays

Sprays or small bore pipes installed within or near the tanks must be grade 316 stainless steel.

M28.18 Testing

M28.18.1 Torque test

The entire sludge collector mechanism must be statically load tested by individually loading each rake arm with 150 per cent of the specified designed running torque. The test must verify the torque overload control device settings for alarm and motor cut out. Each arm must be individually anchored and load measured to demonstrate the rake arm, cages and drive units' ability to withstand the specified torque.

Methodology must be submitted illustrating how the torque must be applied prior to the test taking place.

M28.18.2 Operational test

The mechanism must be operated in a dry tank for a minimum of 6 continuous hours before flow is allowed to enter the system. There must be no binding, jerking, or unusual motion exhibited during this run in period. Motor amperage must be checked at least hourly for any unusual or higher than normal figures. After the unit has successfully passed this initial test, flow must be introduced into the tank and the same 6 hour observation test run.

M29. Decanter equipment

This section covers the general technical requirements for the decanter equipment for IDEAT (Intermittently Decanted Extended Aerated Tank) and IDAL (Intermittently Decanted Aerated Lagoon).

M29.1 Decanting equipment requirements

The IDEAT / IDAL treats sewage in large tanks by a cyclic process involving aeration, settlement, decanting.

After each aeration and settling phase of a cycle, clear surface liquor is decanted from IDEAT / IDAL by strategically placed decanters which are lowered below the surface.

Decanters floating on the liquid surface during aeration and settling with their weirs or entry ports submerged below the surface are not acceptable.

Decanters must be designed to avoid air entrainment during decanting.

During aeration and settling phases the decanters must be in their "parked" or reference position which ensures that the decanter overflow weir trough is above design maximum top water level.

In the park position, decanters must be capable of discharging the maximum design flow for the IDEAT/IDAL and maintain the specified freeboard.

The Contractor must provide the following information to check the design of decant weir:

- Trough travel
- Decant trough and weir type
- Decant time (storm cycle)
- Maximum weir overflow rate
- Design raising speed of trough
- Design lowering speed of trough
- Trough park position
- Trough bottom position
- Drive unit.

M29.2 Side wall decanter

The trough must be installed between the walls of the aeration tank and guided vertically while maintaining the weirs in a horizontal position.

The trough must have guide rails to prevent trough misalignment. The guide rails must have bottom stops to support the full weight of the trough. The stops must be positioned to protect the slip joint from over travel of the trough. The guides must also allow the trough to be supported in the park position for maintenance.

Scum baffles must be attached to both sides of the trough. These baffles must prevent scum and other floating material from being drawn off with clear effluent.

To connect the moving troughs to the fixed outlet piping flexible seal boots must be provided.

M29.2.1 General

The decanter unit must be supplied and installed complete with:

- Decant trough complete with weir
- Scum baffles
- Outlet pipe
- Flexible seal boot
- Trough park position switch
- Maximum water level switch
- Water level detection switch
- Trough bottom stop
- Supporting structure
- Drive unit
- Platform for access and maintenance.

M29.2.2 Drive mechanism

The decanter overflow weir must be positively driven into and out of the liquid by up and down lifting mechanism.

Raising and lowering of the trough must be supported by stainless steel wire ropes or by chain. Alternatively raising and lowering must be by combination of a screw jack electric actuator for drive. Adjustment of the horizontal level of the trough must be by means of turnbuckles on the wire ropes or adjustment nut.

The speed of each decanter must be controlled via a variable speed drive.

To compensate for variations in sewage flow into the wastewater treatment plant the decanter weirs are arranged to travel vertically up more than the maximum water level.

M29.3 End wall decanter

M29.3.1 General

Decanters must be designed to avoid air entrainment during decanting.

During aeration and settling phases the decanters must be in their "parked" or reference position which ensures that the decanter overflow weir trough is above design maximum top water level.

In the park position, decanters must be capable of discharging the maximum design flow for the IDEAT/IDAL and maintaining the specified freeboard.

The Contractor must provide the following information to check the design of decant weir:

- Trough travel
- Decant trough and weir type

- Decant time (storm cycle)
- Maximum weir overflow rate
- Design raising speed of trough
- Design lowering speed of trough
- Trough park position
- Trough bottom position
- Drive unit.

The end-wall, rotating-arm type decant systems must have the following attributes.

The decanter weir and trough must always be visible from the basin side wall thereby providing the operator with a visual check of the effluent quality during the decant phase of the cycle.

The decanter must be parked above the design top water level during aeration and settling phases, thereby eliminating any possibility of solids carryover during these phases.

At top park position, the decanter must provide “fail safe” overflow protection in the event of a power failure. Settled supernatant will flow via gravity, under the scum guard, over the weir, and into the decanters.

The decanter must be designed with a scum guard mechanism to prevent the discharge of scum and floatables during decanter or overflow operation.

All in-basin seals and bearings must be maintenance free.

The trough must be provided with support brackets at the low level position to prevent over travel of the trough.

The trough must be provided with supports when in the park position to allow maintenance of arm.

M29.3.2 Drive mechanism

The drive mechanism or actuator must be mounted on the walkway to provide easy access for maintenance and service purposes.

The drive mechanism or actuator must be designed for a continuous duty, variable speed mode of operation thereby producing a uniform effluent flow rate throughout the decant phase. The decanter drive system must be configured such that the decanter weir reaches bottom water level at the end of the decant phase thereby maximizing settling time.

Actuator limit switches and motor must be integrated with process control system to prevent blower operation during the decant phase of the cycle.

M29.4 Materials requirement

The material construction of side wall and end wall decanters must conform to the following:

- Trough and scum baffle: grade 316 with minimum 3 mm thickness
- Trough outlet pipe: grade 316 stainless steel with minimum 3 mm thickness
- Guide and support brackets: stainless steel grade 316

- Access platform and supporting structure: hot dip galvanised or other suitable material for specific environment.

M29.5 Decant trough control

All decanter operational functions side wall and end wall must be arranged for full automatic operation and are governed by SCADA system to enable lowering speed, decanting speed, raising speed, safety interlocks and etc. The decanter speed must be set in the SCADA.

SCADA terminology must be standardised as UP/DOWN or RAISE/LOWER (rather than forward/reverse) to remove any ambiguity regarding the direction of decanter operation.

Once the plant is operating it must be capable of unattended operation. It must be the Contractor's responsibility to arrange the equipment in the best engineering manner to fulfil the full automatic operation.

If the aeration tank suffers a Fatal Alarm fault or is RESET by the Operator at any time during the cycle the decanter must return to its parked position.

M30. Diffused air aeration system

This section of the Specification sets out the minimum requirements for the design and selection of diffused air aeration system equipment.

The pipework, instrumentation and the diffusers must be correctly sized to deliver the required quantity of air at the available pressure to meet all operating conditions.

The pipework to the tank must be sized for 150% of the required oxygen transfer capacity to cater for the higher loadings.

M30.1 Aeration diffusers

M30.1.1 General

The three basic diffuser types are cylindrical, circular and flat blade diffusers. Expected design life is 8-10 years for membrane diffusers and 18-20 years for ceramic and all diffusers will require automatic purging to remove condensate.

For continuous aeration the process must comprise either rubber (high grade EPDM with low oil content/Polyurethane/Silicone) membrane or ceramic. For an intermittent aeration process the diffusers must be rubber membrane discs.

The diffusers must not clog and must be suitable for use in the selected aeration process. The mixing capacity must also be sufficient to re-suspend any solids that have settled on the floor of the tank if the diffusers are stopped.

The aeration rate must be below that which will shear the flocculated microbiological bacteria.

Performance data for the diffusers must be provided by Tenderers in the Schedule of Guarantees of Performance Data for the offered aeration system showing air flow rates versus the following:

- Oxygenation capacity in kgO_2/hr (clean water)
- Oxygenation efficiency (clean water).

The diffusers must be securely fixed to distribution assembly pipework which must be positioned on the tank floor to give an even distribution of diffused air over the tank floor. Note that an area must be left clear of diffusers around mixers, the suction of the mixed liquor recycle pumps, RAS pumps and WAS pumps.

The air flow rate through individual diffusers must not differ by more than plus or minus 5%. The diffusers must be capable of completely mixing the tank contents and keeping the solids in suspension for all design air flow rates, including the required turndown in oxygen transfer.

M30.1.2 Fine bubble diffusers

The aeration diffusers for the bioreactor/IDAL must be of the type which will produce a fine and even distribution of bubbles. The design of pores must be such that the bubbles are prevented from coalescing into larger bubbles.

M30.1.3 Membrane diffusers

The membrane diffusers must comprise a flexible moulded perforated rubber membrane fitted over a supporting disc.

The diffusers must be designed to give clog-free operation under continuous air supply and after infrequent air failures or shutdowns. The diffuser membrane must seal against the supporting member to prevent the ingress of mixed liquor into the air pipework on air supply shut down.

The design of the retaining ring must ensure seal between the diffuser element and the O-ring. The diffuser system must be easily replaceable and interchangeable with a rubber membrane diffuser system. The modularity of piping and mounting systems must allow quick dismantling and installation of diffusers.

Control orifices must be incorporated into each individual diffuser and into each header of the air distribution pipework to prevent excessive air losses in the event of membrane rupture.

M30.2 Air pipework

M30.2.1 General design criteria

Many factors need to be incorporated in the design of the air distribution pipework to minimise the potential of noise problems occurring.

Factors to be considered in the design of the air pipework to minimise vibration/noise level must include:

a) The diameter of the pipework, to keep velocities low whilst considering flowmeter accuracy

b) Pressure loss of less than 2kPa (downstream of the blower NRV to the diffusers) at maximum future design flows

c) The connection of the blower discharge pipes to the manifold must be "wye", not at right angles

d) No blind flange at the end of the manifold

e) The manifold must be designed to ensure air travels in one direction

f) The air pipework must be designed to minimise changes of direction and use of large radius bends

g) Flexible connections must be provided between the diffuser assembly units and the main air supply pipework to allow for any differential movements

h) Expansion and contraction must be fully allowed for in the design and installation of the air distribution pipework

i) A second silencer in the blower outlet or a main header silencer must be installed to minimise noise

j) Drain taps must be provided on the air pipework to allow draining of moisture

k) Pipework must have inbuilt flexibility such as packer flanges for reasonable construction tolerances on the structures to which it is attached

l) Pipe must be designed to ensure the efficient operation of the aeration system and compliance with the noise limitations.

Aeration main headers and droppers must be SS 316 (schedule to suit application) seam welded pipes. Spiral welded pipe work is not acceptable.

Insulation must be provided for pipework exposed to high temperature weather conditions to protect from heat effects where required.

Lagging/Insulation must be provided for the pipework at a level and location where people are likely to come in contact.

All valves in the air delivery system must be correctly selected for the duty. The Contractor must submit calculations of Cv (head loss coefficient) values for the range of flows and pressure losses across each valve to demonstrate to Sydney Water that each valve has adequate range of controllability for the duty.

M30.2.2 Diffuser assembly pipework

The pipework system to which the diffusers are attached must be fixed to the floor of the tanks. The underwater pipe work must be UPVC class 12 or higher.

The diffuser assembly pipe work must be provided with suitable support arrangements to allow ready installation of the pipes. Provisions must be made in the supports for the distribution assembly pipe work to adjust the level of the diffuser.

The pipework support system must be capable of withstanding all in service forces (buoyancy etc.) while allowing movement due to thermal expansion. The support system must allow level adjustment as detailed below and not be susceptible to working loose in service.

Diffuser assembly pipework supports within the tank must be fabricated of grade 304 stainless steel and they must be fixed to the tank with chemical anchors.

Provision must be made in the supports for the distribution headers to be adjusted for level such that the diffusers can be levelled to $\pm$ 5 mm.

Diffuser pipework systems must be provided with facilities to purge water.

M30.2.3 Downcomers

Downcomer pipe must be fitted for each diffuser assembly pipework to supply air to diffuser assembly pipework. The downcomer pipes to the diffuser assembly pipework must not be less than 75 mm in diameter. Expansion and contraction must be fully allowed for in the design and installation of the diffuser system pipework.

Each downcomer must be provided with a valve for airflow regulation and isolation of the unit. The valves must be positioned so that they are readily accessible from the walkway without requiring the operator to lean out. These valves will be used for adjustment of airflow and must be designed for throttling capability.

The valves must be fitted with a device, which will lock the valve in the required position and ensure that the setting will not be easily tampered with. A graduated position indicator must be provided to ensure that the required reproducible valve setting can be attained.

The pipework must be stainless steel. All piping brackets and support to install the pipes must be stainless steel below water or just above water and suitably protected steel above water.

Anchors must be supplied where necessary to restrain the pipes and prevent forces being applied to mechanical components.

M30.2.4 Air supply headers

The air supply headers run from the main air distribution pipework to the downcomers. Pipework must have inbuilt flexibility such as packer flanges for future modifications and to allow for reasonable construction tolerances on the structures to which it is attached. An isolation valve for each main air supply pipe must be installed at the point of connection to the main distribution pipework. Modulation valves and flowmeter for flow measurement and control of each air supply header pipe must be provided.

The design of the main air supply header must incorporate all components necessary to enable the easy connection of the main distribution pipework to the main air supply header.

M30.2.5 Blower discharge pipework

Discharge pipework from each blower must be connected to a common manifold. Flexible connections must be provided between the blower assembly units and the discharge pipework to allow for any differential movements. Grip connections with appropriately temperature rated coupling material is acceptable.

The design of the manifold pipework must incorporate all components necessary to enable easy connection to the main distribution pipework. Knife gate valves must be used for blower isolation from main headers. Blower isolation knife gate valves shall be fitted with an OPEN limit switch.

M30.2.6 Actuated modulating valves

To maintain the required air distribution for each zone/tank automatic actuated modulating valves must be used. The purpose of the modulating valves must be to control the flow of air into the main air supply headers and thus to the diffuser headers. During normal operation of the plant the valves must be automatically operated.

The valves must be electrically or pneumatically actuated, butterfly or ball valves. The valves must be capable of stopping and remaining at any position of travel. The valves must be provided with travel limit switches to sense the open position, fully open and closed position of the valve.

M30.2.7 Air flow measurement

The amount of air being supplied to each air supply header must be measured by the installation of flow measuring devices. The flow measuring devices must be suitable for the intended application. The sensor assembly must be supplied with suitable fitting which enables easy removal during maintenance. The accuracy of the flowmeter must be within 5% of the minimum design flowrate. The installation must provide adequate distance of straight pipe upstream and downstream of the flowmeter to ensure the accuracy of the meter is attained.

Pressure and temperature sensors must be provided to measure the pressure and temperature of the air in the pipe, upstream of the flow measurement device to record air flow under standard conditions of 20 °C and 1 atmosphere.

M30.2.8 Pressure gauges

Pressure gauges of an accepted type must be installed on each main distribution pipework and main header.

M30.2.9 Lagging requirements

Lagging must be installed to blower pipework to give protection to personnel from pipework where the temperature rise is above 65 °C. Lagging must also be provided for all aeration pipework in the blower building or room to minimise the heating load within the room.

Pipe lagging requirement must be as follows:

a) The lagging must form an integral part of the equipment and must not affect the safety or function of equipment

b) The lagging must not hinder access for operation and maintenance

c) All lagging materials must be rigid, weather resistant, non-combustible type and accepted by Sydney Water prior to procurement. It must be rockwool type or equivalent with aluminium or stainless steel sheet outer cladding to protect from water ingress and damage. Aluminium foil tape type lagging covers are not acceptable.

d) The casing of any lagging in an indoor application, or an enclosed area where heat could present a problem to operations, shall be no more than 5°C higher than the ambient temperature at any time. Valve bodies, non-return valves, pressure regulating or relief valves, expansion or dismantling must not be lagged.

M30.2.10 Sound attenuation of pipework

Secondary sound attenuation must be provided as agreed with Sydney Water to eliminate harmonics caused by the operation of single or multiple blowers at all design speeds. No perceivable noise must be heard at 50 m or more from any blower pipeline/header/sub-header.

M30.3 Purge pipework

An automatic/manual purge system must be provided so that in the event of condensation build up within the laterals, the system can be purged. The automatic purge system must be based on timer control.

The system must have enough head to purge the collected water in the diffuser assembly pipework. Purging of the pipework must not cause damage to diffusers and must not rely on pushing water through the diffusers.

The purge valve should be accessible from outside the tank.

M30.4 On-line diffuser cleaning

An on-line cleaning system must be provided to allow for cleaning of diffusers without taking aeration system off-line. The cleaning must be able to be carried out without interruption to the treatment process.

The cleaning system may entail addition of formic acid (or other chemicals which are not detrimental to the biological process) through a tapping point in the downcomers. All necessary tapping points, access and portable chemical mixing and injection equipment must be provided.

The recommended chemicals must be able to permeate the pores of the diffusers where it must dissolve the minerals and eliminate microorganisms present in the deposited material. This combined action must be sufficient for full restoration of the original quality of the diffuser. The material of construction of pipework, fittings, valves and diffusers must be chosen to withstand the exposure of applied chemicals.

M30.5 Leak and pattern testing diffuser system

The diffuser system must be visually tested by filling the tanks with clean water (the quality of water must allow a visual assessment can be carried out) to a level 1m above the top of the diffuser assembly units. Air must then be passed through the diffusers and a visual assessment of the diffuser operation must be made.

The visual assessment must include the following minimum inspection:

a) Checking all diffusers have been installed in level within the required tolerances

b) Checking that all joints along the diffuser headers have been made airtight

c) Checking the required air distribution of diffused air is achieved across the entire tank floor.

M31. Blowers

The blower equipment specified herein is standard equipment for blowers handling ambient air for use in aeration tank diffusers.

M31.1 General design requirements

The air blowers must be of such design as to achieve energy efficient operation continuously over the range of design air flow rates at the discharge pressure which must remain practically constant.

The sizing of the blower units must ensure that the peak air flow demand can be met by duty blowers. The blower system must be capable of supplying air to meet flow variations in the plant. Each blower must have turndown of 40% of its maximum output.

The discharge pressure must be calculated dependent on the final design layout of the aeration system and of the delivery manifold.

The blowers must also be capable of supplying the design "mass flow" rate at maximum ambient inlet temperature of 50 ºC.

Each of the blowers must be capable of operating without surge in parallel with all the other duty blowers at the air mass flow rate 5 % greater than its maximum design air mass flow rate against designed maximum gauge pressure at the outlet plenum. This must be demonstrated during testing and commissioning.

Standard certified factory test sheets showing the results of each test must be supplied in triplicate to Sydney Water prior to delivery of the blowers.

The blower unit must be capable to operate at maximum duty for continuous operation.

Centrifugal blower technology referred to in this Specification is high-speed turbo with VSD or geared turbo blowers.

Positive Displacement (PD) blower technology referred to in this Specification is the screw type blower with VSD.

Either centrifugal or PD blowers can be used for aeration applications.

M31.2 Blower general arrangement

The Blower arrangement must have the following features:

a) The arrangement must be such that all blowers are accessible for operation and maintenance

b) The blowers must be neatly arranged and housed in a sound attenuated room

c) All blower cooling system ventilation pipes must be lagged at least with Denso type material and all directed to the outside of the building. The exhaust shall be appropriately acoustically treated to reduce blower noise to the environment.

d) The blower building must be designed to have ready accessibility for maintenance and installation work of future work of which the Contractor was made aware

e) All room penetrations must have acoustically treated louvres complete with easily maintainable filters to prevent noise emanating from the room and dust ingress. No perceivable noise must be heard at 50 m or more from any blower house.

f) The inlet air to the blower house must be filtered to suit the blowers and aeration diffusers selected

g) Where there is not sufficient space in the blower house to allow a forklift to enter an overhead travelling crane system must be provided so that any one blower can be removed as a single unit and loaded onto a truck.

The blower building must be acoustically designed to minimise both noise inside the building and noise breaking out of the building. The building ventilation system must be designed to limit the temperature rise not more than 3 °C above ambient temperature.

M31.3 Ancillary equipment for blowers

The blowers must be provided with the usual ancillary equipment for aeration duty, including:

a) Acoustic enclosure with fan cooling

b) Discharge pressure transmitter

c) Power actuated discharge bypass valve or blow-off valve. Modulated blow off valves are preferred to reduce the risk of surge.

d) Discharge check valve

e) Discharge isolation valves

f) Discharge silencer designed to minimise noise propagation along the pipework

g) Vacuum transmitter, pressure transmitter, oil level indicator and any other monitoring device must be mounted outside the acoustic enclosure

h) Inlet and outlet pressure gauges must be mounted outside the acoustic enclosure

i) Vibration absorbing mounting pads.

M31.4 Blower control

An air temperature probe and gauge must be supplied and installed on discharge pipework adjacent to the blower.

Blowers must be provided with a control system which monitors:

a) The condition of the blower

b) The control logic for starting and stopping the blower - All blowers must be provided with standalone control systems allowing for safe starting, operation to a pressure set point, and safe shutting down.

c) Bearing temperature

d) Air temperature in the discharge pipe work

e) Air temperature inside the acoustic enclosure

f) Opening and closing of the blow off valve when starting blower.

Each blower must be fitted with a suitable pressure transmitter which will shut down the blower in the event of excessive discharge pressure. The pressure setting must be lower than the set pressure of the pressure relief valves. The pressure transmitter must be adjustable over the range 10 - 100 kPa.

M31.5 Blower noise limits

Blowers must be quiet in operation. The total sound power noise emission for the aeration system must be broad band and free from any tonal or intermittent components.

Under any loading condition from no load to full rated the blower supplied should comply with at least one of the limits as follows:

a) With all blowers and ancillary equipment, including associated pipework, operating, the maximum internal sound pressure level within the blower building at any point greater than 1 m from the surface of each blower and ancillary equipment must not exceed 85 dB(A).

b) For each blower unit operating individually the combined overall A-weighted sound power level emitted from the blower casing, intake, silencer and silencer casing and associated piping and ancillary equipment must not exceed a level of 92 dB(A).

c) For each blower unit operating individually the combined overall A-weighted sound power level emitted from the blower casing, intake, silencer and silencer casing and associated piping and ancillary equipment must not exceed the values shown in the table below for each octave band.

Sound power level, dB(A) Octave band centre frequency H_2-re10^{-12} W							
63	125	250	500	1K	2K	4K	8K
86	74	79	90	90	77	69	66

The Directivity Index of the blower unit must not exceed 6 dB when measured under free field conditions over a reflective ground plane, where the Directivity Index (DI) is defined by:

DI = 20 log P/Po - 20 log Pm/Po + 3 dB

Where: P = sound pressure level in any given direction at radius “r”

Pm = mean sound pressure level of a hemisphere at radius “r”

Po = 20 micro Pascals

If the Directivity Index of the blower unit is greater than 6 dB then the respective measured overall weighted sound power level in dB(A) must be increased by that number of dB by which the Directivity Index exceeds 6 dB.

If the sound power level in any octave band of the blower unit exceeds the sound power level in both adjacent octave bands by more than 5 dB (i.e. a pure tone is dominant) then the respective measured overall weighted sound power level in dB(A) must be increased by 5 dB(A).

M31.6 Centrifugal blower

The centrifugal blowers must be mounted on a base frame incorporating all ancillary equipment completely enclosed in an acoustic enclosure.

Blowers must be high speed turbo, controlled by variable speed drives, or geared turbo and must operate based on aeration cycle, flow rate and level of dissolved oxygen (DO) in the tank (on-line measurement). Blowers must be provided with control system which must automatically and continuously adjusts the set point during the day to maintain optimum process conditions and achieve efficient power consumption.

The centrifugal blowers must be provided with the usual ancillary equipment for aeration duty, including discharge silencer, designed to minimise noise propagation along the pipework.

The blowers must be provided with control system which provides the control logic for varying suction and discharge valve for flow control.

The blowers must start up under unloaded conditions and must be brought online, when correct operating status has been reached.

M31.7 Positive displacement blower

The air rotary positive displacement blowers must consist of intermeshing screw threaded rotors designed for continuous operation at the required pressures and flows.

The blowers must be controlled by variable speed drives. The blowers must be able to operate over a speed range to deliver the range of air flow rates nominated above.

Rotors and shafts must be of one-piece construction and must be of forged steel or ductile iron on steel shaft. The rotors must have two or more screw threads and shafts must be geared together with timing gears so that the screw threads do not make contact during operation.

Bearing housings and rotor shafts must be fitted with suitable oil seals to exclude dirt and moisture and to prevent oil carryover into the discharge air. Where bearings are oil lubricated the housings must be fitted with effective oil level indicators.

The blower and motor must be mounted on a base frame incorporating an integral silencer, non-return valve, pressure relief valve, discharge connection with flexible joint and flexible mounting pads (vibration dampers must be placed under blower mounts).

The complete assembly including drive motor and lubrication system must be mounted and aligned on a substantial steel sub-frame. Heavy duty anti vibration mountings must be located on the underside of the sub-frame.

M31.8 Filters and silencers

The blowers must receive filtered air via a common plenum fitted with inlet filter and sound attenuator.

The filter elements must be housed in an air-tight housing which must allow easy replacement of the filter elements. Replacement of elements must be possible without the use of tools.

If the filter/silencer elements supplied are located out of doors a weatherproof cover must protect the filter element from rain.

The filter unit must be fitted with suitable vacuum gauges to indicate the suction pressure into each blower. The gauges must be industrial Bourdon of Schaffer type gauges with a nominal diameter of 150 mm. The scale must be suitably selected and must include a red line to indicate the point at which the filter elements require renewal.

Each blower intake must be fitted with a differential pressure switch, which must indicate an alarm signal in the event of excessive pressure drop in the blower intake. The must be adjustable in the range 0-3000 Pa.

Alternatively, each blower intake must be fitted with an integral unit cleanable element type filter/silencer complete with supports.

M31.9 Flexible connections

The blower discharge must be fitted with an approved flexible sleeve with fixing clamps and a flanged outlet spigot for connection to site pipework. If the blower inlet is via a common plenum the inlet pipe must be also fitted with a flexible connection.

Flanges must be drilled to Table D and must comply with AS 2129.

Sleeves must be manufactured from an approved non-metallic material suitable for the duty and location in which the blowers are to be installed.

M31.10 Pressure relief valve

The pressure relief valve must be sized and adjusted to allow the full flow of the blower to be discharged in the event of a blockage or valve closure in the downstream pipeline and without overloading the drive motor.

Each blower must be fitted with a suitable pressure switch, which must shut down the blower in the event of excessive discharge pressure. The pressure setting must be lower than the set pressure of the pressure relief valves.

The pressure relief valve must be installed at a height above 2 m from the floor and away from blower suction point. The pressure relief valve must be fitted with a silencer.

M31.11 Non-return valves

A non-return valve must be installed on the discharge pipework of each blower, upstream of the blower isolation valve.

M31.12 Isolation valves

Isolation valves must be installed on the delivery pipework of the blowers, such that each blower and all associated pipework and valves upstream of the common distribution manifold can be dismantled without disruption to the normal operation of the plant.

M31.13 Temperature measurement

Temperature sensor complete with gauge of an approved type must be supplied for each main distribution pipework and for the blower room.

M31.14 Piping vibration

If the blower type selected produces a discharge flow with a pulsating characteristic, flow pulsation dampers must be installed on the blower intake and discharge, as required, to eliminate excessive noise or vibration from this source.

M32. Surface aerators

M32.1 Surface aerators

Units must be direct coupled low speed types with impeller tip speeds being less than 7.5 m/s. High speed units will not be acceptable.

Aeration equipment must be adjustable to facilitate variations in oxygen transfer rates with all adjustments capable of being made from the aeration maintenance platforms.

Aeration and mixing must be affected by a vertical spindle impeller, designed specifically for surface aeration.

Baffles must be provided to prevent formation of vortices or other undesirable hydraulic conditions. These baffles must not be attached to aerators but must be mounted onto the floors of aeration lagoons and must be designed not to collect rags and grit around the baffle plates.

For floating aerators:

- Adjustment of impeller immersion by ballasting of the pontoons must not be acceptable
- Each floating support structure must be moored to at least two mooring posts to allow the surface aerators to move up and down with the changes of water level in the tanks
- Mooring posts must be either held by bolts cast into the concrete floor or cast in situ to the tank floor in the concrete base
- Dampening mechanisms must be attached to all surface aerators at each mooring post and must be located well above the sewage level to prevent disturbance of the settled sludge caused by movements of the pontoons during windy periods. The dampening mechanism must consist of an adjustable dashpot, a spring loaded roller or similar device. The dampening mechanism must be sufficiently robust to withstand all aerator start-ups and wind forces.

M32.2 Impellers

Impellers must be non-ragging types and be inverted cone or open blade types with equally spaced blades extending through the periphery and constructed from steel plate of adequate thickness to ensure rigidity.

The impellers must be dynamically balanced to ensure vibration free operation under all water levels and conditions.

Impellers must be self-cleaning. Rags etc. that form a normal part of effluent to be treated should not accumulate on the impeller or other parts of the aerator.

M32.3 Floating platforms

Maintenance and inspection platforms are required around each motor and gear box. Each platform must have self-draining, non-slip decking and must be fitted with handrails and kickboards. Platforms must be constructed from mild steel and be adequately protected against corrosion.

Platforms must have lifting lugs.

Pontoons must be constructed from grade 316 stainless steel. Pontoons must be capable of supporting the entire weight of aerators when the aeration lagoons are drained. Bearing pressures on the floor of the aeration tanks must not exceed 500 kPa.

The support arm assembly from the maintenance platform to each of the three pontoons must be enclosed hollow steel sections. The torsional resistance must be such that the maximum twist along the length of the arm must not exceed 12 mm under dynamic loading conditions.

Platform structures must be designed to have a structural resonant frequency above 7 Hz and to exceed any forcing frequency by a minimum of 20%. An example of a forcing frequency is the impeller blade passing frequency.

Provision must be made to allow free vertical movement of each aerator unit relative to its walkway access platform. Aerator working platform design must be such that vertical movement of the aerator unit relative to the fixed access ladder will not allow any part of the body to become trapped between the fixed ladder and the moving platform.

The platform must be at least one metre above the water level at all operating conditions.

M32.4 Deflectors

Circular mist deflectors must be provided for each aerator to eliminate spray and splash above aerator platforms. Each deflector must be mounted in a stationary position above the aerator impeller and supported from the underside of the platform.

Deflectors must be constructed from steel plate of adequate thickness and corrosion protection with reinforcing members to provide sufficient rigidity during aerator operation.

M32.5 Aeration noise

The installed equipment must be quiet in operation. The operating noise emission from the aeration system must comply with specified noise criteria, or in the absence of specified noise criteria, with statutory noise criteria.

Necessary sound barrier walls must be installed preventing sound intrusion on the prevailing background noise criteria.

M33. Mixers

M33.1 General

All mixers must be of a standard and proven design.

The number, size and position (including depth and orientation) of mixers must be designed to maintain a fully mixed homogeneous solution within the entire volume of the tank or zone being mixed. Solids must remain in suspension in a homogenous mixture for each cell.

The design and arrangement of the mixer(s) must be determined and verified by hydraulic and mixing performance modelling. All modelling and analysis must be based on the specific mixer design proposed and all modelling results must be submitted for Sydney Water's acceptance.

The performance modelling must verify that the velocity profile across the entire floor area of the mixing tank/zone must be sufficiently high so as to eliminate potential "dead-spots".

The effectiveness of the installed mixers must be such that the % w/vol solids at any single point within the tank or zone do not vary by more than ± 10%.

The mixer must be designed so as not to entrain air or promote surface vortices.

The mixer must possess the necessary features to prevent any ragging in the mixer impeller.

Where there is a high probability that rags are present (such as thickened sludge storage tank or scum well) alternative means of mixing must be used. Recirculation pumps must be used as an alternative mixer in thickened sludge storage tanks.

The mixers must comply with the following requirements:

- The mixers must provide continuous operation at their calculated design duty point. All calculations and drawings must be submitted to Sydney Water.
- The continuous rated output of the electric motor driving the pump and mixers must be at least 10% in excess of the maximum power required by the unit under all operating conditions.
- Each submersible mixer and its motor must withstand without damage to the mixer or any other equipment the effects of reverse rotation up to 120% of normal direction rated speed.
- Mixers and driving units must be purchased from one source (the mixer manufacturer) to ensure the parts are compatible mechanically and electrically.

M33.2 Materials

The materials of construction for mixers must be at least equal in quality to the following:

Component	Material	Standard or additional information
Motor Casing	Cast Iron	AS 1830 Grade T220
Impellers	High-Chromium abrasion-resistance white iron	AS 2027-Cr 27
	Phosphor bronze	AS 1565 C90250 (refer WSA101)

Component	Material	Standard or additional information
Shafts	Stainless Steel	
Mechanical seals	Silicon Carbide	Only for fluids with pH < 3
	Silicon Carbide	Only for fluids containing particles with hardness equal or in excess of that for tungsten carbide.
	Tungsten Carbide	Elsewhere
Bolts, Studs, Washers and Anchor Bolts:	Stainless Steel	Grade 316
Nuts	Stainless Steel	Grade 316
Guards	Stainless Steel	Grade 316

M33.3 Submersible mixers

Each submersible mixer must be supplied complete with the following:

- Mounting arrangement, complete with coupling devices, guide rails and support brackets
- Swivel mechanism for rotation of the mixer in horizontal and vertical planes
- Placement / removal apparatus, including swing type lifting davit, stainless steel grade 316L lifting cable, stainless steel winch and shackles
- Composite power and control cable length.

The mixers must be provided with adjustment for depth and mixing direction.

Mixers must include a motor and impeller; in a close-coupled configuration, forming a compact, and robust mixing unit.

Appropriate shroud arrangements must be provided where necessary to prevent air entrainment and vortices. The design of the casing and propeller must allow an uninterrupted flow across the units, allowing the mixing media not to be caught and allowing cooling of the mixer.

The mixers must be manufactured from stainless steel materials selected by the manufacturer to suit the duty requirements, fluids and operating conditions.

The guide rail arrangement must permit easy adjustment of the submersible mixer orientation in the vertical and horizontal planes, by an operator standing on the access platform.

Mixers must be readily removable for inspection and maintenance using the lifting equipment, without the need for personnel to enter the tank. The lifting arrangement must enable a single operator to easily lift each mixer from its installed location and place it on the access walkway/platform without removing the handrails. Similarly, a single operator must be able to easily replace each mixer to its installed location.

No portion of the mixer must be permanently fixed to the base of the tank.

A stainless steel lifting chain of sufficient length to reach from the mixer to the platform level must be provided with each mixer. All holding down bolts must be of grade 316 stainless steel. For lifting facilities by a davit the mixer must be fitted with stainless wire rope and brake winch.

Electrical cables for each mixer must be suitably protected and secured in place so as to prevent any damages.

M33.4 Top entry mixers

The mixers must enter tanks vertically from the top and normally operate continuously. The speed of the mixer must be variable and easily changed over a 3:1 range and must be capable of being changed while the mixer is in operation.

The mixer paddles and shafts must be grade 316 stainless steel. The shafts must be sufficiently rigid to prevent flexing. Maximum deflection must be limited to shaft length/1000. The shafts must be fitted to the gearboxes in a positive manner, which may take the form of keyed flanges with retaining bolts or equivalent. Mixers can be supported near the blades.

M33.5 Shaft seals

M33.5.1 General requirements

Mixers must be supplied with mechanical seals.

Two independent mechanical face seals assembled in tandem must be fitted to provide reliable and durable sealing performance.

The seals must be designed for a minimum design life of 5 years under normal operating condition. Spare mechanical seals must be supplied to the extent of the life of the mixers.

The seals must be of the balanced type, cartridge mounted, incorporating bellows or multiple helical springs of Hastelloy® C or chloride corrosion resistant grade stainless steel and high nitrile synthetic rubber or ethylene propylene static "O" rings.

Seal faces must be lapped flat to within two helium light bands and the depth of interface roughness must not exceed 0.3 microns.

M33.5.2 Seal failure detection

Submersible mixers must be fitted with seal failure probes for moisture and oil leakage.

The probe must be fitted in the oil bath between the two mechanical seals and must be arranged to detect the presence of water in the oil bath, e.g. to detect failure of the propeller seals.

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

Sensors must be compatible with Tritronics RT1 relay.

M33.6 Motor protection

All mixers must be protected from overheating by a positive temperature coefficient (PTC) thermistor in each phase of each stator winding. Each thermistor must be connected in series to terminals adjacent to the stator terminals and encapsulated and compatible with the motor selected or with Tritronics RT1 relay.

Mixers must be fitted with seal failure probes for moisture and oil leakage. The probe must be fitted in the oil bath between mechanical seals and must be arranged to detect the presence of water in the oil bath, e.g. to detect failure of the shaft seals.

M34. Rotary drum thickener (RDT)

Also refer Dewatering Equipment Design Specification (D0001932).

M34.1 General

Each thickener must be designed to have a clean screening surface to the oncoming wastewater stream at all times while in operations. The unit must be designed for minimal head loss at peak flow. Spray piping must be arranged for both internal as well as external sparging where fitted, and for washing of the drum filter mesh. The drum thickener manufacturer must be ISO 9001 certified with prior drum thickener installation in Australia and units operating reliably at least 3 years at the wastewater treatment plant.

Each thickener must be manufactured for a 20 year design life and made from materials suited for coastal and high corrosive environments.

Each thickener must consist of screening element/s, flexible joined inlet entry pipe, internal spray bar with accessible nozzles for effective intermittent cleaning cycles of the filter mesh, infeed mixing valves/mixing device (optional), flocculation tank with mixer and polymer dosing port, full covers which are easily lifted by personnel, integrated solids discharge chute, sludge hopper (optional), base frame, filtrate outlet drain suited for maximum hydraulic loading rate via gravity, accessible sampling points for thickened sludge and filtrate, trunnions (if manufacturer design includes trunnions), central/accessible greasing points for bearings and drive unit appropriately geared to reliably thicken at maximum thickness at maximum hydraulic and solids loading rates.

M34.2 Rotary screen

Each rotary drum thickener must be designed to thicken sludge up to 6% (Dry Solids) and capture minimum 95% solids. The feed sludge enters the flocculation tank with manufacturer recommended polymer dosing point, or via a mixing device prior to the flocculation tank, where it is distributed for maximum flocculation and then introduced tangentially into the screen surface. Liquid gravitates downward through the screen slot openings passing through the screen, which retains the thickened sludge. Spiral pattern diverter flights and other manufacturer designed aids continuously move thickened sludge along the screen, into a discharge assembly and into a sludge hopper (as supplied by the manufacturer or custom built for the site and pumping needs (depending on target thickness and site layout).

M34.3 Drive system

A variable speed drive must be provided for controlling the speed of the drum. The cylindrical drum must be driven using a chain and sprocket arrangement (single chain or double chain). A manual or automatic chain oiler arrangement for the chain drive must be provided. The drive system must be designed to rotate the drum at maximum speed.

M34.4 Cylindrical screen

The drum assembly must be constructed from 316 stainless steel unless accepted otherwise by Sydney Water. The screen must be constructed from a minimum grade 304 stainless steel Vee-wire® or polyester cloth. The Vee-wire® dimensions must be designed to minimize the stapling effect. The manufacturer may recommend an alternative mesh to achieve the thickening requirements for specific applications, and approval for its use to be authorised by this specification’s custodian.

M34.5 Enclosure

The full enclosure must be designed to contain aerosol emissions from the rotating drum and the wash-water system. It must also serve to protect personnel from all the moving parts. The enclosure must be constructed of lightweight corrosion resistant material with structural integrity to withstand environmental conditions. Inspection hatches for observation of the trunnions (if trunnion design is adopted), spray bars, discharge thickened sludge end and chain and sprocket must be provided with adequate open stays to prevent accidental cover closure.

M34.6 Frame and access

The drum thickener must be installed with grade 316 stainless steel main body/frame, and the installation contractor must provide ladders, platforms and railings. All bolts, nuts, studs and washers must be grade 316 stainless steel and hand-rails and kick-plates made from aluminium.

M34.7 Infeed tank

The infeed tank must be constructed of not less than 2 mm thick grade 316 stainless steel. The infeed tank must be designed for optimum stilling and distribution of the incoming flow onto the internal section of the screening element. A capped pipe must be furnished at the end of the infeed tank for discharge of settled solids if the tank floor is not sloped toward the drum thickener. Penetrations in the tank lid must be made for level transmitters and high level switches.

M34.8 Pipe connections

Pipe connections must comply with Pipe connection requirements stated in Clause M16 of in this Specification.

M34.9 Spray system

An Internal spray water system for periodic cleaning of the drum screen mesh must be provided. The spray headers must be type 316 stainless steel with BSP connection. The headers must be furnished with a combination of type NiCr brass vee jet nozzles or as recommended by the manufacturer for the most effective cleaning of the drum mesh.

M34.10 Thickened sludge pumping

The thickened sludge is recommended to be pumped directly out of the thickened sludge discharge hopper and directed by a stainless steel 316 chute into a progressive cavity “cake pump” to minimise friction losses and ensure pumpability at all times and at the thickest sludge concentration (%TSR).

M34.11 Accessories

The following accessories must be provided for the operation and integration of the Rotary Drum Thickener specified in the above section.

M34.11.1 Flocculation tank

The flocculation tank with motorised mixer must be used to condition the sludge and chemicals and must be designed to give a minimum residence time of 90 seconds within the tank. Alternatively, if recommended by the supplier, a mixing valve or mixing device at the inlet to the flocculation tank must be provided and be of 316 stainless steel construction with easily adapted polymer dosing points.

It must be made from not less than 2 mm thickness grade 316 stainless steel. It must include a single outlet that allows the conditioned sludge to flow by gravity into the inlet of the RDT.

Flanged feed inlet pipe, outlet pipe, overflow pipe and drainpipe must be provided. All flanges must comply with AS 4087 PN16.

If a mixer is required, it must have a motor installed suitable for a VSD for control of the mixer speed.

M34.11.2 Liquid discharge tank

The liquid discharge tank must be constructed from not less than 2 mm grade 316 stainless steel and extend the full length and width of the liquid discharge area.

The bottom must be sloped to an appropriately sized (based on flowrate), grade 316 stainless steel flanged discharge outlet.

The outlet may be changed to recycle the filtrate through the wash water system.

M34.11.3 Liquid discharge tank stand

This stand must be constructed in grade 316 stainless steel.

The height of the stand must be designed to allow containers to be placed completely under the frame to eliminate spillage of discharge onto the floor.

M34.11.4 Wash water system

If the site has limited service water for the spray system, then a wash water system must be installed and made up of a duty/standby pressure pump skid and tank with all interconnecting pipework, valves and electrical devices between the pump and tank.

An inlet and a single outlet must be provided with a control system to ensure the manufacturer recommended pressure is maintained at all times.

M34.11.5 Chemical makeup and delivery system

Chemical dosing systems must be capable of automatically adjusting to changes in the treatment processes. Chemical makeup and delivery system must comply with Requirements stated in Clause M37 of this Specification.

M34.12 Spare parts

Equipment must be provided with at least the following spare parts:

1. Trunnion Assemblies (Includes support blocks) if trunnion design
2. Set of nozzles (A set must include nozzles for both drum cleaning spray-bars if two are fitted)

3. Motor and gearbox assembly (optional)
4. Filter mesh for the drum.

M35. Sludge dewatering equipment

Also refer to Dewatering Equipment Design Specification (D0001932).

M35.1 Centrifuge

This section covers the general technical requirements for the dewatering/thickening centrifuge.

M35.1.1 General

The centrifuge must be a horizontal decanter type unit comprising an outer rotating bowl and an inner scroll conveyor which must rotate in the same direction at a slightly different speed. The scroll must be arranged to thicken/dewater sludge to the conical end of the bowl to discharge through ports in the bowl periphery via a discharge chute. Centrate must be discharged through ports at the other end of the bowl for gravity discharge into the centrate chutes which are piped to the centrate pumping station.

All protective coatings for base-frames and non-wetted parts must comply with environments classed as “coastal corrosive” as per WSA 201, or equivalent, to withstand corrosive environments across sewage treatment plants for a design life of a minimum of 20 years.

The centrifuge will be designed to produce at least 2500 G centrifugal acceleration when running at maximum speed.

The unit must meet the noise and vibration standards and requirements of this Specification at maximum G acceleration.

Where centrifuges are to be installed on a steel mezzanine level, the centrifuge main supports must be isolated from the mezzanine floor to prevent harmonics, vibration and noise.

The centrifuge must have a variable speed bowl drive and a variable speed scroll drive.

The centrifuge must be fitted with a gearbox and a VSD drive to ensure a steady increasing load during start-up for both the bowl drive and the scroll drive. The torque of the scroll conveyor must be continuously monitored so that the optimum speed of the scroll conveyor, for a specific duty, can be maintained.

The centrifuge must be supplied as a completely assembled unit on its base-frame and vibration take-up feet.

The centrifuge must be supplied complete with ancillary equipment. Ancillary equipment must include logic controller, frequency converters for both drives, push button stations, sludge diversion gates, central grease lubrication system, vibration isolators vibration take-up joiners for feed pipe connections, polymer dosing connections, cake discharge chutes and centrate discharge chutes.

Suitable lifting facilities must be provided for maintenance of the centrifuge.

The centrifuge shall be manufactured to DIN EN 12547 or equivalent standard.

M35.1.2 Centrifuge design

The decanter design must incorporate, but must not be limited to the following:

- Facility for automatically regulating scroll drive must be provided. The differential speed must adapt automatically as a function of scroll torque and the solids content

- All structural parts must be centrifugally cast stainless steel
- The linings to prevent erosion must be provided as follows:
  - In the feed zones: Hard surfacing protection
  - On the conveyor flights: Tungsten coating and/or sintered carbide tiles (sludge characteristic dependent)
  - At cake discharge end: Tungsten carbide, except for nozzles as recommended by the manufacturer for the sludge characteristics
  - Casing wear liner must be urethane or rubber based
- Bearing design life must be a minimum of 8,000 hours or for the agreed period between machine overhauls
- Conveyor bearings must be sealed to prevent contamination so additional lubrication is not required for the life of the bearings or between major overhaul intervals
- Torque reducer unit and gearboxes must have a minimum design life of 40,000 hours before overhaul
- Polymer injection points must be provided
- Diverter gate to divert solids discharge to drain during start up must be of 316 stainless steel
- Both the cake and the centrate chutes must have air vents at the same pressure and provisions for flushing of the vents
- The differential speed must be adaptable automatically as a function of scroll torque and solids content in the bowl
- Accessible safe sampling points for dewatered sludge and centrate must be provided.
- The centrifuge units must have flanged connections for feed and centrate and vibration take-up joiners for all fitted pipework as required by the manufacturer. These must be supplied with the centrifuge.

M35.1.3 Centrifuge controls

The control system must provide real data from all installed instruments as well as major alarms to the SCADA PLC system.

The scroll drive must be automatically adjustable during operation to suit the varying characteristics and flow rate of the feed sludge to ensure optimum operating conditions.

The ability to vary weir levels by weir plate adjustment must be incorporated into the design of thickening centrifuges.

M35.1.4 Centrifuge bowl

The bowl must be of the solid bowl decanter type and must be manufactured from duplex stainless steel. The feed end of the bowl must be provided with circumferential discharge ports. The ports must be replaceable and manufactured from high wear resistant material. Easily adjustable weir plates must be provided to vary the pond depth. The discharge port for the thickened/dewatered sludge and centrate must be designed to ensure free discharge and to avoid any build-up of material.

The complete assembly including drives, motor and lubrication system must be mounted and aligned on a sub frame. The frame must be a stainless steel or galvanised or painted steel frame. The steel base frame must be painted to WSA 201.

Heavy duty anti-vibration mountings must be located on the underside of the sub frame.

The equipment must be complete with all necessary items for efficient dewatering and thickening centrifuge operation.

M35.1.5 Scroll conveyor

The scroll conveyor must be manufactured from material which is capable of resisting the wearing and corrosive effects of the sludge. The scroll flight tips must be designed to have a minimum design life of 15,000 hours. They must be protected by either ceramic or tungsten spray or carbide tiles.

The scroll and bowl assembly must be statically and dynamically balanced before and after assembly.

M35.1.6 Outer casing

The outer casing must be grade 316 stainless steel and must be designed to ensure segregation of cake and centrate into their respective discharge hoppers. The casing must be of two sections connected by a flanged joint with the upper half easily removable for inspection and servicing of the rotating assembly. The outer casing must have insulation under cover with acoustic material for noise reduction if noise doesn't meet =/< 85 dB within 1 m proximity of the decanter at full speed.

M35.1.7 Centrate discharge chute and surge sump

The centrifuge assembly must be fitted with a grade 316 stainless steel centrate discharge chute which must collect all centrate without splashing. The centrate chute must be connected to the centrate pipe with a vibration take-up joiner and allowing for free gravity of the liquid discharge without backing up into the machine (adequately vented).

M35.1.8 Solids discharge chute

The centrifuge assembly must be fitted with a dewatered/thickened sludge chute which must direct all the dewatered /thickened sludge into the receiving conveyor/hopper.

The solids discharge chute must be connected to a diverter gate manufactured from grade 316 stainless steel material and separated by a vibration take-up piece supplied by the manufacturer.

The cake discharge outlet chute (post the diverter valve) must be sized to deliver dewatered/thickened sludge without spillage, to the receiving conveyor/hopper and must be of grade 316 stainless steel construction.

A flexible connection to the centrifuge discharge flange must be provided. The centrifuge discharge connection must not transmit any vibration or load from the centrifuge to the discharge chute to receiving chute.

The centrifuge centrate chute must terminate with a flange connection. The discharge pipe flange size must be of Table E with table D flange thickness to AS 2129 and vibration take-up joiners supplied as per supplier recommendations.

M35.1.9 Maintenance platform

The walkways around centrifuge to provide maintenance access must be as per Sydney Water Technical Specification – Civil (CPDMS0023). The access platforms must be designed in a manner to allow maintenance and operating personnel to easily access lubricating points, bearings, inspection bowl drive, adjustment of weir plates, removal of centrifuge cover, access to instruments, access to manual and control valves of the centrifuge.

M35.1.10 Feed pipe

The feed pipe must be manufactured from grade 316 stainless steel.

M35.1.11 Assembly

The complete assembly including drive motor and lubrication system must be mounted and aligned on a substantial steel sub-frame.

M35.1.12 Bearing temperature monitoring

A temperature sensor must be fitted to the centrifuge motor bearings for motors >75 kW. The sensor must be connected to the control room to provide an alarm and trip function if the Temperature exceeds the maximum temperature limit.

M35.1.13 Lubrication system

A central grease lubrication system must be provided mounted on the centrifuge base assembly. Lubrication system details and bearings served are to be set by the manufacturer to ensure that the external bearings are greased correctly (grease volume and intervals) and specified in the O&M manuals.

M35.1.14 Testing of centrifuge

The Contractor must allow for sampling and testing of the dewatering/thickening performance. The Contractor must conduct the sampling and testing over seven working days at the settings selected by the Contractor as per the supplier's manual.

The dewatering and thickening performance testing must be carried out in two phases. Two days initial testing must be carried out at the maximum capacity of the centrifuge. The second phase of testing must be carried out over five days at the design capacity.

During the testing of the centrifuge, the following parameters must be monitored, calculated and recorded:

a) Bowl speed (rpm)

b) Centrifugal force (g)

c) Pool depth (mm)

d) Differential speed (rpm)

e) Scroll torque (% or kNm) (in the case of variable speed scroll drive)

f) Sludge feed (m^3/hr)

g) Solids loading (kg/hr)

h) Feed solids concentration in sludge feed (%)

i) Solids concentration in dewatered/thickened sludge (%)

j) Polymer used (kg/dry ton)

k) Centrate solids concentration (NFR mg/L)

l) Solids Capture Rate (%: Target =/> 95%)).

The test will consist of four samples per day.

Samples, which will establish the solids concentrations of feed sludge, dewatered sludge and centrate, must be collected at the rate of one per every two hours for each centrifuge.

For dewatering centrifuge, the samples taken for each centrifuge must be tested for total solids concentration in the case of dewatered sludge cake and sludge feed, and suspended solids/Non-Filterable Residue (NFR mg/L) concentration for the centrate.

For thickening centrifuge, the samples taken for each centrifuge must be tested for total solids concentration in the case of thickened WAS and total suspended solids /NFR (mg/L) concentration in the case of the centrate and WAS feed.

M35.2 Rotary screw press

This section covers the general technical requirements for the Rotary Screw Press dewatering equipment.

M35.2.1 Rotary screw press (RSP) process description

The Screw Press is a continuous dewatering device. A screw is installed between the two bearing housings, which are situated in the main frame. The rotating screw is surrounded by the filter screen which is attached to the main frame of the Screw Press.

Sludge enters the Screw Press, between the screw and the screen, where the solid matter is separated from the filtrate water. The filtrate water flows through the perforated screen and is collected by the drip tray. The solid matter is slowly conveyed through the press with the internal rotating screw, driven by a gear motor. Additionally, the screw is also equipped with a replaceable or adjustable scraper which cleans the inner surface of the filter screen.

A set of spray bars also allow for cleaning of the screen perforation to allow for clear pressate to free-flow the perforated screen.

The screw and filter screen are enclosed to contain odours and aerosols, as well as sprays and prevent spills. Access hatches on the sides of the filter cover allows for access, maintenance and viewing.

A washing device, which includes multiple washing nozzles, is contained in the enclosure to rinse the filter screen and the inside of the cover regularly, or on demand, using service water. The washing nozzles are installed on spray-bar tube/s. During the washing of the filter screen, the dewatering process is not interrupted.

The Screw Press filter screen is split into several sections for dismantling and screen panel section replacements.

When the sludge reaches the end of the rotary screw press, squeezing of the cake occurs, as the sludge is squeezed via a controlled pressure-plate/disc at the cake discharge end. The sludge cake is discharged at the end of the Screw Press, where a pressure-plate or cone is situated. This presser is used to push against the discharge, achieved by pneumatic cylinders or manually set, to remove further filtrate and obtain a dryer cake.

Preparing the sludge to the correct degree of flocculation is important. This is aided by the conditioning / flocculation tank which allows the flocs to grow and develop accordingly. Variable agitation in the conditioning tank assists the development of the flocculation of the suspended solids. The slurry enters the tank at the base and exits the tank via the top directly into the Screw Press.

The efficiency of the dewatering is determined by the composition of sludge, the degree of flocculation, the speed of the screw and finally the pressure on the presser at the end of the unit.

M35.2.2 Rotary screw press (RSP) equipment design life

The RSP equipment must have a minimum design life of 20 years.

To achieve this design life, the Contractor’s designs must include the selection of appropriate materials to withstand the corrosive and highly abrasive environments typically found in Municipal Sewerage treatment plant equipment.

M35.2.3 Manual handling and safe access

The design and installation of all RSP equipment must adequately consider the management of all potential manual handling risks associated with Sydney Water’s ongoing operation, servicing and inspection of the equipment. This design must meet the requirements of the relevant Australian standards.

All machine covers and safety barriers must be designed to enable safe removal by an operator, without the aid of an overhead crane where possible. N.B. designs may require the inclusion of mechanical assistance e.g. spring or pneumatic devices.

The design and installation of the RSP equipment must include the provision of safe access for personnel involved in operation, inspection, cleaning and maintenance duties.

All access platforms (if standard supply inclusive) must comply with the relevant Australian standards.

M35.2.4 Rotary screw press assembly

The RSP unit is to be supplied mounted on a standard OEM subframe which can be secured to either concrete or steel structural beams.

Nb. For machines prone to high vibration levels, any equipment that is susceptible to damage can be mounted remotely from the assembled unit e.g. electrical controls modules / main control systems.

Each RSP unit and sub assembly, must be provided with designated lifting points to enable safe installation and ongoing maintenance.

Details of any specialised lifting frames or attachments required for installation or ongoing maintenance, must be provided with the equipment.

The operating environment of Sydney Water's WWTP's is harsh. Particularly on machine components subjected to wetted areas, including but not limited to; rotating drums, pressate and sludge discharge chutes.

The drum/filter must be of minimum 304 stainless steel construction and the rotating screw must be of 316 stainless steel.

Machine covers must be of 316 stainless steel material of construction, and alike for the pressure plate or cone, unless the manufacturer recommends otherwise.

Base frame must be 316 stainless steel.

M35.2.5 Protective coatings

All non-stainless steel, ferrous components must have protective coatings applied to WSA 201, or equivalent for 20 years design life in coastal corrosive environments.

- Non-wetted structural components and bearing housings to be coated to withstand coastal corrosive environments
- Gearbox and electric motors to be coated to withstand coastal corrosive environments.

M35.2.6 Fasteners

All fasteners must be of 316 stainless steel.

M35.2.7 Rotary screw press – cake discharge chutes

The design of all discharge chutes (Sludge and Centrate/Filtrate) must be sized and utilise materials to ensure free discharge of materials, prevent material build up / blockages and prevent splashing.

The RSP must have provision for sampling points that are safely accessible during operation utilising grade 316 stainless steel components.

M35.2.8 Flocculation tank

The flocculation tank must be fixed to the floor using grade 316 Stainless Steel anchors, and the tank and components must be of grade 316 stainless steel construction.

M35.2.9 Rotary screw press functional requirements

The following electrical devices are to be supplied by Sydney Water or the manufacturer as a minimum to automate and enhance the operation of the screw press:

- Solenoid valves for spray systems, or motorised stainless steel 316 ball valves with digital limit switches
- Rotary screw speed sensor if required
- Electronic shear pin if required
- Level Transmitters (for flocculation/header tanks). Reliable level indication is critical, thus must be provided of hydrostatic type
- Flow Switches or flow transmitters for spray system/s (adjustable)

- Pressure Transmitter for Back-Pressure Control (pressure measuring instrument as supplier recommendation)
- Mixer for flocculation tank to be easily sourced, accessible and maintained.

M35.2.10 Rotary screw press polymer dosing

The manufacturer must supply a polymer dosing point to either or both, the feed pipe to the flocculation tank (via a mixing valve or inline mixer) or into the flocculation tank as recommended by the manufacturer.

The dosing points must be of grade 316 stainless steel.

M35.2.11 Testing of rotary screw press

The Contractor must allow for sampling and testing of the dewatering performance. The Contractor must conduct the sampling and testing over seven working days at the settings selected by the Contractor as per the supplier's manual.

The dewatering performance testing must be carried out in two phases. Two days initial testing must be carried out at the maximum capacity of the RSP. The second phase of testing must be carried out over five days at the design capacity.

During the testing of the RSP, the following parameters must be monitored, calculated and recorded:

a) Screw speed (rpm)

b) Spray Timers (ON & OFF timers)

c) Pressure Plate or Cone Pressure (kPa)

d) Flocculator Mixer speed (rpm)

e) Sludge feed (m^3/hr)

f) Solids loading (kg/hr)

g) Feed solids concentration in sludge feed (%TSR)

h) Solids concentration in dewatered sludge (%TSR)

i) Polymer used (kg/dry ton)

j) Pressate solids concentration (NFR mg/L)

k) Solids Capture Rate (%: Target =/> 95%) recovery (%).

The test will consist of four samples per day.

Samples, which will establish the solids concentrations of feed sludge, dewatered sludge and pressate, must be collected at the rate of one per every two hours for each RSP.

M36. Conveyors

M36.1 General

This section covers the technical requirements for the supply of screw conveyors, belt conveyors and their appurtenances associated with the plant.

Permanent access platforms, ladders and walkways must be provided as required for the operation and regular maintenance of the installed conveyors.

Minimum safety requirements must be in accordance with AS/NZS 4024.3610.

All conveyors must be designed for both automatic and manual operation and all the necessary instrumentation and controls must be supplied and installed.

All other safety requirements in accordance with AS 1755 must be supplied and installed.

All discharge chutes from conveyors must be vertical or pyramid type to prevent build-up of material. Inverted pyramid type chute will not be accepted.

The continuous rated output of the electric motor driving the conveyors must be at least 50% more than the maximum power required by the unit under all operating conditions.

M36.2 Motion detectors

Conveyors must be provided with proximity sensor type motion detectors on a driven element (e.g. conveyor screw element) to initiate a failure alarm and/or machine shutdown.

The motion detector must detect rotation or movement of the item and a suitable metal "target" must be supplied and fitted to operate the motion detector. The motion detector contacts must be wired to the SCADA system to give an alarm if the equipment is running but the motion detector indicates driven elements are not rotating.

M36.3 Screw conveyors

M36.3.1 Screw conveyor construction

The following requirements apply when screw conveyors are used to convey materials. Shaft type screw conveyors must only be used for the sludge hopper bottom conveyor under the sliding frame silo. Otherwise, all screw conveyors must be a shaftless type comprising of a helical screw with flights having abrasion resistant surfaces. No supports or bearings must be provided for the screw within conveyor trough casings. The conveyor screw must have a support bearing at the drive end, which must be capable of taking all the thrust loadings.

The conveyor must be designed so that clogging and build up on the flights must not occur. The screw pitches must be selected to efficiently convey material of the required moisture content. Screw, troughs and drive shafts must be correctly aligned and free of sharp projections that might catch rags or stringy materials.

For the purposes of clarity, the term “biosolids” used in this section also refers to other common terms used such as “dewatered digested sludge” and “biosolids cake”.

Screw conveyors for screenings must be “push” type. For biosolids and grit, “push” type screw conveyors are preferred but “pull” type can be used where acceptance from Sydney Water is obtained.

The screw conveyor must be designed to have the following maximum parameters:

- Maximum operating speed of a horizontal screw conveyor 10 RPM, (with capability to change the reduction gear box to increase the speed up to 15 RPM)
- Maximum operating speed of an inclined screw conveyor 15 RPM, (with capability to change the reduction gear box to increase the speed up to 20 RPM)
- Maximum inclination of screw conveyor must not exceed 30 unless specifically accepted by Sydney Water
- No inclination above 45 degrees is permitted
- Screw conveyors must only be utilised to convey biosolids over as short a distance as possible. Belt conveyors are the preferred option to convey biosolids.
- Exceptions:
  - Shorter Screw conveyors for silo feed
  - Screw conveyors for truck loading where the operation of sequential outlet gates is required.

Locked or bolted access opening for inspection and blockage clearance must be provided at all intersections of the conveyor with other equipment.

Frequent inspection (twice a month) access opening must be of hinged locked type.

A safety grill or mesh must be installed within all hinged access openings in accordance with AS4024.3610 and relevant requirements from Safework NSW regarding machinery guarding.

The normal mode of operation must be to drive away from the motor end. The operation of the screw conveyors must be designed and supplied to be interlocked with the operation of surrounding equipment and to prevent unwanted spillage of conveyed material when equipment is not operating.

The design of the collection / discharge points must meet the requirements of Work Cover Authority of NSW.

All other safety requirements must be in accordance with AS 1755.

M36.3.2 Spiral

The spiral must have a minimum of 280 mm diameter for dewatered screening and sludge handling conveyors. All free screening conveyors must have a minimum of 250 mm diameter.

M36.3.3 Screw conveyor troughs

The screw conveyor trough must have an easily replaceable wear resistance liner, to prevent the steel casing contacting the conveyor screw. The trough must be fitted with wear liners which have coloured wear indicators in the liners.

Screw conveyor troughs must be fitted with drain plugs at low ends of each trough. Drains must be installed so that they do not create trip hazards.

M36.3.4 Screw conveyor cover

Screw conveyors must be enclosed throughout their length by a cover, by fixed covers and by hinged access covers that can easily be locked closed.

Suitably sized and spaced air intake nozzles must be provided in the covers to allow an even collection of foul air from the screw conveyors.

M36.3.5 Screw conveyor feed hopper(s)

Feed hoppers must be designed to receive and discharge material without blockages occurring. Feed hoppers must be integral parts of the conveyor troughs and must be manufactured from grade 316 stainless steel. The feed hopper must be fitted with securable airtight inspection doors

M36.3.6 Screw conveyor discharge chute(s)

Discharge chutes must be integral parts of the conveyor troughs and must be manufactured from grade 316 stainless steel. Chutes must be fitted with a securable and airtight inspection door.

The discharge chute may be manufactured from rubber when the material leaves the conveyor to drop into a bin etc.

M36.3.7 Screw conveyor supports

Conveyors must be supported at each end and at intermediate locations. All support steelwork must be fabricated from structural steel and be hot dipped galvanised or painted after fabrication. Connections between grade 316 stainless steel and galvanised steelwork must be bolted using insulation between the dissimilar metals. Welding between grade 316 stainless steel and galvanised steel is not permitted.

M36.3.8 Screw conveyor drive

The screw conveyor drive must be by an electric motor with a directly mounted speed reduction unit. The motors must be mounted at accessible locations.

Drives must be fitted with electronic shear pins to prevent excessive loading or seizure.

M36.3.9 Emergency outlet

All screw conveyors must be provided with an emergency outlet chute or emergency relief flap gate to prevent over loading of conveyors.

M36.3.10 Material of construction

The material construction of screw conveyor must conform to the following:

- U-Trough and lids: 2.5 or 3 mm stainless steel grade 316
- Liner: 12 mm extra wear resistant, ultra-high molecular weight polyethylene
- Spiral: High tensile micro-alloy steel
- Chute and feed hopper must be min. 2 mm thick stainless steel grade 316
- Support brackets must be stainless steel grade 316.

M36.4 Belt conveyors

M36.4.1 Standards

Belt conveyor terms must be as defined in AS 4035.

Additional safety requirements for belt conveyors must be in accordance with AS/NZS 4024.3611.

Conveyor belts for conveyor belting made of elastomeric materials with textile reinforcement, intended for use on conveyors using flat or troughed idlers must comply with the requirements of AS 1332.

Conveyor belting of elastomeric materials and steel cord construction in which the carcass is composed of a plane of steel cords with or without supplementary reinforcements must comply with requirements of AS 1333.

M36.4.2 Inclination angle

Conveyor inclination angle must be such that it does not result in product being conveyed moving relative to the belt.

M36.4.3 Belt material

Belt carcass and reinforcement must be of sufficient strength to provide reliable and durable belt operation under all design conditions.

Belt cover material must have physical properties and chemical resistance with the product being conveyed to protect the carcass and to give the conveyor belt an economical life span.

M36.4.4 Emergency

Lanyards must be provided along belt conveyors to stop the conveyors in an emergency.

M37. Chemical systems

M37.1 General

This section of the Specification covers the general requirements for chemical related assets located at Sydney Water's facilities.

Many of the chemicals used within Sydney Water's facilities and network are classified as Dangerous Goods and are subject to specific requirements governed by both federal and state legislation.

M37.1.1 Applicability

A range of chemicals are used for different purposes at Sydney Water's facilities. The application of the requirements of this Specification apply in principle to all chemical installations.

The table below summarises the chemicals found at various Sydney Water's facilities.

Common chemicals	*application specific chemicals
Ferrous Chloride	Hydrochloric Acid
Ferric Chloride	Sulphuric Acid
Ferric Sulphate	Acetic Acid
Spent Pickle Liquor	Citric Acid
Aluminium Sulphate	Ammonium Hydroxide
Sodium Hydroxide	Biocides
Sodium Hypochlorite	Anti-scalants
Sodium Bisulphite	Powder and Liquid Polyelectrolytes
Hydrofluosilic Acid	Magnesium Hydroxide
	Methanol/ Ethanol
	Carbon Dioxide Solutions
	Liquid Chlorine
	Potassium Permanganate
	Hydrated Lime

* Application Specific Chemicals are less commonly used and are generally used for a specific process requirement. For these chemicals this Specification still applies, however amendments may be required to suit the specific properties of the chemical.

M37.1.2 Relevance to other documents

Other specifications have been produced to cover the specific requirements for the following:

a) Network Re-chlorination Dosing Systems (D0000389)

b) Network Chemical Dosing Units (ACP0002).

For those specific applications, the documents noted above take precedence over this Specification.

M37.1.3 Innovation and variance to this specification

This document provides an indicative solution for the works. The indicative solution stated within this Specification may be further developed or the designer may produce their own design that will fully comply with the Specification requirements.

Any alternative materials, designs, methods of assembly, and processes that do not comply with specific requirements of this Specification, or are not mentioned in it, but give equivalent performance outcomes to those specified, are not necessarily prohibited. Written acceptance from Sydney Water must be sought with the design submission, prior to construction.

M37.1.4 Relevant regulations, codes and standards

M37.1.4.1 Legislation and regulations

Work Health and Safety Act 2011

Work Health and Safety Regulation 2017

Work Health and Safety (Managing Risks of Hazardous Chemicals in the Workplace) Code of Practice 2015

National Transportation Commission (NTC) - Australian Dangerous Goods Code

Protection of the Environment Operations Act 1997

New South Wales Code of Practice for Fluoridation of Public Water Supplies

M37.1.4.2 Australian and other standards

ADR43/04	Vehicle Configuration and Dimensions
AS 1319	Safety signs for the occupational environment
AS 1345	Identifications of the contents of pipes, conduits and ducts
AS 1940	The storage and handling of flammable and combustible liquids
AS 2032	Installation of PVC Pipe Systems
AS 2129	Flanges for pipes, valves and fittings
AS 2700	Colour standards for general purposes
AS 2890.1	Parking facilities - Off street car parking
AS 3500	National plumbing and drainage code
AS 3735	Concrete structures retaining liquids
AS 3780	Storage and handling of corrosive substances
AS 3996	Access covers and grates
AS 4130	Polyethylene (PE) pipes for pressure applications
AS 4506	Metal finishing - Thermoset powder coatings
AS/NZS	Australian Standard/New Zealand Standard
AS/NZS 3000	Electrical Installations (Australian/New Zealand Wiring Rules)

AS/NZS 4766	Polyethylene storage tanks for water and chemicals
ANSI Z358.1	Compliance requirements- Emergency shower and eye wash stations
ASTM D1784	Standard specification for Rigid PVC Compounds and cPVC Compounds
ASTM D1785	Standard specification for PVC plastic pipe
ASTM D2467	Standard specification for PVC Plastic Fittings, Schedule 80
EN 13121	GRP Tanks and Vessels for Use Above Ground
BS 4994	Specification for Design and Construction of Vessels and Tanks in Reinforced Plastics
WSA 201	Manual for Selection and Application of Protective Coatings
WSA 01-2004	Polyethylene Pipeline Code

M37.1.4.3 Sydney Water Standards

Health and Safety Procedure HSP-058: Risk Assessment in Design

Instrumentation and Control Standards TOG_TS01

Sydney Water Confined Space Work Health and Safety Procedure WHSMS0068

Technical Specification – Civil (CPDMS0023)

Technical Specification – Electrical (CPDMS0022)

Safety Signage Specification (SDIMS0026)

Specification – Commissioning, transitioning assets into operation (D0001440)

Jointing Requirements for Solvent Cement Welding Using Weldon 724 System.

M37.1.4.4 Supplier standards

Chemicals are supplied through contracts that are reviewed periodically. Suppliers have their own specific requirements for chemical delivery and storage. The most recent standards should be obtained from the chemical supplier prior to commencing design.

M37.2 Overall requirements

M37.2.1 Site Conditions

The site is normally subjected to temperate climate conditions, with an ambient temperature range of (minus) -6 °C to 50 °C, and humidity of up to 100%. All equipment, unless otherwise specified, must be designed to accommodate and operate satisfactorily within these conditions.

Additional consideration must be given for sites that are subjected to strong wind and saltwater spray/mist, for example, marine conditions. Thus, all equipment must be designed to accommodate and operate satisfactorily within these weather conditions.

M37.2.2 Materials

M37.2.2.1 General

All materials selected or adopted in the design must be suitable for installation in the proposed environment, and suitable for use and contact with the chemical involved. They must be corrosion resistant and selected to match the specified design life. Where required, materials must be coated in accordance with WSA 201.

All components of the chemical dosing system should be from the same manufacturer (and where possible, supplier) for a specific dosing system and where possible, for any existing chemical dosing system on site. All valves of the same size, duty and type supplied under the contract must be identical.

M37.2.2.2 Corrosion resistance

All internal parts in contact with the chemical substances are required to be corrosion resistant against the chemical involved.

All bolts, nuts, and washers must be made from stainless steel grade 316, or equivalent, which is deemed to be suitable for the application.

M37.2.2.3 Gaskets, “O” rings and rubbers

Only approved gaskets, O rings and rubber that are compatible for use with the specific chemicals must be used. FPM and EPDM products are to be used for chemical applications as specified in the table below. For any chemicals not listed below, direction to be requested from Sydney Water.

Chemical applications for FPM and EPDM

FPM (viton)	EPDM
Ferrous Chloride	Ammonium Hydroxide
Ferric Chloride	Sodium Hydroxide
Ferric Sulphate	Methanol/ Ethanol
Spent Pickle Liquor	
Aluminium Sulphate	
Sodium Hypochlorite	
Sodium Bisulphite	
Hydrofluosilic Acid	
Biocides	
Anti-scalants	
Powder and Liquid Polyelectrolytes	
Magnesium Hydroxide	
Hydrochloric Acid	
Sulphuric Acid	
Acetic Acid	
Citric Acid	
Carbon Dioxide Solutions	

M37.2.2.4 Design and selection for temperature effects

Different chemicals are influenced by site ambient conditions, leading to crystallisation, off-gassing and chemical breakdown. Consideration is required during the design process to ensure appropriate controls such as shading, heat tracing and expansion/contraction loops are included to minimise the effects of these impacts.

M37.2.3 Operability & maintainability

The layout of the equipment within a chemical storage or dosing bund must be submitted to Sydney Water for acceptance prior to construction. This is to ensure that all equipment including key valving and maintenance items can be easily reached by personnel for maintenance and operation.

The general principle to follow in the design is that the area must have adequate space to work in. There must be no floor-mounted obstructions and working areas must have immediate access to the point of safe egress. For adequate emergency access / egress, pathways around tanks etc. must be a minimum of 1 m wide. Permanent access for maintenance must be provided to all maintainable equipment within a chemical dosing installation unless otherwise accepted by Sydney Water.

Access into each bunded area must be one or two exits depending upon ease of access and maintenance of equipment. At each exit / entrance, there must be stairs and a platform on each side of the bund wall. Access into chemical storage bunds must comply with the requirements of AS 1657 and AS 3780.

M37.2.4 Safety

All chemical dosing and storage installations are subject to WHS legislation and all appropriate steps are to be taken to protect persons from the potential of harm. The legislation, codes and standards referenced in this Specification detail specific safety requirements and obligations. Specific requirements for chemical dosing applications are summarised within this section.

M37.2.4.1 Safety showers and eyewash

For all chemical dosing systems, deluge type safety shower and eye wash stations, conforming to AS 4775 and ANSI Z358.1, must be supplied and installed adjacent to the dosing equipment. Water to these facilities must come from the potable water supply line. Water supply to safety showers and eyewashes must be connected directly to the main supply and not be subject to disruption from plant maintenance.

Water pressure to the safety showers must meet the requirements of AS 4775 at all times, regardless of the demands of other equipment. Suitable backflow protection must be considered in the potable water supply network in accordance with AS 3500.

Long water lines to the safety shower and eyewash station that are exposed to sunlight must be lagged, as water may be heated and therefore unsuitable for use. All lagging materials must be rigid, weather resistant, non-combustible type and accepted by Sydney Water prior to procurement. It must be rockwool type or equivalent with aluminium or stainless steel sheet outer cladding to protect from water ingress and damage. Aluminium foil tape type lagging covers are not acceptable..

The installation must be complete including the necessary cut-in into the nearest potable water supply line, fittings, isolation valves, etc. The shower must be free standing and hand operated. The eye/face wash must be capable of being operated by both hand and foot and include two double aerated outlets complete with dust covers. The material of construction must be stainless steel.

M37.2.4.2 Splashguarding and protective barriers

Where chemical storage areas are located adjacent walkways and potential hazard of chemical spraying outside of a bunded area may exist, splashguarding is to be provided.

Splashguards are to be constructed from materials impervious to the chemical stored. They are to be located such that any chemical hitting the guard is directed into the storage bund or other contained location.

Guarding must be adequately supported in consideration of any wind loads.

M37.2.4.3 Safety equipment cabinet

All chemical dosing facilities must be fitted with a lockable cabinet at the chemical storage area. The cabinet must be used to store personal protective equipment (PPE) for use by Production Officers.

M37.2.4.4 Signage, labelling, tagging and marking

Tags, labels, signs, and other markings must be provided for all these systems which clearly indicate the individual system, chemical contents, hazards, warnings, and any other pertinent information in accordance with the requirements of the relevant standards, codes of practice and specifications.

Signage must be in accordance with SDIMS0026 Safety Signage Specification.

All assets must be labelled and identified in accordance with Sydney Water's Specification – Commissioning, transitioning assets into operation (D0001440).

M37.2.5 Environmental management

The complete chemical system, including but not limited to; storage facilities, delivery facilities, transfer pipework, dosing systems and dosing lines through to the dosing location must be designed to provide a complete containment strategy for all aspects of the system. This ensures that any component failure or leak is captured and contained for safe disposal.

The containment must direct any leakage or spillage to a safe location where it may be managed appropriately. This methodology is to include appropriate locations for visual identification of leaks and leak detection at any low points. The containment methodology is to be discussed and accepted by Sydney Water prior to implementation.

M37.3 Staff requirements and design deliverables

M37.3.1 Training requirements

The following specific training requirements apply to all personnel working on chemical dosing systems: All project engineers, design engineers, project managers, supervisors, leading hands and fitters specifically working on the chemical dosing systems will attend Sydney Water's Chemical Dosing Training.

a) All personnel installing plastic pipework including uPVC, cPVC and electrofusion welded polyethylene will undertake specific supplier or industry training on installation techniques. The selected training is to be pre-approved by Sydney Water.

b) Principal: Jointing Requirements for Solvent Cement Welding Using Weldon 724 System. The use of tools, inclusive of pipe cutters, chamfering and de-burring tools detailed in this procedure must be

adhered to. Personnel carrying out the work must be adequately trained in accordance with the requirements of this document.

c) Records / certificates for this training will be submitted with construction ITPs and checklists or produced upon request by Sydney Water.

M37.3.2 Minimum design deliverables

The following deliverables are required for all chemical dosing system designs. This list establishes the minimum requirements, and variance to these deliverables is subject to Sydney Water's acceptance. All normal requirements for delivery and handover are also applicable to chemical dosing projects.

Item	Deliverables	Sub deliverables (additional to normal design)
1.	50% detail design documentation	3D layouts of equipment and dosing skid. These must be provided in 3D PDF format for review. Equipment schedule identifying all components of the system including Supplier, Manufacturer, Model, Size, Pressure Class and Process Connections. Schedules to include valves, pumps, fittings, pipework materials and all dosing system ancillaries.
2.	90% detail design documentation	
3.	IFC detail design documentation	
4.	HIDRA - Design	
5.	IFC detail design documentation	
6.	HAZOP / CHAZOP report	
7.	CHAIR report	
8.	Final Work As Constructed (WAC) drawings supplied electronically in both AutoCAD DWG and Adobe PDF formats	
9.	Workshop and factory acceptance test (FAT)	Any fabricated dosing "skid" arrangements must require a factory based inspection prior to gluing and painting. Inspection must be undertaken by Sydney Water.
10.	Construction, Commissioning and Handover	This will be in accordance with the requirements of project specific specification and Sydney Water Technical Specification - Commissioning, transitioning assets into operation (D0001440). Evidence of training records will be a required deliverable with ITPs and Check sheets. Update of Documentation

M37.4 Chemical system description and requirements

M37.4.1 General description and generic process diagrams

Safe chemical receiving, storage, transfer and dosing systems are to be provided for all chemicals that are to be used. The chemical systems must include all pipework, fittings, valves, instruments and controls, from the point of bulk delivery to the point(s) of injection into the process streams.

This Specification and supporting documentation have been developed to ensure chemical installations are designed, constructed and commissioned to ensure process security, safety, environmental protection and quality.

Sydney Water have developed a set of generic Deemed to Comply (DTC) Process and Instrumentation Diagrams (P&IDs) to provide indication of the minimum standard for required equipment, instrumentation and valving on typical installations at Sydney Water treatment facilities. These P&IDs are provided for guidance only, and a specific P&ID must be developed and submitted for review for each unique chemical system being designed. Variation to the standard arrangements will be subject to acceptance by Sydney Water.

The generic DTCs are outlined below:

DTC Number	Description
7500	Typical Chemical Dosing System - Instrumentation & Notes
7501	Typical Chemical Dosing System - P&ID - Single Tank
7502	Typical Chemical Dosing System - P&ID - With Day Tank

M37.4.2 Key elements of chemical systems

Chemical Systems are made up of a number of key elements. These elements all have specific requirements to ensure the complete chemical system is designed and constructed accordingly.

The elements are summarised below, and the requirements for each element are detailed in the following sections.

Element
Chemical Delivery Bund
Chemical Storage Bund
Chemical Storage Tank
Chemical Dosing System
Chemical Pipework and Fittings (Including Dosing lines)
Dilution Water

M37.5 Chemical delivery bund

A chemical delivery bund must be designed and constructed to provide safe arrival, parking, off-loading, turning around (if necessary), and departure of bulk chemical tanker trucks.

Where a single bund is used for delivery of multiple different chemicals, the compatibility of these chemicals will be assessed, and appropriate steps taken to prevent cross-contamination.

M37.5.1 Location

The delivery bund must be located adjacent to the chemical storage facilities. Unless otherwise specified, the storage facility must be located on the left (passenger) side of the tanker.

The unloading point must allow the chemical delivery tanker to be fully inside the delivery bund when unloading. The length of the hose required to connect a tanker to a filling point shall not exceed 6m as per AS 3780.

M37.5.2 Access

The chemical delivery bund must be separated from the plant road where possible so that traffic moving around the plant does not have to travel through the delivery bund. The chemical delivery bund must be designed to accommodate semi-trailers and truck and dog combinations up to 19 m long to drive through. Swept path analysis must be carried out to demonstrate vehicle accessibility during design development. The design is to avoid the possibility of the delivery truck having to pass back through a bund in which a spill has occurred.

Delivery bunds may be reduced to 9 m to accommodate an 8m flat-top tray truck carrying a maximum 8 off individual 1,000 L intermediate bulk containers (IBCs). It must be stated on the WAC drawings that the bund is designed for a flat top tray truck carrying a maximum of 8 off IBCs.

M37.5.3 Bund

The delivery bund must be a concrete slab with a rounded bund wall, to provide containment for any spill or leaks. Relevant aspects of AS 3780 must be complied with where corrosive chemicals are used.

The bund must be designed as a water retaining structure in accordance with AS 3735. It must have a capacity of 9,000 litres or 110% capacity of the largest tanker vehicle compartment, whichever is greater.

The bunded area must be designed with a 1 in 75 grade towards the sump drain, such that no pools of chemical or rainwater will accumulate on either side of the bund. The bund walls must also be painted yellow or marked with yellow edge strip to increase visibility and reduce the risk of tripping onsite. The step between the delivery bund low level adjacent footpaths is to be a maximum of 225 mm as per AS 1657 step size criteria unless accepted by Sydney Water.

Any humps in the roadway at either end of the tanker delivery bund must be designed to allow normal passenger vehicles (Class B99) to enter and exit without scraping the bottom of the vehicle, as per the clearance requirements of ADR43/03 and AS 2890.1, unless other vehicle types agreed or specified by Sydney Water.

The area between the tanker bay bund and the storage bund must be concreted, and any spills in this area must be contained and drain into the delivery bund.

The delivery bund arrangement must ensure any stormwater from the surrounding roadway and ground must be channelled away, and not flow into the delivery bund.

A suitable coating may be applied to the internal surfaces of the delivery bund. Where epoxy paints are used, they must be resistant to the chemical involved. Coatings are to be selected in accordance with

WSA201. In applying the coatings, the manufacturer's specific instructions on surface preparation and application requirements must be followed. The resultant finish must be non-slip.

M37.5.4 Sump and discharge

A sump (minimum 600 mm x 600 mm x 600 mm deep), complete with a lightweight lid, must be located adjacent to the delivery bund.

The sump pit must be located where it is not subjected to vehicle loading at one of the sides (outside) of the delivery bay bund. It must be fitted with a grate/cover, made from lightweight materials, weighing no more than 16 kg, in accordance with AS 3996, Class A. The weight limit must be labelled where appropriate. Where the unit's location is subject to falling debris from trees in the area, perforated sump covers with 12 mm diameter holes must be used as opposed to grated covers to prevent blocking of drainage system.

A sump pump is to be provided to transfer any spills to a discharge point fitted with a 50 mm "camlock" coupling or to a point early in the overall process (e.g. the head of works, or as agreed with Sydney Water). The pump must only be activated by a local stop/start station and include an automatic low level cut-out. The sump pump must be manufactured from appropriate materials to withstand corrosion from the chemicals that it may be subjected to. The submersible pump must be elevated from the floor of the sump to prevent clogging by dirt and debris. It must be furnished with an accessible discharge union coupling, to enable removal for cleaning and servicing without the need for confined space entry permit.

A "camlock" pump out point must be installed to allow pump out from the sump pit and bund area. The location of the "camlock" pump out point must be such that the pump out truck does not have to enter the bunded area where possible. Isolation valves must be installed to allow pump out from the sump pit pump or "camlock" connection.

The line from the sump pump to the point of disposal must not include any branches where incompatible materials can mix (e.g. sodium hypochlorite with an acidic liquid).

There must be individual lines from each tanker delivery bund sump to the point of disposal.

Note that the type of sump pump selected is dependent on the viscosity of the fluid and a submersible centrifugal pump may not be appropriate. An alternative pumping and/or drainage solution may be required to remove spills based on the properties of the sump contents, e.g. magnesium hydroxide, lime, polymer, etc.

M37.5.5 Unloading point

The chemical storage tank fill line must be installed in accordance with the following requirements, or those specified by the chemical supplier:

- A minimum 50 mm tanker fill pipe connecting from a 50 mm suitable male "camlock" fitting, with lockable cover, through to the storage tank. The "camlock" must terminate over the storage bund or other appropriate leak capture arrangement.
- A ball valve is to be installed on the fill line but is to be accessible from the delivery bund for delivery driver operation.
- A drain line of smaller diameter than the fill line is to be installed between the "camlock" and fill line isolation valve. The drain line will be fitted with a ball valve that must also be accessible from the

delivery bund for delivery driver operation. The drain must drain to a tundish that is to be visible to the delivery driver from outside the storage bund. The tundish must subsequently have a drain line routed to the storage bund sump.

- The coupling point must be positioned at least 600 mm and no more than 900 mm above the ground and firmly supported. Support must be provided for the delivery hose, including clamping, to prevent damage to the coupling point during chemical delivery.
- A placard containing information on chemical, tank descriptor (storage or dosing), tank capacity and safe fill volume must be placed clearly on each line at the loading point as per SDIMS0026 service delivery safety signage specification
- Two permanently mounted electrical power outlets are required for delivery of chemical. The power outlets are 400 V and 240 V IP56 GPOs with RCD protection for each chemical storage tank (or tank pair in some dual tank systems) as per Sydney Water SCADA standard starter template. These will be interlocked with tank high level such that power will be cut to the outlets when high level is reached. Where multiple tanks exist in a common bund, a single GPO pair may be used (subject to Sydney Water's acceptance), provided that the single GPO pair is interlocked with the high level of both tanks.
- Power outlets must be located between 2 m and 7.5 m from the tanker hose connection.
- A weatherproof digital display of the tank level must also be installed at the filling transfer point to indicate the actual level during filling. An alarm system consisting of a klaxon and beacon must also be installed at the filling point, to alarm if tank has overflowed during filling. The digital display for tank level must be suitable for operation with 24 V DC power supply. It must be equipped with sunlight readable LEDs and a minimum reading range of 10 m. It must be suitable to display percentage values.

Where multiple different chemicals are delivered using a single common delivery bund, non-compatible chemicals must not share the bund unless approved by the chemical supplier and accepted by Sydney Water, and appropriate protection is put into place to prevent any potential reactions occurring. Locked unloading points or security cages must be used to ensure the correct delivery point is used.

A meeting must be arranged with the relevant chemical supplier for the specific chemical to confirm the tanker unloading arrangement is acceptable for delivery. Sydney Water must be invited to attend this meeting.

M37.5.6 Safety equipment

The following minimum safety equipment will be provided at the delivery bund:

- A safety shower and eyewash complying with the requirements of this Specification, located within 2 m to 7 m of the chemical delivery connection point
- A UV resistant hose reel (20 mm NB minimum) permanently attached to a water supply (reclaimed effluent at Treatment Facilities) and capable of reaching all parts of the chemical delivery bund must be provided
- Sufficient lighting to enable safe work beyond daylight conditions, particularly for the chemical delivery activities

- An MSDS for each chemical must be provided in a weatherproof fixture near the respective unloading points
- An ABE fire extinguisher for use in electrical fires must be provided.

M37.6 Chemical storage bund

M37.6.1 Bund

Each chemical storage area (including polymer solution) must include a storage bund constructed of reinforced concrete. Bunds must meet the requirements of AS 3780 and must be designed as a water retaining structure to AS 3735. The bund structure is to be hydrostatically tested after construction.

The bund must meet the storage capacities as detailed in AS 3780 (Normally 110% of the largest container in the bund). Bund flood level is to be indicated on design drawings.

The bunded area must be designed with a 1 in 75 grade towards the sump pit such that no pools of water/chemical will accumulate on the bund floor.

A pipe chase must be provided in the bund floor for the overflow/drainpipe from the storage tank to the sump. The pipe chase must drain to the sump and must be complete with FRP grating.

A suitably sized reinforced concrete plinth of minimum 150 mm high must be provided for the mounting of the chemical storage tank(s). The plinth must be appropriately designed for the maximum forces imposed on it by the tank, and any wind loads.

Access steps/stairs must be provided on the inside and outside of the bund wall to provide safe access and egress, in accordance with AS 1657. Normal working areas must have immediate access to the point of safe egress. The width for emergency access and egress must be no less than 1 m, unless specified otherwise.

A suitable coating must be applied to the internal surfaces of the bunds, including any sumps or pipe chase(s). Coatings must be resistant to the chemical involved and meet the requirements of WSA 201. In applying the coatings, the manufacturer's specific instructions on surface preparation and application requirements must be strictly followed. The resulting finish must be non-slip.

Electrical components must be installed above the bund flood level, except for the tank isolation/anti-syphon valve if it is installed below that level.

M37.6.2 Sump and discharge

A lined concrete sump (minimum 600 mm x 600 mm x 600 mm deep), complete with a lightweight lid, must be located adjacent to the bund wall such that the sump pump may be accessed without entering a flooded bund. This may require installation of a gate in the security fencing. The sump must be fitted with a grate suitable to accept the weight of personnel. The grate must have handles which will allow the grate to be removed.

A sump pump is to be provided to transfer any spills to a discharge point fitted with a 50 mm “camlock” type hose coupling or to a point early in the overall process (e.g. the head of works, or as agreed with Sydney Water). The capacity of the pump must be such that it can empty the full capacity of the bund within approximately 4 hours. The pump must only be activated by a local stop/start station and include an

automatic low level cut-out. The sump pump must be manufactured from appropriate materials to withstand corrosion from the chemicals that it may be subjected to. The submersible pump must be elevated from the floor of the sump to prevent clogging by dirt and debris. It must be furnished with an accessible discharge union coupling, to enable removal for cleaning and servicing without the need for confined space entry permit.

A “camlock” pump out point must be installed to allow pump out from the sump pit and bund area. The location of the “camlock” pump out point must be such that the pump out truck does not have to enter the bunded area where possible. Isolation valves must be installed to allow pump out from the sump pit pump or “camlock” connection.

The line from the sump pump to the point of disposal must not include any branches where incompatible materials can mix (e.g. sodium hypochlorite with an acidic liquid).

The bund must also include a level switch connected into the SCADA system to activate an alarm to warn that a high level has been reached in the bund. The level switch set point must be agreed with Sydney Water.

Note that the type of sump pump selected is dependent on the viscosity of the fluid and a submersible centrifugal pump may not be appropriate. An alternative pumping and/or drainage solution may be required to remove spills based on the properties of the sump contents, e.g. magnesium hydroxide, lime, polymer, etc.

M37.6.3 Storage bund roof structure

Car port type roofs must be provided over all chemical storage and dosing systems, and to extend at least 1m outside bunded areas. Car port type roofs must have:

a) Wall cladding down to approximately 2.5 m above the top of the bund walls

b) Gutters and downpipes which are in accordance with relevant section of Technical Specification – Civil (CPDMS0023), and which must dispose roof water to the plant stormwater drainage system. Roof water must not be directed into the bunded areas nor to the truck delivery bund.

c) The roof connections are to be bolted to minimise the works involved in removing the roof if a tank replacement is required where applicable

d) natural ventilation to prevent condensate build up where corrosive chemical vapours are present.

Equipment and instruments supplied and installed on top of each tank must be capable of being removed without dismantling the roof. The roof must be designed so that it does not impede access for the delivery road tanker trucks.

Structure to be designed to AS 1170.0 - AS 1170.4 Structural Design Actions - Set. The design must be site specific to evaluate wind direction, topographic and shielding factors.

The roof cladding must be “Colorbond” metal roof sheeting supported on steel columns and beams, appropriately designed and constructed. The colour and profile of Colourbond sheeting used will be site specific as determined by strength requirements and collaboration with the plant manager.

Wall cladding must be similar to the roof cladding.

M37.6.4 Fencing

A man proof, cyclone wire fence and single locked gate (or gates) must surround each bunded area. Steps must be provided at each gate over the bund wall. Supports for the man proof fence must be separate from the columns for the storage tank covers. The fence must be at least 2.0 m in height.

Consideration is to be given to the installation of shade protection to protect chemical tanks and equipment from heat where appropriate.

M37.6.5 Safety equipment

The following minimum safety equipment will be provided at each storage bund:

- A safety shower and eyewash complying with the requirements of this Specification located within the storage bund, and directly accessible from key storage bund work areas
- A UV resistant hose reel (20 mm NB minimum) permanently attached to a water supply (reclaimed effluent at Wastewater Treatment Facilities) and capable of reaching all parts of the storage bund must be provided. The hose must be of sufficient length for connection from the service water tapping point to the suction flushing point at the dosing pumps. The hose must be fitted with a female “camlock” connection on the end of the hose and supplied with a nozzle that connects to the “camlock” (male “camlock” on the nozzle). This will enable the hose to be used for flushing chemical lines and pumps.
- Supply a secondary hose (not connected to the water supply) for use as a drain hose to direct flushing water to the storage bund sump. This hose must be supplied with a female “camlock” fitting on each end.
- Sufficient lighting to enable safe work at night, including immediately over the dosing equipment to enable all equipment to be readily seen and be accessible
- A carbon dioxide fire extinguisher for use in electrical fires must be provided.

M37.7 Chemical storage tank

Chemical storage tank(s) must be provided for safe storage of chemical and be located within the chemical storage bund. The tanks to be sized to provide four weeks of storage at nominal use.

M37.7.1 Introduction

The storage tank must be manufactured from a material suitable for the chemical specified and the operating environment. Commonly used materials include high density translucent (white) polyethylene, spirally wound GRP and epoxy coated mild steel. Tank material selection is subject to the Sydney Water’s acceptance.

Storage tanks must be cylindrical in shape with vertical walls for ease of instrument calibration. Tanks of non-uniform cross-sectional area will not be accepted.

The tanks supplied must be fitted out with branches, fittings, labelling and identification numbers attached so they can operate as required by this Specification.

The storage tank(s) must be designed and constructed to provide maximum draining of the tank and its connections while still maintaining the structural integrity of the tank walls and base. Equipment, such as access hatches and level sensors must be easily accessed for ease of operation and maintenance.

There are 3 acknowledged references to tank capacity as follows:

a) Nominal Capacity - This is the tanks capacity as stated by the manufacturer. It is the tanks nominal capacity without fittings

b) Effective capacity - This is the capacity of the tank to contain product. It is the tanks volume as determined from the floor of the tank to the invert of the tank overflow.

c) Working capacity - This is the tank capacity to deliver product. It is determined from the obvert of the discharge to the invert of the overflow.

The storage volume must be calculated from the Working capacity.

M37.7.2 General requirements

As a minimum, tanks must be designed for and comply with the following:

a) Chemical storage tanks must be fabricated in accordance with the minimum requirements of the applicable standards.

b) Where a tank requires an access hatch for personnel entry and egress, the minimum clear opening must be 600mm in diameter. Where entry using a gas bottle is required for maintenance then a minimum 750mm diameter clear opening must be provided. Access hatches must be hinged. All tanks, having a capacity of 5,000 litres or greater, must be furnished with a side mounted access hatch. The invert level of the access hatch must be 500mm above the surface (floor or platform) from which the access and egress is to be made.

c) All polymer tanks with mixers must be provided with an inspection hatch. The inspection hatch must have a minimum clear opening of 200 mm x 300 mm and must include a safety grille.

d) All powdered polymer makeup tanks and liquid polymer delivery tanks must be supplied with a toroidal style conductivity transmitter.

e) All tanks must be suitably reinforced to withstand all forces, including filling forces, without deformation when they are filled, and wind loads when they are empty.

f) The tanks must be self-supporting and have a flat base. Suitable ‘mats’ must be supplied and installed between the tank and the plinth to prevent abrasion of the tank.

g) Tanks must have appropriate mounting lugs, sized to ensure there is a minimum of 100 mm cover for the hold down bolts from the edge of the plinth.

h) All tanks must be fitted with lifting lugs designed so that two only can take the weight.

i) The tops of tanks must be capable of supporting the weight of maintenance personnel. All necessary stairs and platforms must be provided for maintenance access.

j) Where a tank requires a mixer, the mixer must be supported on a suitably designed steel (or stainless dependent on chemical) frame independent of the tank. The frame must also be painted with a paint, which is resistant to the chemical involved.

k) Furnish all manways and spare connections with the specified type of nuts, bolts and gaskets. Furnish all spare connections with suitable blind flanges.

l) Gaskets with full face such as Viton or Hypalon, of 50 to 60 Shore "A" Durometer must be provided. Grade 316 stainless steel nuts and bolts are to be used.

m) Where practical, tanks must be painted/coloured to reflect the chemical contained, as per the colour guide included in this Specification.

M37.7.3 Tank features

Chemical storage tanks must have the following features:

a) A suitable vent (breather) on the apex of the tank roof. The vent must penetrate the tank roof and finish in a 180-degree bend with the open end facing downward. The end of the vent pipe must be covered with a 6.5 mm mesh to prevent vermin ingress. Where chemicals stored have a corrosive vapour, vent is to be directed to a safe location away from metallic structures or equipment.

b) In cases where stored liquid may emit corrosive or hazardous vapours during filling, draining or storage (e.g. sodium bisulphite), the vent must be directed to a location to minimise the impacts of vapour discharge to the surrounding personnel or structures. The vent must be directed down at the end , fitted with vermin mesh and designed such that any condensation falls back to the storage tank.

c) One minimum 80 mm diameter overflow branch. The overflow line diameter should be at least 1.5 times the diameter of the filling line. This must be located 50 mm down from the roof-wall joint.

d) One drain branch with minimum diameter of 80 mm must be provided as close to the tank floor level as practicable.

e) Two 50 mm diameter branches located in the same vertical plane at appropriate levels for the installation of a level indicator.

f) One 50 mm diameter branch on the top of the tank for the inlet from the delivery point, located on the side closest to the delivery point.

g) One 25 mm diameter top mounted branch for the calibration cylinder vent return line. Where multiple dosing systems are fed from one tank, a separate connection is required for each calibration cylinder.

h) One suitably sized chemical outlet. This should be located approximately 50 mm above the floor of the tank to allow suspended matter in the chemical to settle in the tank.

i) One suitably oversized (~300 mm) top mounted flanged connection with blank for an ultrasonic level transmitter, or alternatively a flanged branch at the bottom of the tank for a pressure type transmitter, complete with transmitter with local level indication, and complying isolation and drain valving to enable in service maintenance on the instrument.

j) For chemical systems with degassing, an additional 25 mm diameter top mounted branch for the degassing line return to the storage tank.

k) An isolation valve on each tank outlet connection. Isolation valves must be directly connected to the tank outlet flange to minimise risk of breakage. Where connection to the tank outlet flange is not

possible, consideration must be given to the use of appropriate metallic pipe (such as schedule 40S stainless steel, DICL and preferably concrete encased) located between the tank discharge flange and isolation valves. The design of the discharge pipe should be such that it does not constitute a trip hazard (i.e. must be buried or have step/s or cover installed if/where access over a discharge pipe is required). No fittings (elbows etc.) are permitted between the valve and tank flanges.

l) All branches on the tank must finish with 150 mm or more from the tank wall or roof with a Table D or E flange of AS 2129.

M37.7.4 Level instrumentation

A high level switch must be provided just below the overflow level of the storage tank to cut power to the tanker delivery power outlets and a low level switch must be provided as a suction safety switch to stop the metering pumps. Installation of these switches on a magnetic indicating level is permissible subject to the Sydney Water's written approval. Capacitance type level switches mounted on the outside of non-metallic tanks is preferred to all other types of level switches due to lower maintenance effort.

Chemical storage tanks will be fitted with continuous level monitoring to relay the level/quantity of contents in the tank to the facility control system in accordance with the requirements of the Instrumentation and Control Standards (General) TOG_TS01. Ultrasonic level transmitters, hydrostatic pressure transmitters and radar level sensors are acceptable.

If a particular liquid is not sticky or has solids that can block small bore pipes its chemical storage tank shall be fitted with a local level indicator rather than a float based system. Examples of these types of liquids include ferrous and ferric chloride, ferric sulphate, sodium hydroxide, hydrated lime solution and concentrated sulphuric acid. The indicator must be adjacent to the tank wall, in order to indicate actual liquid level inside the tank during filling and must be visible from the filling point. There will be a label indicating in litres the meaning of a full indication.

Level indicators must be installed with complying isolation valves at the connections with the storage tank, and with a drain valve at the base. Construction of level indicators will be to the same requirements as all other chemical pipework. Magnetic type indicators are preferred.

M37.7.5 Tank inspection and testing requirements

Chemical tank designs are to be verified by an independent third party and inspected during and after manufacture by an independent inspector (this may be the same person as the design verifier). The selection of a design verifier or inspector is subject to Sydney Water's acceptance, and they must be able to demonstrate relevant design verification experience across multiple fabricators and suppliers on industrial and chemical/petrochemical applications, i.e. verification of FRP tanks designed to BS 4994 Category 1 requires design experience across multiple fabricators and suppliers in FRP tanks designed to BS 4994 Category 1.

Inspection and testing activities are to include hold points and witness points as agreed by the independent inspector and subject to Sydney Water's acceptance.

Tanks must be hydrostatically tested with water to a level equivalent to the SG of the chemical, at overflow level for 24 hr prior to delivery to site.

Prior to installation, tank plinths are to be inspected to ensure they provide a level, even surface with no high or low points that may create high load points on the tank.

Chemical tanks are to undergo a secondary hydrostatic test (using water, then chemical) once the tanks are installed in their final location to ensure no tank damage or failure has occurred during transportation and installation.

Onsite inspections post fabrication will be required at Sydney Water's discretion.

Supplier to include detailed maintenance and inspection program with offer to ensure longevity of tank.

M37.7.6 Glass fibre reinforced plastic (GRP) chemical storage tanks

Fibreglass chemical storage tanks must only be used where suitable for the chemical being contained.

In addition to the requirements for chemical storage tanks elsewhere in this Specification, fibreglass chemical storage tanks must also comply with Sydney Water's Specification for FRP Chemical Storage Tanks Specification (D0000824).

M37.8 Chemical dosing system and components

The required dosing system must be designed to provide a reliable, continuous dosing of metered volumes of chemical. All pumps, valves, fittings and pipework necessary for the proper operation of the dosing system must be provided. The piping must be suitable for the chemical conveyed.

The required elements in a typical chemical dosing system are detailed on the generic P&IDs.

M37.8.1 General requirements

The following general requirements apply to all chemical dosing systems:

a) All chemical systems must be designed to allow for drop tests or individual system maintenance without a need to isolate all the other systems on the same tank

b) The system must be failsafe against siphoning. Two protection devices must be installed. A combination of a pressure retaining/anti-siphon valve and an actuated isolation valve are required.

c) Design of chemical systems must facilitate draining and minimise low points

d) Where multiple dosing systems (multiple dosing points) draw from one common storage/day tank, a manual isolation valve, an actuated isolation valve and calibration cylinder must be provided for each dosing system. Each system should be capable of being isolated such that adjacent systems may continue to operate.

e) Chemical dosing skids and associated pipe work must not be painted prior to a pressure test being undertaken on site. Painting must only be completed following a successful, final pressure test for a specific pipe section.

f) Layout of chemical dosing system components should be logical and be oriented in direction of flow where possible

g) Electrical equipment is to be installed above the flooded bund level where practicable. It is noted that this may not be possible for the actuated anti-syphon valve.

M37.8.2 Mounting and support of dosing equipment

Where support frames are used to hold pumps, valving and equipment (dosing “skids”) materials for the support frames and pipe supports must be selected in consideration of the chemical stored in each respective bund. The use of powder coated stainless steel in accordance with AS 4506 - Metal Finishing - Thermoset Powder Coatings - (See table 2.1) Classification Application D is preferred where appropriate.

Design of skid arrangements should be in consideration of their final installation location. Appropriate consideration is to be given to guarding of splashing as a result of equipment failure, such that any chemical is contained appropriately.

Pipe clips and fittings must be suitably raised with spacers to ensure that there is sufficient space for the unions on the valving and equipment that is mounted on a backing board or supports to be unscrewed and tightened as required for maintenance activities.

Where practical to do so, a minimum distance of 2 x socket lengths must be left between fittings so that in the event of failure of the fitting new fittings can be installed without the need to remove additional joints.

M37.8.3 Chemical dosing pumps

Two identical duty and standby dosing pumps of suitable brand, type and capacity range, must be provided for dosing. Should the duty pump fail, the switchover to the standby pump must be automatic.

The dosing pumps must be integrated electronic dosing type unless process constraints (such as electrical hazardous areas) prevent their use. The pumps may incorporate internal pressure relief and automatic air bleed of the hydraulic medium. The liquid ends must provide for easy maintenance. Orientation of the pump dosing head must be specified when procuring to facilitate access for maintenance in situ.

Dosing pumps must be specified such that they comply with the requirements of the current SCADA/IICATs standard. The requirements of the Treatment Plant SCADA Standards are to be met unless otherwise accepted by Sydney Water.

Even if a metering pump is supplied with an internal pressure relief system, the Contractor must provide an external pressure relief valve in the discharge pipework for each pump. This relief line must be designed such that the inlet and discharge sides of the relief valve remain flooded to prevent the diaphragm in the valve drying out. The relief line will be piped to the vent line of the calibration cylinder (for polymer dosing the pressure relief discharge must be piped into the pump suction line). This enables a pump relieving to be visually seen in the calibration cylinder.

The dosing pumps must be supplied with a turndown ratio of 100:1 or better and be compatible with the chemicals used. The dosing pumps shall meet the flow and pressure range requirements for the application. The dosing pump pressure requirements for applications where dosing into pressure lines can exceed 10 bar.

Where standard motor driven piston pumps are used, turndown must be by a variable speed drive (VSD) and motorised stroke controller. The turndown ratio must match the process requirements regarding dose, range of process flows, and the specific gravity and concentration of the chemical. The stroke adjustment must incorporate a calibrated dial [0 - 100%] to facilitate pre-setting and must be capable of adjustment regardless of whether the pump is operating or not. Alternatively, the pumps must incorporate digital indication of the set rate. The minimum stroke setting for automatic control must be not less than 20%.

Back pressure valves must be installed on each discharge line from the metering pumps to maintain dosing accuracy over the range of operating depths in the storage tank. The minimum back pressure setting of the valve must be 3 bar.

Metering accuracy of the pumps must be better than 2.5% of the minimum rate at a variable suction head.

For each dosing pump supplied, the Contractor must supply a graph showing pump setting versus flow rate in litres per hour. A copy of this graph must be supplied in a perspex-covered frame and mounted on the wall near the metering pumps.

If the required turndown cannot be achieved using a single pump, multiple pumps must be used.

Pumps that have no calibration below a pre-set flow will not be accepted.

Pumps must be supplied and installed with suction strainers with a maximum opening of 1 mm (not required for polymer dosing pumps in a bulk storage/day tank arrangement).

Each pump must be provided with appropriate isolation valves.

All pumps requiring lubrication must be lubricated as per manufacturer's recommendations. In addition, the Contractor must supply all lubricants proposed to be used over the period of twelve months following successful commissioning of all equipment.

M37.8.4 Transfer pumps

Where required self-priming, centrifugal pumps are recommended for transfer of chemical from a storage tank to a day tank, particularly "seal-less" magnetic drive types. Appropriate materials of construction are:

- Fluoro-polymer lined steel
- Titanium
- Glass Fibre Reinforced Polypropylene.

Where seals are used, they should have a double mechanical-seal with water flush. The seal should be constructed with wetted parts from titanium and have PTFE and ceramic seal faces.

The transfer pumps are to be designed to provide sufficient flow in the batching process to meet the required transfer time as specified by the facility’s operational needs.

M37.8.5 Calibration cylinders

Each dosing system suction header must be provided with a graduated calibration cylinder for determining the discharge rate of the pump. The measurable capacity of the cylinder must be sized to the normal operating range of the pump (rather than maximum flow). Volume of the cylinder should enable test to be performed in 45 seconds to 1 minute. Each cylinder must be permanently calibrated in litres and centilitres.

The calibration cylinder must be complete with isolation valve and be capable of being easily dismantled for maintenance purposes. The calibration cylinder vent line, in rigid uPVC pipework, must be connected to the storage/day tank (for polymer dosing the vent line of the calibration cylinder must be open to the atmosphere with any spills contained within the storage bund). The pressure relief vent line must also be connected to this vent line to the storage/day tank.

The top of calibration cylinders must be below the “re-order” level in the associated storage tank.

Calibration cylinders are to be manufactured from a minimum of schedule 40 µPVC clear pipe, and solvent welded fittings. Screwed fittings are not acceptable, with the exception of standard unions upstream and downstream of the cylinder for dismantling purposes.

Isolation valving on the main suction header upstream of the calibration cylinder, and the calibration cylinder isolation valve must be located in close proximity such that they may both be operated simultaneously by a single operator when performing a drop test.

M37.8.6 Pulsation dampeners

Pulsation dampeners must be provided in the discharge pipework from the dosing pump and must be suitably sized for the displacement of the pump so that discharge pressure fluctuation does not exceed 10 %. The pulsation dampeners must have a diaphragm separating the air chamber from the liquid chamber. The air chamber must be pressurised and be capable of re-pressurising by air pump via a Schrader valve. An air pressure gauge must be installed.

Where possible, pulsation dampener should be located vertically at the top of the common discharge from the dosing pumps, such that discharge flow is directly into the dampener before a change of direction along the dosing line.

Pulsation dampeners must have a bolted flange arrangement for jointing of the two halves of the diaphragm chamber.

Each pulsation dampener must be fitted with an isolation ball valve.

Process connection is to be solvent welded type. This includes jointing to the isolation valve.

M37.8.7 Pressure indicators

Pressure gauges must be supplied and installed where specified. The pressure gauge must be capable of being isolated, for maintenance purposes, by including a ball valve immediately upstream.

The pressure gauge dial size must be 63 mm and the scale must be calibrated in kilo Pascals. The pressure gauges must be fitted with diaphragm seals. The seal must be solvent welded to the dosing side of the system.

M37.8.8 Valves

Valves must be uPVC or cPVC PN16 for all chemical applications unless not suitable to the chemical conveyed. Other valve materials will be subject to Sydney Water’s acceptance.

Valves will be rated for chemical use. Ball valves are to be used for isolation, and diaphragm valves for flow control applications.

All valves must be full-bore type. These, along with other non-standard pipework fittings must be double union type to minimise damage during repair and maintenance. Appropriate space is to be left around unions to enable dismantling. Utilise spacers under proprietary pipe clips where attaching directly to flat surfaces.

Union “O” Rings, seals and diaphragms will be of a material suitable to the chemical conveyed, in accordance with this Specification.

Valves must be supplied with lockable handles where there is a safety or environmental risk from inadvertent operation. The generic P&IDs indicate the recommended minimum lockable valves.

In applications where chemicals may be subject to off-gassing, vented ball valves must be used.

M37.8.9 Actuated isolation valves

Actuated isolation valves must be of motorised actuation type where compressed air system is not available onsite and must include a compact electric actuator operating on 24 V DC. Pneumatic type actuation can be used where a compressed air system is available onsite such as treatment plants. The valve must consist of two separate modules - the valve body and the actuator. The material of construction must be suitable for the chemical being conveyed. The valve must include open/close feedback and be complete with position indicator and a facility for manual control. The valve position signal must be sent to the control system.

Actuated isolation valves must be fail-safe and close on power failure, powered by the site/area UPS.

To protect against syphoning, any single dosing system will have at least one actuated valve that is hard wire interlocked into the dosing pump starter i.e. one valve in the system between the storage tank and the dosing location for any chemical dosing system will have at least one hard wired actuated isolation valve. Valves for this purpose must also meet the following requirements:

a) The hard-wired actuated valve must not require a local hand station, as it must be operated directly in line with the dosing pump operation (from the dosing pump field hand station). Actuated valves must also be operated by the PLC.

b) The hard-wired actuated valve must be equipped with open/close limit switches such that the connected dosing pump must not start until the open limit is reached. On pump shutdown valve must start closing immediately.

M37.8.10 Pipework flushing, drain and venting points

The generic P&IDs provide indication of typical requirements for drain, flush and vent points. Additional points must be added as required to meet the requirements of each unique installation, in consideration of the following requirements.

Metering pumps must be installed with suction and discharge flush points on the pipework according to the generic P&IDs. Flush and drain points must include a manual isolation valve and a “camlock” fitting to suit the existing services at the plant. The “camlock” connections must be supported as close to the “camlock” as possible to provide adequate support for the weight of a hose when connected. Installation of the flush points on an angle directed down will reduce loads on the connection. Flush and drain point “camlock” must be 20 mm.

Drain points must be provided at low points on the entire system to ensure that all pipework can be drained safely and flushed as required for maintenance. These must be directed to a safe, contained location.

Vent points must be provided at high points in pipework to facilitate priming of systems for commissioning and start-up. Some chemicals will require additional venting facilities to prevent build-up of gas.

M37.8.11 Chemical dosing flowmeter

A flowmeter (magnetic and Teflon coated type preferred) must be installed in each common dosing line (typically prior to the pressure sustaining valve). There should be sufficient upstream and downstream

straight pipe run to prevent flow disturbances affecting the flowmeter. The dosing flowmeter must be calibrated to units of litres per hour. The flow meter must measure the flow and transmit the flow signal to the control system. The flow meter must display the flow rate and any error messages.

Flowmeters must meet the requirements of the Instrumentation and Control Standards TOG_TS01.

Flowmeter must be flanged to AS 2129 Table D.

M37.8.12 Diffusers and spargers

Diffusers and spargers for chemical dosing must be of rugged construction, easily cleanable, of the withdrawable type and must be designed by the Contractor. Diffusers must be for dosing into reservoirs, tanks, channels and dosing into large mains (> 450 mm in diameter). Spargers must be used when dosing into smaller mains (≤ 450 mm in diameter).

The diffusers must be adequately secured and supported and installed to ensure optimal diffusion of the chemical solution.

M37.9 Chemical pipework and fittings

M37.9.1 General requirements

To ensure quality and fit for purpose pipework installation, the following general requirements are to be adhered to for all chemical carrying pipework:

a) All personnel undertaking pipework installation to be competent and have undertaken appropriate training in accordance with this Specification.

b) Screwed connections are not permitted, joints must be either solvent welded (glue), electrofusion weld, or flanged. Only approved pipe glues (Weldon 724) and solvents (P70 Primer) that are designed for use with the specific chemicals and piping systems are to be used. Minimum curing times for primers and glues, as specified by the manufacturer, are to be strictly adhered to.

c) Pipe work jointing and installation must be carried out in accordance with the manufacturer's specification and requirements, inclusive of use of the correct tools including pipe cutters, chamfering and de-burring tools.

d) Valves, piping and fittings should be from the same supplier for a specific dosing system and where possible, for any existing chemical dosing system on site. All valves of the same size, duty and type supplied under the contract must be identical.

e) Allowance for expansion and contraction is to be made, particularly on long pipe runs. Expansion loops are to be installed as recommended by the piping manufacturer.

f) White PVC (class 18) will only be permitted for polymer dosing. Otherwise, white PVC will not be permitted to convey chemicals.

g) uPVC metric fittings will only be used with metric pipe and imperial fittings will only be used for imperial pipe.

h) All piping systems must be accepted by Sydney Water.

M37.9.2 Materials

Materials for pipe work must be uPVC or cPVC Schedule 80 or Polyethylene (PE) to AS 4130. The first preference is uPVC schedule 80 unless chemical properties make in unsuitable for use.

All PVC pipework and fittings conveying chemicals must be uPVC or cPVC ASTM D1785 schedule 80 pipe.

Polyethylene pipes conveying chemicals must:

a) Use will be subject to Sydney Water's acceptance

b) Be PE100 pipe complying with AS/NZS 4130 and fittings to AS/NZS 4129

c) Be a minimum pressure class PN16

d) Have the pipe work coloured, either by stripes or jacket. Colour as per this Specification

e) Marking of the pipe work clearly identifying the type of chemical being carried and comply with AS 4130

f) Method of jointing PE pipe work must be electro fusion jointing. The manufacturer's recommendations must be followed with the correct specialised tools when installation of pipe and fittings.

Pipes made of stainless steel, titanium or other metals may be used in special applications when pipes nominated above are not suitable.

M37.9.3 Support of chemical pipework

Support of PVC pipework and installation to be in accordance with AS 2032. Supports and pipe clips are to allow for axial movement of the pipework due to expansion and contraction as well as forces associated with valve operation and hose connections. All supports must be installed with a minimum of 20 mm of grout to prevent pooling of chemical.

All fasteners and support systems to be utilised on the chemical dosing system must be selected for compatibility with the chemical to be conveyed and must maintain the pipework off the ground. All pipe supports are to be resistant to chemicals and provide for axial movement. In addition to this the following specific requirements apply:

a) Within chemical bunds - all anchors are to be stainless steel Grade 316. When SS 316 is not compatible with the chemical the anchors are to be epoxy coated after installation to ensure contact with chemicals cannot occur. Coating must be in accordance with WSA 201.

b) External to chemical bunds - all supports, anchors and fasteners must be corrosion resistant for the application. These supports must provide sufficient structural support for the application. Hot dipped galvanised steel can be utilised in most applications unless there are corrosion concerns for example, for all seaside plants SS 316 must be utilised as a minimum.

Above ground piping must be supported and protected from mechanical damage.

Pipe trays located outside must be supplied and installed with suitable covers.

M37.9.4 Leak containment for pipework carrying chemicals

Pipework carrying chemicals must be designed and installed to achieve the following objectives, to prevent:

1) Leakage of chemicals to the environment
2) Mixing of incompatible chemicals
3) Leakage of chemicals into processes for which the chemical is not intended.

To achieve the above objectives a leak containment strategy must be provided for each chemical.

The leak containment system must include at least the following elements:

a) Capture system
b) Collection device
c) Detection means.

Suitable capture systems must include:

i. “Pipe-in-Pipe” system (not required for polymer)
ii. “Pipe-in-Culvert” system
iii. A leak containment system that includes the three elements a) through to c) stated above and designed and installed to achieve the above objectives 1) through to 3).

Pipework located inside bunds where the leaks are contained must be deemed to comply with the above objectives. Pipes located over process tanks, where the leakage will not cause process upset, may also be permissible, however consideration must be given to how spray may be directed to a safe location in the event of a pressurised leak.

Where a “pipe in pipe” arrangement is used, the following will apply:

a) This work will be an approved manufactured product.
b) The outer casing will be of material that is indelibly coloured and labelled. Jacketing the colour would be preferred. Painting of polyethylene pipe material will not be accepted but painting of PVC is acceptable.
c) Be installed to the manufacturer’s requirements.

A double containment piping system should be selected based on the practicalities of the site, and provision of the highest level of safety to plant personnel and the environment. Selection should be made in consideration of site specific aspects such as:

a) Will the pipe work be buried?
b) Access for maintenance/emergency repair
c) Length and bends in pipe runs
d) Proximity of pipe runs to walkways, process units, vehicle operating areas etc
e) Can the outer containment become pressurised?
f) Where will a leak in the pipe run be directed to?

It should be noted that all systems have mechanical limitations, with most external containment pipes being de-rated in pressure due to jointing methodologies. The supplier of the selected system should be consulted in this regard.

In case of leakage, the leaked chemical must freely and fully drain into a collection device, which may be a bund, tank, sump or a purpose-built pit. The collection device must have level switches to alarm to SCADA (or to the appropriate monitoring system) in case of a leak. Other instrumentation, as an alternative to the level switches, may be permitted, provided the alternative instrumentation enables the detection of the leak.

The capture system must terminate at, and drain to a collection device, such as a bund, pit or sump provided with level switches, so that a leak can detected.

The distance between leak collection devices must be a maximum of 100 m. Chemical dosing lines must have a slope of at least 1 in 200, towards the leak collection devices, so that no part of the dosing line is lower than the connection of the line to the contiguous leak collection device.

Underground dosing lines must be designed so that the pipe work can be replaced without the need for excavation. A leak detection pit is to be installed at any change of direction of the buried lines.

Where pits are used as a leak collection device, the pits must be single piece pre-cast concrete pits at least 900 mm x 900 mm square and 300 mm storage below the lowest dosing line connected to the pits. The pits must protrude at least 200 mm above surrounding ground. Pits are to be coated with an appropriate epoxy internally, similar to the requirements for storage bund coatings.

The pits must be accessible so that the chemical dosing pipework can be replaced when required.

Each pit must be supplied with an aluminium cover that sits on a gasket fixed around the perimeter of the pit. The cover must have skirts, which are at least 100 mm deep, on all four sides, to prevent ingress of rainwater. The cover must have two inspection port-holes, each at least 100 mm diameter. The port-holes must have a rotating cover, which can be secured and sealed in the closed position, so that water does not enter the pit. Pit floors must be graded towards one side for ease of pump out.

Where chemicals are not compatible then a separate pit system must be used. If only two incompatible chemicals are used, then the same pit system may be used but the pit must have segregation to prevent any mixing of these chemicals.

M37.9.5 Pipe lagging

Pipes of less than 50 mm bore and external to the building must be suitably lagged to prevent freezing at air temperatures down to -6 °C where appropriate to the chemical conveyed. . All lagging materials must be rigid, weather resistant, non-combustible type and accepted by Sydney Water prior to procurement. It must be rockwool type or equivalent with aluminium or stainless steel sheet outer cladding to protect from water ingress and damage. Aluminium foil tape type lagging covers are not acceptable.

Chemical compatibility must be considered when choosing the insulation sheet cover material.

Maintenance considerations must be included in the design. The lagging must be easily removable (e.g. consider the use of self-tapping screws as opposed to rivets for joining cladding) and must be easily removed from valves etc.

M37.10 Dilution water

A dilution water (or carry water) system must be supplied and installed to cater for each chemical provided. Dilution water must be piped from the service water system (recycled effluent at WRPs and WWTPs) to provide a minimum dilution ratio of 10:1 of dilution water to each chemical.

Flow from the dilution water supply line must pass through isolation ball valve, solenoid valve, diaphragm valve, flow switch, isolation ball valve and check valve. The dilution water line must have a bypass line with manual ball valve normally closed. The flow switch must be a programmable type for low flow alarm and control purposes. Pressure indicator gauge with isolation cock must be provided after the check valve.

M37.11 Specific requirements for individual chemicals

In addition to the specified requirements, provision must be made for any other specific equipment as may be necessary for the operation, maintenance and cleaning of the particular chemical system being provided.

M37.11.1 Sodium hypochlorite

An automatic gas vent (motorised ball valve) must be supplied and installed in each dosing system. Any gas released from the sodium hypochlorite solution must be automatically vented off. The vent line from this “degas” system will be run separately to the storage tank such that chemical and gas is vented to a contained location.

Pipework must be laid, and sloped appropriately, to facilitate venting and prevent the accumulation of chlorine gas.

The roof and wall cladding for the sodium hypochlorite storage tank must be provided to ensure the storage tank is shielded from the sun.

Where in-line ball valves are used, the valve must have a vented ball to prevent the build-up of gas.

M37.11.2 Sodium hydroxide

If sodium hydroxide strength is above 30% concentration by weight, then all lines prior to dilution must be electrically (heat) traced and lagged. This heat tracing must have a system that indicates to SCADA that the electrical (heat) tracing is operating correctly.

cPVC in lieu of uPVC pipework must be used in the section of pipe that is being heat traced.

Lagging of the traced pipework must be in accordance with this Specification.

An alternative solution to prevent sodium hydroxide from freezing at low temperatures is to dilute the caustic with water immediately after the tanker is unloaded (sodium hydroxide can freeze at temperatures between 0 °C and 15 °C for concentrations between 30 to 50 wt%). Typically, the sodium hydroxide concentration needs to be less than 30 wt% for freezing not to occur in most areas in Australia. Should this solution be chosen then water dilution hardware and procedures are required. Consider the need for adequate mixing etc. This may necessitate the need for a dedicated recirculation pump.

The tank must be constructed from carbon steel with welded or flanged joints or fibreglass. The tank and its foundation must be designed to safely contain the mass of caustic soda solution when full. A minimum corrosion allowance of 2 mm must be added to the calculated wall thickness of steel tanks.

Valving must be steel globe and diaphragm valves where steel tanks are used. Piping must either be manufactured from carbon steel schedule 40 or welded PVC.

The storage tank fill line is to be manufactured from 316 stainless steel and fitted with a stainless “camlock” connector in compliance with the Orica Bulk Chemical Delivery Requirements (Liquid Caustic Soda).

M37.11.3 Sodium bisulphite

Sodium bisulphite can also freeze at low temperatures (0 °C or lower for the typical strength sodium metabisulphite sold in Australia). Electrical (heat) tracing and appropriate lagging may be required (particularly for small bore piping). This tracing must have a system that indicates to SCADA that the electrical (heat) tracing is operating correctly.

Exposed sodium bisulphite pipework, from the storage tank up to the connection of the RE dilution pipework, must be cPVC, which is capable of withstanding a working temperature up to 80 °C maximum.

M37.11.4 Acetic acid

The coating for the bund must be specifically resistant to acetic acid. Should a suitable coating not be found, then a fibreglass tray, appropriately designed, must be provided to capture and contain spills emanating from the dosing skid.

A water seal arrangement must be provided for the tank vent to prevent corrosive gas damaging surrounding structures and equipment.

M37.11.5 Acids

Dilution water must be designed carefully for acid storage and dosing systems. Particular consideration must be given to heat generation events in the storage bund/sump and at the dilution point. Appropriate materials of construction must be selected where heat is generated or has the potential of being generated.

M37.11.6 Ammonium hydroxide

Storage tank must be pressurised to negate the discharge of vapour to the atmosphere.

Storage tanks manufactured from FRP are not permitted.

M37.11.7 Liquid emulsion polyelectrolyte make up and dosing systems

M37.11.7.1 General

The system must include all necessary equipment and controls for liquid bulk storage, mixing of the bulk storage and dosing tanks for liquid polyelectrolytes, and the dosing of the polyelectrolyte solution.

The polyelectrolyte make-up and dosing systems must be fully automatic. The dosing rate must be controlled by a signal from the SCADA based on kilograms of “active” polymer per dry tone of solids.

The polyelectrolyte solution must be capable of being prepared as a solution ranging from 0.25% to 1.5% by volume (neat liquid to batched liquid). Dilution water is only required to control batching concentration. Where this solution range is met there is no minimum requirement to provide carrier and/or post dilution (after batching) water.

M37.11.7.2 Polyelectrolyte bulk storage tank

Polyelectrolyte will be delivered to the site by bulk loading tankers, parked at the truck loading bay, and pumped from IBCs into the storage tank.

The tank must be designed to accept bulk loading from a road tanker/truck of IBCs. The storage tank/s must be stainless steel or FRP having a tapered bottom or designed to negate stagnation on the tank floor of neat emulsion, allowing for the viscous neat liquid to naturally drain to the batching pump outlet.

The stainless steel or FRP Bulk Storage tank must be supplied and installed. The mixing tank must have at least 200 mm freeboard above static top water level and must be fitted with the following:

a) Flanged outlet connection to batching transfer pumps

b) Flanged drain connection for tank overflow into the bund (min DN80)

c) Flanged overflow connection

d) Support beams for mixer/shaft

e) Platform for the accessibility of all the equipment and instruments

f) High and low tank level sensors securely mounted

g) Mixer (Slow Speed and intermittent timer from SCADA)

h) Level transmitter (hydrostatic type) with remote indicator for loader to visualise content level. The level transmitter is to be displayed on SCADA as both % Tank Volume and Litres (litres for usage calculation in litres per day and calculated kg per day once the specific gravity is entered the SCADA). The instruments should be side insertion type for ease of maintenance and limiting access needs to tops of tanks.

The bulk storage tank must be mounted on a steel base frame suitable for installing on a concrete floor plinth using stainless steel grade 316 anchor fasteners and steel to concrete plinth separation pad.

An access platform and stairs must be provided for maintenance of equipment on the top of the tank. The access platform must be fabricated from mild steel and hot dip galvanised or painted. This platform must be connected with the bulk storage tank platform.

M37.11.7.3 Unloading pipework

Unloading pipework for commercial delivery of liquid polyelectrolyte must be provided. A filling line must be provided with considerations of pumping into this line to prevent hardening or thickening of the emulsion between deliveries.

The loading point must have a T-section with fill and drain valves to allow for safe connection and disconnection and minimising spills.

M37.11.7.4 Liquid transfer metering system

Liquid polymer metering must be performed by progressive cavity pumps in a DUTY/STANDBY arrangement.

The neat polymer and water must be mixed via a purpose-designed mixing unit during a batch in progress, and flow into the polymer mixing tank.

The following liquid polymer metering equipment must be provided/installed:

a) Progressive Cavity Pumps

b) Optional: Polymer Flow Meter (neat polymer) - Coriolis type specific for low flow polyelectrolyte

c) Mixing Device such as Static Mixer or other as recommended by vendor

d) Water Supply pipe with NRV to be fed into the common polymer transfer line just prior to the static mixer or mixing device

e) Water supply manual or automatic flow regulating valve, flow transmitter and actuated valve to open and close as batching is required.

M37.11.7.5 Liquid polymer dosing tank

A stainless steel or FRP dosing tank must be supplied and installed. The dosing tank must have an active storage capacity sufficient for at least approximately 20 minutes of aging before being dosed assuming future loads under normal operating conditions and with at least 200 mm freeboard above static top water level and must be fitted with the following:

a) Outlet connection

b) Drain connection

c) Overflow connection

d) Mixer (Slow Speed and intermittent timer from SCADA)

e) Level transmitter (hydrostatic type) with remote indicator for loader to visualise content level. The level transmitter is to be displayed on SCADA as both % Tank Volume and Litres (litres for usage calculation in litres per day and calculated kg per day once the specific gravity is entered the SCADA). The instruments should be side insertion type for ease of maintenance and limiting access needs to tops of tanks.

The dosing tank must be mounted on a galvanised or painted steel base frame suitable for installing on a concrete floor plinth using stainless steel grade 316 anchor fasteners and steel to concrete plinth separation pad.

An access platform and stairs must be provided for maintenance of any equipment on the top of the tank where required. The access platform must be fabricated from mild steel and hot dip galvanised or painted. This platform must be connected with the dosing tank platform.

M37.11.7.6 Metering pumps

Metering pumps must comply with requirement for metering pumps specified elsewhere in this Specification.

M37.11.7.7 In-line mixers

In-line static mixers must be supplied and installed to ensure complete mixing of the dilution water and polyelectrolyte prior to the point of injection. The mixers must achieve complete mixing without causing excessive turbulence or destroying the polyelectrolyte flocculant chains. Specific and specialised liquid polyelectrolyte mixing devices are required.

M37.11.8 Powder polyelectrolyte make up and dosing systems

M37.11.8.1 General

The system must include all necessary equipment and controls for storage, mixing of powder polyelectrolytes, aging, transfer and the dosing of the polyelectrolyte solution.

The bulk storage powder capacity must allow for a 30 days storage at future capacity.

The polyelectrolyte make-up and dosing systems must be fully automatic. The dosing rate must be controlled by a signal from the SCADA. The polyelectrolyte solution must be capable of being prepared as a solution ranging from 0.25% to 0.35% by weight. Dilution water is only required to control batching concentration. Where this solution range is met there is no minimum requirement to provide carrier and/or post dilution (after batching) water.

M37.11.8.2 Polyelectrolyte bulk storage hopper

Polyelectrolyte will be delivered to the site by bulk loading tankers, parked at the truck loading bay, and pneumatically conveyed into the storage hopper with a 30 day capacity.

The hopper must be designed to accept pneumatically operated bulk loading from a road tanker.

The storage hoppers must be stainless steel having a conical bottom with a minimum slope 60 degrees to the horizontal. All internal surfaces must be finished smooth and all internal welds finished flush. The hopper must be complete with a supporting structure and installed on suitable footings.

Electric vibrators (hammer types are not acceptable) must be provided and mounted to the conical portion of the hopper to facilitate free material flow and to prevent any bridging, arching and hanging-up of polyelectrolyte powder.

A knife gate type isolation valve must be provided at the outlet of the hopper, complete with a discharge section to connect to the screw feeders.

The hopper must be fitted with a dust separator on the outlet of the air venting frame, to filter the air exhausted.

The hopper loading hatch must be fitted with a dustproof and moisture proof lid which must be easily removable without hand tools.

Floor drainage must be installed adjacent to the polyelectrolyte area to direct hose down water to the chemical hose-down sump. A non-slip floor surface must be provided around the polyelectrolyte preparation and dosing system. The hopper must be installed on raised concrete feet of min. 100 mm height to enable clean out and hosing of spilled polymer material.

The hopper must be fitted with a pressure relief valve.

If in a humid environment, the silo must be fitted with a dehumidifying unit to ensure that the silo internal air is kept dry.

M37.11.8.3 Unloading pipework

Unloading pipework for commercial delivery of polyelectrolyte must be provided. A filling line must be provided with no horizontal or near horizontal sections and with bends having a radius of at least 0.5 m. The

unloading pipework must be anti- static and the pipe connections must be located and secured at a convenient position for powder transfer.

M37.11.8.4 Weighing system

A weighing system must be supplied and installed for the storage hopper utilising "bolt-on" strain transducers, one for each supporting leg. Alternatively, load cells may be considered. Accuracy must be better than ± 0.5% and resolution better than 1 kg. A local display unit must be visible to the unloader driver.

M37.11.8.5 Dust collection equipment

Dust collection equipment must be supplied and installed by in order to minimise escape of polyelectrolyte dust to the atmosphere during unloading from the bulk tanker. Filtered air from the dust extractor must exhaust to outside the building or structure. Exhaust air must comply with air quality standards, EPA regulations and any applicable Australian Standards.

The dust collection equipment must be installed adjacent to the storage hopper and in the vicinity of the unloading area.

The separator must include a vibrator or approved means to clear the filter cloth dust. The vibrator must be operative whenever the hopper receives polyelectrolyte powder.

M37.11.8.6 Low capacity systems

For smaller systems, where usage is less than 10 kg/d, the powder storage hopper must be designed to accommodate a minimum of 50 kg of polyelectrolyte powder.

Polyelectrolyte powder will be supplied and stored in 25 kg bags. A designated polyelectrolyte storage area must be provided with sufficient space for a standard pallet. Access must be provided for a forklift truck to deliver and remove pallets.

The powder loading facility must be a vacuum transfer from 25 kg bags.

M37.11.8.7 Powder metering equipment

Powder metering must be performed by a Volumetric Screw Feeder. The following powder metering equipment must be provided:

a) Screw feeder

b) Venturi eductor

c) Air blower

d) Anti-static delivery hose

e) A high level switch (LSH) on the eductor lid.

The feeder must be of the volumetric [screw] type which must convey the polyelectrolyte powder at a constant pre-set rate to the wetting assembly. A heater must be supplied and installed for the discharge spout and eductor.

The powder must discharge to a venturi eductor and be transported by air to the wetting assembly through an anti-static delivery hose, stainless steel pipe (schedule 10) or tubing. Where stainless steel is used provisions must be made for dismantling in the event of blockage.

The eductor must have a high level switch installed to prevent poor batching and polymer powder spills.

An air blower must be supplied to transport the powder. The air flow and pressure must be capable of transporting 1.5 times the maximum powder flow from the screw feeder to the powder wetting unit.

M37.11.8.8 Mixing tank

A stainless steel or FRP mixing tank must be supplied and installed. The mixing tank must have at least 200 mm freeboard above static top water level and must be fitted with the following:

a) Outlet connection

b) Drain connection

c) Overflow connection

d) Feed water inlet line

e) Support beams for mixer shaft and wetting unit

f) Platform for the accessibility of all the equipment and instruments

g) High and low tank level sensors securely mounted

h) Powder wetting unit

i) Mixer

j) Level transmitters (hydrostatic type) and switches to control the addition of water, polyelectrolyte mixer operation and the transfer of polyelectrolyte solution.

The mixing tank must be mounted on a steel base frame suitable for installing on a concrete floor plinth using stainless steel grade 316 anchor fasteners. Larger mixing tanks can be secured directly to the concrete plinth subject to Sydney Waters acceptance. An access platform and stairs must be provided for maintenance of equipment on the top of the tank. The access platform must be fabricated from mild steel and hot dip galvanised or painted. This platform must be connected with the bulk storage hopper platform.

The preparation unit must completely dissolve the dry polyelectrolyte such that a minimum of 60 minutes aging time is achieved after batching a clear solution is produced (with no "fish eyes").

M37.11.8.9 Mixing tank accessories

a) Mixer

The mixer must be purpose designed and built for complete homogenous mixing of powder polymer dilution batching.

The stirrer must be of the propeller type with grade 316 stainless steel shaft and impeller(s). The stirrer must be automatically controlled. The mixer must be supported on a mild steel or stainless-steel frame independent of the mixing tank.

b) Polyelectrolyte Wetting and Make-up Systems

A proprietary wetting system must be provided to ensure that uniform and thorough wetting of all polyelectrolyte particles takes place. The wetting system must be supported on a galvanised or painted steel frame, independent of the tank. If stainless steel tanks are provided the wetting head can be supported from the tank.

The wetting and make-up systems must use potable water.

A booster pump must be supplied as an integral part of the batching system, should the supply pressure be inadequate for optimum operation of the batching system.

A pressure gauge must be fitted to the polyelectrolyte preparation unit batching water piping at the top of tank level and adjacent to the service water isolation valve.

M37.11.8.10 Dosing tank

A stainless steel or FRP dosing tank must be supplied and installed. The dosing tank must have an active storage capacity sufficient for at least 2 X batch volumes (working batch volumes made up in batching tank) under normal operating conditions and with at least 200 mm freeboard above static top water level and must be fitted with the following:

a) Outlet connection

b) Drain connection

c) Overflow connection

d) High and low tank level sensors securely mounted.

M37.11.8.11 Transfer pumps

The transfer pumps will transfer batched polymer to the dosing tanks.

Transfer pumps must comply with requirement for progressive cavity pumps specified elsewhere in this Specification.

M37.11.8.12 Metering pumps

Metering pumps must dose the polymer to the receiving process and comply with requirement for progressive cavity pumps specified elsewhere in this Specification.

M37.11.8.13 In-line mixers

In-line static mixers must be supplied and installed to ensure complete mixing of the dilution water and polyelectrolyte prior to the point of injection. The mixers must achieve complete mixing without causing excessive turbulence or destroying the polyelectrolyte flocculant chains.

M37.11.9 Hydrated lime

The dosing pipework associated with hydrated lime is susceptible to blockage due to the properties of the solution.

Lime dosing pipework must be flexible PE pulled through double containment pipe.

The angles at which the pipework and fittings are installed must not exceed maximum 45 degrees bends for pull through, must use long radius bends only, must provide quick decoupling joints to facilitate dismantling for unblocking and cleaning the lime dosing pipework. Do not use short radius bends or elbows.

A Flushing water cycle (using RE where available) during changeover and after stoppage must be included and the valves used must be full bore pinch valves.

Quick decoupling joints must be used to facilitate dismantling and clearing of blockages.

M38. Gravity filters

If Tertiary filters are provided, the following clauses contain the minimum requirements.

M38.1 General

The work must include, but must not be limited to the provision of the following:

a) Piping to the filters inlet structure

b) Filter inlet structure

c) Filter structure including platforms, walkways, stairways, handrails, etc

d) Open mono or dual media gravity filters with a plenum underdrain system with nozzles for collection of filtered effluent, distribution of backwash water and scour air

e) Filter media and media support

f) Filter outlet structure to convey filter effluent

g) Overflow structure

h) Bypass system, including structure, penstocks and, if required, pumps

i) Filter backwash system, including pumps, and a backwash storage tank

j) Filter air scour system, including blowers

k) Filter washwater transfer system, including pumps and storage tank, to temporarily store and convey washwater to the nominated tank at the head of the WRRFs/WRPs or sludge handling process for WFPs

l) System to prevent over-pressurisation of the filter floors during a backwash

m) All pipework, valves and other flow control devices, machinery, electrical power, instrumentation, controls, etc., to monitor and ensure the filtration facility performs as required under the Contract

n) Building(s) to house blowers, compressors, pumps and other equipment

o) Instrumentation to operate the gravity filters successfully and safely.

p) For plants producing recycled water that complies to AGWR and for plants producing drinking water that complies with ADWG, gravity filters must have online turbidity meters for each filter and for combined filtered effluent. The turbidity meters must be located as close as possible to the sampling point to minimise sampling lag time.

q) It is the responsibility of the designer to size the filter including depth and media configuration to achieve the desired filtered water quality requirement and performance.

M38.2 Type of filters

The filters must be either mono or dual media open gravity, down-flow, deep bed type single cell filters. The filters must be designed with equal flow splitting of influent by weir or similar to each filter and constant level maintained by a control valve on the outlet of each filter. Each filter level control is independent of other

filters. The flow into each filter must be equal. No other type of filters, including dual cell type, or other filter control configuration will be accepted.

M38.3 Performance requirements

M38.3.1 Filtration rate

The filters must be capable of filtering the flows, without exceeding maximum filtration rate of 12 $m^3/m^2/h$ (m/h) when one filter is off-line for backwashing and one filter is off-line for maintenance.

M38.3.2 Filter run time

Filter must run a minimum of 24 hours for wastewater and 48 hours for water filtration between backwashing under normal operating conditions.

M38.3.3 Media depth

Filter media depth must be determined based on the required turbidity, runtime and headloss performance.

M38.3.4 Filtration plant arrangement

The tertiary filtration plant must include filter observation platforms, walkways, accessways, stairways and handrails from which access, including visual and inspection, to all the filters on a minimum of three sides (2 long sides and 1 short side) must be possible. The filter control panels must be located on the observation platform so that the whole of the filters, controlled from the panel, are clearly visible from the operating position.

A Colourbond™ metal deck roofing and associated steelwork support structure must be provided over the filter console platform and over the access stairways to the top of the filter block.

Safe access must be provided to operate all manual valves, and any valve and item of equipment, which requires regular or periodic maintenance.

M38.3.5 Filter (Hydraulic) control

Flow must be distributed evenly between operating filters by means of the inlet distribution device for each filter structure.

A constant water level in each filter must be maintained using automatically controlled modulating valves (filter outlet control valves) in the effluent lines from each filter - usually butterfly valves. For drinking water and applicable recycled water gravity filters, the filter outlet control valves must be located upstream of the in-spec valve (for product diversion to clear water tank) and out-of-spec valve (for filter-to-waste).

Each filter outlet control valve must be controlled by a level control system in the associated filter cell. The level control must be set so that the depth of water is, at all times during filtration, at least 1.2 m above the filter media surface. The filter outlet control valve and associated equipment must maintain the operating level of the filter within a span of 300 mm. That is when the filter level is at top operating water level (TWL) the filter outlet control valve is fully open and when the operating water level is 300 mm below TWL the outlet control valve is closed. The available head loss across the filter must be at least 2.5m and at most 3.5 m.

This function must be demonstrated during the testing period by checking inputs and outputs of the individual components that make up the total control loop, and observation during operation combined with the trending graphs of the filter head loss produced for each filter. Filter head loss curves for each filter must be identical.

The outlet of the filters must be designed so that there is a constant head downstream of the filter outlet control valve. This must be provided by a weir, the filter control weir, located in the backwash storage tank. The depth of flow over the filter control weir must be less than 100 mm at the design flow.

At a flow, up to the maximum flow, into each filter, the inlet to each filter must not be submerged but must have a free fall from the inlet weir to the operating level of the filter under all conditions.

M38.3.6 Filter outlet inspection box

Gravity filters for drinking water treatment must include a filter outlet inspection box located downstream of the “in-spec” valve (refer M38.4) on each individual filter outlet. Flow from the outlet of the filter must pass through the filter box, then to the combined filtered water flow path by weir, or similar, to prevent reverse flow into the box from other filters.

The filter inspection box must be designed in a way that enables visual inspection of the filtered water. The filter inspection box must be:

a) lined with pure white tiles on all sides and floor. Grout must be tested to comply with AS 4020.

b) sized to minimise turbulence at maximum design flow with maximum upwards velocity of 0.1 m/s.

c) designed to allow access for cleaning.

d) protected from external contamination by pathogens, chemicals or particulates.

e) protected from sunlight to inhibit algae growth.

f) designed to allow safe access for regular visual inspection, including platforms and handrails.

M38.4 Filter valves and control

The Contractor must, for each filter, supply and install the following valves, control and associated piping:

a) Inlet distribution device (weir or similar)

b) Inlet isolation valve

c) Backwash outlet valve

d) Air scour inlet valve

e) Filter outlet / level control valve

f) Backwash inlet valve

g) Backwash rate of flow control valve

h) Scour air release valve

i) Filter (plenum) drain valve.

j) For drinking water and applicable recycled water gravity filters, filter to waste (off-spec) and filter to production (in-spec) valves must be provided downstream of the filter level control valve.

The valves, except for the filter drain valve, which is for maintenance purposes, must normally be automatically operated but each valve must be supplied with a manual override device. The filter drain valve must be manually operated and must have a minimum size of 100 mm.

M38.5 Launders

Launders must be suspended at even spacing above filter beds to provide uniform removal of washwater during back washing. Launders must be fibreglass reinforced plastic (FRP) type, stainless steel grade 316 type or reinforced concrete type. Launders must be properly supported both vertically and horizontally so that their weirs remain absolutely level during backwashing. Launder bottoms must be sloped to the gullet. The invert of the launder must be high enough above the media level to allow freeboard during backwash to accommodate media expansion of at least 20%.

M38.6 Filter underdrains

A system employing a plenum with nozzles suitable for combined air/water backwash must be provided.

All materials in the underdrain system must be corrosion resistant.

The underdrain system must provide even distribution of backwash water over the whole area of the filter as well as even collection of filtered effluent. The system must also provide even distribution of scour air over the whole area of the filter for satisfactory scouring of the media bed.

The design of the nozzle system must allow for cushioning of the air inflow surge at blower start-up.

Filter nozzles must also be designed to minimise clogging by biological growth.

The underside of the plenum underdrains must be elevated by at least 900 mm above the filter shell floor and permit access from two opposing points for each filter. The underdrain support system must provide access to, and easy rescue from all parts of the plenum from this point. A 750 mm diameter manhole, as a minimum, must be provided for this purpose at each access point. The manhole cover must be supported by a hinge or similar device so a lifting device is not required to open the manhole.

Disparity between levels of the top of nozzle heads must not exceed ± 3 mm. Centre distances between nozzles must not vary by more than 3 mm from dimensions given on the accepted design drawings.

Proprietary nozzles must be installed in accordance with the nozzle manufacturer's installation instructions. Modifications to nozzles (which include nozzle domes, stems and bushes) without the nozzle manufacturer's authorisation will not be permitted.

Nozzles must be threaded with a coarse thread suitable for use with plastics. BSP threads are not acceptable. Nozzles must screw into plastic inserts cast into the plenum floor planks. The stems of the nozzles must project a minimum of 150 mm into the plenum chamber.

Nozzle spacing must not exceed 150 mm and the minimum number of nozzles must be 64 per square meter of filter floor filter area. The minimum distance between end nozzles and the adjacent filter wall must be 75 mm.

The entire underdrain system including nozzles, effluent pipework, filter and clear water tank must be left scrupulously clean before the initial air scour and backwash.

The plenum floor components must be provided with adequate reinforcement and anchorage to resist all possible loads.

M38.7 Filter media

M38.7.1 General

The work includes the supply, delivery to site and unloading at the site, protection of bags of media (stored on site) from sunlight, testing, placing and washing the filter media in the filters.

All details, including media type, design depth, grade, supplier, etc. for each layer of media and support gravel must be described in the Schedule of Technical Data - Equipment - Tertiary Filters.

As a minimum, each grade of media must be supplied to the qualities, grading and design depth stated in the Schedule of Technical Data - Equipment - Tertiary Filters, and each grade must be placed in successive layers over the filter underdrain system.

To prevent drying and caking of media, the minimum water level must be 80 mm above the surface area of the media.

Filter media must be free from clay, shale and foreign materials.

M38.7.2 Sampling

The following must be carried out, well in advance before placement of media into the filters, in accordance with the latest version of American Water Works Association (AWWA) Standard B100:

a) In the presence of Sydney Water, collect a representative field sample of each size, of filter media

b) Reduce each sample in size to two equal portions, called Sample A and Sample B

c) Each sample must be of sufficient quantity for all tests nominated in AWWA Standard B100

d) Forward Sample B to a registered NATA laboratory, which is not the filter media supplier itself, to carry out all testes nominated in AWWA B100

e) Sample A must be held by Sydney Water.

Allowance for the above should be made in the program for the works so as not to delay placement of media and commissioning of the filters. After testing, the test results must be submitted to Sydney Water.

Tests for quartz content of sand and gravel to meet specified minimum limits must be carried out as follows:

a) By counting quartz particles under a microscope

b) By mass (based on quartz particle count) obtained in (a) above.

The minimum limit of quartz content in either sand or gravel, carried out by methods (a) and (b), must not be less than the specified limit.

Testing for clay, dust and other impurities must be carried out to ASTM C117. Sample of sand must be 100 g minimum. Impurities content must not be greater than 0.1% for sand and gravel as calculated in the above Standard.

Failure of the samples to comply with the Specification must result in the rejection of the filter media.

All costs associated with the collection, testing and retesting of the filter media must be included in the price tendered for the works.

Filter media must not be placed in a filter until the following certified results have been provided to and accepted by Sydney Water:

- filter media test results
- filter nozzles cleanliness check, water distribution test and air distribution test.

Any rejected filter media must be removed from the site.

M38.7.3 Filter support media

The preferred filter support media to be used is garnet (typically two layers). Quartz gravel can be used in lieu of garnet, where garnet is not available.

M38.7.3.1 Quartz Gravel

Filter gravel must be placed in successive layers. Each layer must be to the depth and size nominated by the designer. The thickness of each layer of gravel must be at least three times the maximum particle size of gravel in the layer, but not less than 80 mm in any case.

Filter gravel must be of the best quality, clean, hard, durable, non-calcareous quartz and be of rounded shape. The gravel must contain no more than 2% of thin, flat or elongated pieces in which the largest dimension exceeds five times the smallest dimension and no more than 25% fractured or "angular pieces" in any size. Thin, flat, elongated, or angular pieces must be determined by hand picking. The material must contain at least 95% quartz.

Not more than 8% of the weight of filter gravel must be finer or coarser than the nominated size limits.

The specific gravity of the gravel must not be less than 2.5.

The solubility of gravel in 10M hydrochloric acid, when tested in accordance with AWWA Standard B100 procedure, must not exceed 5 %.

M38.7.3.2 Garnet

Filter garnet shall consist of the best quality, clean, hard, durable and dense grain garnet (almandite and andradite) in which a high proportion of the particles are either round or equidimensional in shape.

The garnet shall possess sufficient strength and hardness to resist degradation during handling and use.

The garnet shall be visibly free of clay, dust, shale and organic matter.

The garnet shall contain no more than 2% of thin, flat or elongated pieces in which the largest dimension exceeds five times the smallest.

Not more than 8% of the weight of the garnet shall be finer or coarser than the nominated size limits.

The specific gravity of the garnet shall be not less than 3.8.

The garnet shall have a hardness of 7.5 to 8.5 (Mohs scale).

The solubility of garnet in 10M hydrochloric acid, when tested in accordance with AWWA Standard B100 procedure, shall not exceed 5%.

Garnet size:

- 1.2 – 2.4 mm Layer 1
- 2.4 – 4.8 mm Layer 2

M38.7.4 Filter sand

Filter sand must be of the best quality quartz. At least 95% of the sand must consist of clean, washed, single, rounded grains of quartz. Uniformity coefficient <1.35.

Friability tests on sand must be carried out as per AS 1141.30 Section 32. Friable materials as obtained from these tests must not exceed 0.3%.

The solubility of sand in 10M hydrochloric acid, when tested in accordance with AWWA Standard B100 procedure, must not exceed 1.5%.

The depth nominated must be net after scraping of fines.

M38.7.5 Filter coal

Filter coal must be composed of hard and durable grains and must be visibly free of shale, clay and other extraneous matter. Uniformity coefficient <1.35.

M38.7.6 Top-of-media plates

In order to indicate media loss over time, a “top of media” indicator plate must be installed in each filter. The bottom of the plate must be installed at the design surface level, during filtration, of the filter media. The location, other than elevation, of the plates must be the most visible position and as agreed by Sydney Water. Plate details must be as follows:

M38.7.6.1 Plate

Stainless steel grade 316 plate, 2 mm thick with radius corners and 6 pre-drilled 5 mm diameter holes for fixing to filter wall with grade 316 stainless steel pan head type screws into Hilti HUD5 type nylon wall anchors. Length of plate depends on lettering. Depth of plate will be approximately 150 mm.

M38.7.6.2 Letters

Letters must be 50 mm high; top of letters 30 mm below top edge of plate; start and finish of print 30 mm from side edges of plate.

M38.7.6.3 Arrows

Four equally spaced arrows 50 mm long starting 15 mm below print and ending at bottom of plate or slightly above bottom of plate. Shaft of arrow must be approximately the same thickness as the letters.

M38.7.6.4 Method of production

Engraving of plate - either engraving of letters and arrows or engraving area around letters and arrows - will be satisfactory. To maximise contrast the depth of engraving must be between 0.75 mm and 1 mm.

M38.7.6.5 Plate finish

To maximise contrast, each plate must be installed in an industrial type environment rather than an architectural type environment.

M38.8 Preparation for media placement

Each filter must be thoroughly cleaned and an air pattern test completed before any filter materials are placed and keep the filter clean throughout placement operations.

Before any materials are placed, the top elevation of each layer must be clearly marked by a continuous level line on the internal wall of the filter.

Filter materials must be kept clean and stored separately.

M38.9 Packaging

Filter media must be delivered in ultraviolet light resistant bags, which must contain no more than one cubic metre (1 m^3) of sand and gravel, and not more than 1.6 m^3 of filter coal.

The bags must be suitable for lifting by crane and for ease of unloading into the filters. The bags must be supplied with manufacturer's instructions.

After delivery to site, all bags must be fully covered with thick plastic sheeting (not less than 250 microns) such that all sides are completely sheltered from sunlight.

M38.10 Air scour system

An air scour system (dedicated to filters) must be provided for filter backwashing to enable sequential air scour followed by combined air and low flow water wash.

The air scour rate must be as nominated by the designer, but must not be less than 60 m/h.

Each air blower must be supplied and installed complete with the following equipment:

- 1 isolation valve
- 1 suction filter silencer
- 1 outlet silencer
- 1 vacuum indicator
- 1 reflux valve
- 1 isolation valve
- 1 pressure gauge (anti-vibration type)
- 1 thermometer
- 1 relief valve
- 1 set anti-vibration mountings.

The suction filter must be suitable for continuous service and must be readily cleanable.

A visual alarm indicator (400 mm wg maximum vacuum) must be placed between the air filter and its respective inlet to give warning when the filter requires cleaning.

One pressure gauge and one thermometer of at least 150 mm diameter must be supplied and fitted on the delivery side of each blower.

Each air blower must draw air from the atmosphere through a filter-silencer and discharge it through a silencer into the scour air delivery line to the filters. The delivered air must be completely oil-free.

M38.10.1 Air flow measurement

An air flow measuring device must be provided in the common delivery line from a blower. Air flow rate in L/s must be indicated on the relevant SCADA screen and locally adjacent to the blowers.

Measurement must be by an orifice plate, in accordance with the relevant British Standard.

The flow meter must have pressure and temperature compensation, from ambient pipe pressure and temperature, to provide air flow in standard conditions (20 °C, 1 bar).

M38.10.2 Air scour blowers

At least one duty air blower of the designed capacity and one standby air blower of the same capacity as the duty blower must be supplied and installed.

Blowers must be of the rotary positive displacement type and must comply with the blower requirements specified elsewhere in this Specification.

Air supply for air scouring for filters must be a dedicated air supply system and not to be tapped from other air supply systems such as aeration blowers

M38.10.3 Air pipework

The air pipework must include a high level loop rising to level 1 m above the overflow level of the filters. A check valve to prevent the accidental entry of backwash water must be installed in this line on the filter side between the filter and the loop.

M38.10.4 Soft start valve

An air vent to atmosphere for soft start of scour air flow into the filter must be incorporated in the air pipework located upstream of the primary measuring flow element. The soft start valve must open on shutdown of the air scour blower and slowly close on start-up over an adjustable time period of 10 to 180 seconds. The valve must include a discharge silencer and permit full flow venting.

The valve must either be a Saunders diaphragm type with a pneumatic diaphragm operated spring return to open actuator or a butterfly valve with a pneumatic spring return.

A limit switch positioned on the soft start valve must prevent the air blower from starting unless the valve is fully open.

M38.11 Filter scour air release

An air release valve must be provided for each filter to exhaust residual air in the underdrains at the end of the air scour operation during a backwash and thereby avoid media disturbance during the remainder of the backwash.

Each valve must be piped to operate in conjunction with the associated filter air scour inlet valve. The release valve must open when the air scour inlet valve is closed and vice versa.

M38.12 Backwash system

M38.12.1 General

The backwash flowrate to be used must be as nominated by the designer. Backwash inlet valves may be arranged for slow opening if considered necessary by the designer.

Backwash flowrate must be automatically controlled via a backwash flowmeter and modulating valves.

M38.12.2 Backwash water storage

The backwash must eliminate mud ball formations, media grain coating and biological solids growth without the need of chemical cleaning systems.

The system must be designed to achieve a minimum backwash rate of 48 m/h @ 20°C and maximum backwash rate up to 65 m/h to achieve 20% bed expansion.

Backwash water storage must be provided of sufficient volume equivalent to two backwashes each for a duration of ten minutes.

A storage tank must be constructed of a material suitable for the purpose and must be covered to prevent foreign materials getting into the water.

The tank must have connections for inlet, outlet, overflow, drains, inspection and cleaning and other connections as required. Visual indication of the contents must be provided on the outside of the storage.

The level and volume of the contents of the tank must be displayed on the SCADA and appropriate high and low level alarms must be provided.

Overflow from the storage tank must be to the UV disinfection facility.

All valves, actuators, pipework, fittings, fixings and mountings must be provided and backflow from the tank must not be possible.

M38.12.3 Backwash pumps

If backwash pumps are required there must be at least one duty pump and one identical standby pump. The pumps must be capable of performing to the duties as determined by the Contractor.

Pressure in the backwash delivery line must be provided and displayed and logged on the SCADA.

To prevent high pressure in the filter underdrains a hydraulic loop must be provided in the common backwash manifold. This loop must relieve pressure/flow back to the backwash storage tank (where available). If a backwash storage tank is not available, then alternative forms of suitable protection from over-pressure must be provided (pressure transmitter interlock on pumps etc.).

M38.12.4 Backwash flow measurement

A backwash water flow measuring device must be provided in the common delivery line. The backwash flow rate, in L/s, must be indicated on the relevant SCADA screen and at the filter control panel associated with the filter being backwashed. The amount of backwash water used must be available and stored in the SCADA.

The accuracy of flow measurement must be ± 2%.

M38.12.5 Filter head loss indicator

Head loss across each filter must be measured.

Each filter must have a turbidity meter and a head loss indicator, calibrated in metres and decimetres, must be mounted on the filter local control console.

The head loss across each filter must be provided and displayed and logged on the SCADA.

M38.12.6 Backwash wastewater disposal

Launders in the top of the filter must collect backwash wastewater to discharge to the backwash wastewater storage. Weirs must be adjustable with an overall tolerance of ± 2 mm to ensure level overflow. Media loss during backwash must not occur.

A filter to waste system must be provided for WFPs and WRPs to divert the filtered water to waste handling process (for WFPs) and HOWs (for WRPs) during filter ripening stage.

Backwash wastewater must either gravitate or be pumped to the head of the WWTP. The transfer flowrate must be such as to have at least storage for one backwash available in the backwash wastewater storage prior to the next filter backwash and to not adversely affect the WWTP performance.

Backwash water for WFPs requires treatment before returning supernatant to the head of the WFP or discharge to environment.

M38.12.7 Backwash washwater transfer pumps

If backwash washwater transfer pumps are required there must be at least one duty pump and one identical standby pump. The pumps must be capable of performing to the duties as determined by the Contractor.

M38.12.8 Control

The tertiary filter system must be designed for automatic, manual and field operations.

Field operation of each filter must be possible from a console located on the filter observation platform and the whole area of the filter must be clearly visible from the operating position. One common console with controls for every two filters is acceptable.

In automatic mode the filters must operate continuously without operator assistance. In this mode the filters perform all filtering and backwashing functions (filter, drain, backwash, etc.) automatically. A filter run continues until the backwash cycle is initiated by:

- a filter run timer (0 - 60 hours, adjustable)
- time of day

- exceeding a pre-set adjustable filter head loss
- Filtered water turbidity
- manual backwash initiation.

In field mode, the operators must be able to manually set the position of each valve.

M38.13 Filtration sequencing

M38.13.1 Normal (Automatic) operation

When a filter cell is placed on automatic, the following sequence must occur, beginning at the start of the filtering cycle:

1. The backwash water inlet, backwash rate of flow control valve, backwash outlet and air scour inlet valves close
2. The filter inlet valve opens completely to allow influent to the filter and the air release valve will be open
3. Filter to waste valve opens
4. Filter to was continues until target filtered turbidity set point is reached
5. Filter to waste valve closes, and filter outlet control valve opens
6. Filtration commences
7. The filter outlet valve begins modulating to maintain the pre-set level in the filter
8. Filtration continues until the backwash cycle starts.

M38.13.2 Normal (Automatic) backwash sequencing

When an automatic backwash cycle is initiated, the following sequence of events must occur:

1. Influent valve closes
2. Backwash outlet valve opens
3. The contents of the filter must drain through the filter outlet valve to a set air scour level, approximately 75 - 100 mm above the media level. The filter outlet valve must remain at the last operating position during the filter step or at an operator adjustable set point for drain down. This is to avoid any turbidity breakthrough.
4. At that level the filter outlet valve must close.
5. Air scour inlet valve opens when water drains to a set level and the air release valve closes
6. Air blower starts and the air wash timer starts and the backwash pump delay timer starts
7. Backwash water inlet valve opens and the backwash pump starts after the timer times out
8. The combined air/water wash continues until sensors detect air wash mixture is at a pre-set level below the bottom of the trough
9. The air scour inlet valve closes and the blower stops and the air release valve opens

10. The backwash rate increases and continues until the backwash timer times out
11. The backwash outlet valve closes
12. The backwash pump continues until the water level in the filter reaches a pre-set level above the top of the media and then the backwash inlet valve closes and the pump stops
13. The filter inlet valve opens and the filtration cycle commences.

All automatic sequence controls and times must be operator adjustable.

M38.13.3 Siphon system

A siphon system must be supplied to facilitate the filter drain down step. The siphon system must draw from three locations and discharge into the filter gullet.

The siphon system must be complete with automatic siphon priming/break solenoid valves. The control and operation of these primary/break solenoid valves must form part of the backwash cycle.

The siphon system is **not** required for drinking water applications.

M38.14 SCADA screens

SCADA screens must be provided to monitor and show the status of all aspects of the filtration plant. There must be at least an overview screen, a screen for each filter, a screen for the backwash system, a screen for the air scour system and a screen for any compressed air system.

A filter statistic pop up window must also be provided showing summary data on all filters e.g. Current filter set points (turbidity, run time, headloss trigger), current values, time since last backwash, time to next backwash, previous backwash data (e.g. run time, headloss, and turbidity at trigger etc.).

M39. UV Disinfection equipment

M39.1 General

This section covers the technical requirements for the supply of UV disinfection equipment.

The UV system must be capable of disinfecting the range of flows as given in this contract.

The Supplier must provide a validation certificate based on US EPA requirements or equivalent for the UV system and a validation report to clarify the Critical Control Point (CCP) requirements for SCADA and Water/Recycled Water quality management.

Low pressure UV systems and medium pressure UV systems must both be provided with Cleaning and Safety Equipment.

M39.2 Low pressure UV

M39.2.1 General

The UV disinfection system must be capable of continuous operation in ambient conditions experienced in an outdoor wastewater treatment plant. Equipment will be subject to chemicals and other conditions associated with the water and wastewater treatment plant operating environments.

The equipment and channel configuration must be designed such that the equipment must be capable of treating effluent with transmissivities determined by the Contractor as a result of his process design.

The UV system must be comprised of units, which must be fully submerged in the effluent. The system must consist of units designed and installed with appropriate protective covers to preclude the escape of UV light. The system must allow each unit to be readily isolated. The channel configuration must be designed to suit the UV disinfection units, which are appropriate for the effluent standard.

The Contractor must ensure that hydraulic conditions through the UV unit are satisfactory and that no short-circuiting of effluent can occur, and the facility must operate at maximum flow without overflowing.

The UV system must comprise a number of separate chambers to allow for maintenance. At times of low flow it must be possible to isolate one chamber for maintenance whilst the flow is diverted to the remaining chambers, without loss of disinfection efficiency.

The system must provide for efficient distribution of the effluent throughout the entire disinfection channel and be designed such that flow conditions within the channel are optimised to achieve maximum disinfection.

The system must:

- During periods of low flow, operate only sufficient banks of lamps to disinfect the low flow
- During periods of increasing flow, when it is apparent that the flow is about to be greater than that which can be disinfected by the operating banks, activate further banks in each channel
- During periods of decreasing flow, when it is apparent the flow can be adequately treated by a lesser number of operating banks, deactivate a bank of lamps in each channel
- When an isolation penstock is closed, deactivate the module in that channel.

Subject to achieving maximum economy in power consumption consistent with optimum tube life, the system must allow for portions of the lamps to be turned on and off to cater for varying flow rates. The facility must be controlled using data from a flow-measuring flume.

The UV disinfection system must be supplied complete, but not limited to the following:

a) Disinfection channel(s) or pipes/chambers

b) Disinfection units complete with lamps, enclosure, safety switches/circuit breakers and other fittings suitable for installation into disinfection channel(s) or pipes/chambers

c) Cleaning equipment suitable for cleaning all parts, fittings, lamps and supporting structures installed within the UV channel

d) Any baffles required for flow straightening to ensure the robustness and efficiency of the process over the entire range of operating flows

e) Channel covers as necessary to protect the UV installation and personnel

f) Automatic lamp cleaning system

g) Inlet isolation penstocks or valves

h) A system to prevent the ingress of solid matter that could result in the catastrophic breakage of the UV lamps within the channel such as a screen

i) Level regulating penstock with actuator

j) Cleaning equipment suitable for cleaning all parts and fittings

k) Online UV Intensity / Dose measurement

l) All control system requirements fully programmed and commissioned to operate the UV system based on flow signal provided

m) Online UV-Transmissivity analyser to interlock and/or control UV dose to ensure UV reactors are meeting the CCPs as specified in the Validation Report and/or provide better power optimisation of the system

n) Lifting provisions / eyebolts.

The UV system must disinfect the effluent in a safe, simple and automatic operation and be easily maintained. All features requiring cleaning, maintenance and adjustment must be readily accessible.

All wetted parts of the UV units must be grade 316 stainless steel, quartz glass, teflon or other materials not susceptible to UV or chemical degradation and must be readily removable.

M39.2.2 Performance requirements

The UV disinfection system must be capable of achieving the required effluent quality at the end of lamp life with up to 5% failures in any bank/vessel of lamps and uncleaned for a period of one month of normal operation.

During the Proving Period weekly sampling and analysis must be undertaken as follows:

- Final effluent before UV: faecal Coliform, SS, transmissivity Cryptosporidium, Virus.

- Disinfected effluent after UV: faecal Coliform, Cryptosporidium.

M39.2.3 Lamps

The UV lamps must be low-pressure high output LOHO lamps of the hot cathode instant start design in which the cathodes of coiled wire are heated by the arc current.

The filament must be the clamped design, sufficiently rugged to withstand shock and vibration.

The ultraviolet lamps must emit UV light at a frequency of 253.7 nm. Emission of light in the spectrum 310 to 410 nm and less than 230 nm must be minimum. At least 90% of energy must be transmitted in the 233 to 275 nm band.

The lamp design life must be not less than 12,000 hours. UV system output shall be not less than 40mJ/Wcm2. For recycled water plants minimum UV dosage shall be determined based on Log reduction required for plant pathogen..

The lamp bases must be either of a metal and ceramic construction, or of other materials resistant to UV light and ozone to ensure base integrity at the end of the lamp life.

For WFPs and WRPs the UV system supplied must be provided with validation certification and must be able to be operated to ensure LRV (Log Reduction Value) verification.

M39.2.4 Level control

An adjustable automatic level controller or "finger" weir arrangement must be placed at the discharge end of the channel, to ensure that all of the UV lamps are submerged in the effluent irrespective of flow rates.

M39.2.5 Control system

The control system must include:

- Resettable and cumulative hours run meters for each rack of lamps
- Indicator lights showing the operation or non-operation of all lamps
- Intensity monitors measuring the intensity of UV light in each bank. When the intensity drops below the end of lamp life UV dosage, an alarm must be activated. Sensors for the monitor must measure only the germicidal portion of the light emitted by the UV lamps. The detection system must be calibrated in the factory. Detection systems, which can be field, calibrated, will not be permitted. Additional online UV-T measurement of the process water is required to interlock the process (Water and Recycled Water) against the Critical Control Point and for dose control.

Intensity must be indicated as a percentage of that required to effect the reduction of faecal Coliform as specified in this contract and must be continuously displayed.

A single beam UV filter photometer with 100% transmittance control adjustment must be provided to measure UV transmittance of the effluent in the channel. The range must be 0 to 100% transmittance of the wavelength 253.7 nm. Online monitoring is required. The photometer to be installed must be suitable for this purpose.

The control system must provide an alarm for the following event:

a) More than 5% of lamp failure in any one bank of lamps

b) More than 5% of lamp failure in the complete unit

c) On reduction of the transmittance below an operator pre-set limit between 35% and 50%.

All electrical components e.g. ballast and lamp-monitoring systems must be completely isolated from all wetted parts to ensure safe operating conditions.

The ultraviolet units and respective control boards must have built in, the following monitoring and indicator equipment:

a) On reduction of intensity below the end of lamp limit

b) Lamp operating/not operating indicators for each lamp

c) Hours run meters with both not able to be reset cumulative hours run and able to be reset hours run displays for each rack

d) Bank operating indicator

e) Failure of lamp

f) One UV intensity sensor per bank with meter mounted on the control panel

g) One UV photometer per channel with meter mounted on the control panel

M39.3 Medium pressure UV

The UV disinfection system must be capable of continuous operation in ambient conditions experienced in an outdoor wastewater treatment plant. Equipment will be subject to chemicals and other conditions associated with the wastewater treatment plant operating environment.

All ancillary equipment necessary for the successful operation of the UV systems, such as lifting devices for removing UV system components and hydraulic or pneumatic power packs for the operation of the self-cleaning mechanisms, must be provided.

The UV system must consist of medium pressure, high intensity UV modules, and these modules must be required to be validated and certified based on the German DVGW Standard which requires the use of Computational Fluid Dynamic technology to demonstrate uniform dosing throughout the water passing through the UV system.

The UV modules must be in mounted pipe.

The UV treatment system must provide an ultraviolet dose of not less than 40 mJ/cm² at all times with the same dose level applied uniformly throughout the system as described above.

M39.3.1 Performance requirements

The UV disinfection system must be capable of achieving the required effluent quality at the end of lamp life with one lamp failure in any bank of lamps and uncleaned for a period of one month of normal operation.

During the Proving Period weekly sampling and analysis must be undertaken as follows:

- Final effluent before UV: faecal Coliform, SS, transmissivity, cryptosporidium, virus.
- Disinfected effluent after UV: faecal Coliform, Cryptosporidium.

M39.3.2 Lamp assemblies

Each UV lamp assembly must consist of a UV lamp, enclosed in an individual quartz sleeve, with the ends appropriately sealed using an O-ring sealed quartz end plug.

Lamps must be removable with the quartz sleeve and wiper system remaining in place. The lamp assembly design and UV module mounting must allow all of the following to be easily achieved by an operator for maintenance purposes:

a) Disconnection of lamp power cable only, without removing the UV lamp or the lamp assembly from the module

b) Disconnection of lamp power cable and removal of the UV lamp without removing the lamp assembly from the module

c) Disconnection of the lamp power cable and removal of the entire lamp assembly without removing the lamp from the assembly.

M39.3.3 Chamber

The module chambers must be constructed of stainless steel grade 316. All wetted parts must be stainless steel grade 316, high purity quartz, Teflon, and/or Viton. Aluminium wetted materials must not be used.

All wiring exposed to UV light must be Teflon coated. All materials exposed to UV light must be grade 316 stainless steel, Quartz glass, Teflon, Viton, or other suitable long-term UV resistant materials.

The chambers must not allow any possibility of direct UV light exposure to the Operator.

The chamber must incorporate the following provisions:

a) Automatic Energy Level Control

b) UV Intensity Monitor

c) Temperature Sensor

d) Automatic lamp cleaning Mechanism

e) Inspection Access Hatch with proximity switch.

M39.3.4 Inspection access hatch

A 200 mm diameter access hatch must be provided for each chamber to allow easy access for visual lamp/sleeve inspection.

M39.3.5 Lamps

Lamps must be medium pressure high intensity type. Low pressure or other lamp types will not be acceptable.

The UV lamp orientation must ensure that uniform UV dose is applied to the water passing through the chamber. The UV lamps must not be driven at powers above their specified safety range. The lamps must be protected from contact with water by high purity quartz sleeves of the F220 ozone free type. Each lamp must also be equipped with an individual lamp intensity monitor. Removal of the lamps must be achieved

from one end of the chamber without the need to drain the chamber or to remove the quartz sleeves from the flow.

UV output energy of the lamp must be variable. The lamp must be capable of maintaining a UV-C output proportional to the variable power settings. Medium pressure-low intensity or medium pressure-high output lamps with no capability to automatically vary the UV power output in operation must not be permitted.

The lamp design life at continuous operation with automatic various energy level control mode must not be less than 5,000 hours. A minimum UV bioassay validated RED dose of 40 mJ/cm^2 must be maintained at the end of lamp life and at the maximum flow rate in each module.

UV lamps must not require a long cool down period prior to re-start should the power to the UV system fail or be interrupted for a short period of time. Systems or lamps that require long cooling periods, (e.g. 10 - 30 minutes) before re-start are not acceptable.

The lamps must be capable of operating in a " No flow " condition for a minimum period of 60 minutes without causing any damage to the lamps. Systems or lamps that cannot withstand no flow conditions for a minimum period of 60 min will not be acceptable. The lamp output must not fluctuate more than 5% due to water temperature variations between 10-30 °C.

The lamps must be available from more than one supplier and the suppliers must accept the return of used lamps for recycling.

M39.3.6 Automatic energy level control

The UV module must be equipped with an automatic energy level control system that will calculate and adjust the appropriate ultraviolet dose based on flow, water transmissivity, and ultraviolet intensity.

M39.3.7 UV intensity monitor

Each ultraviolet chamber must be equipped with an ultraviolet monitor for measurement of UV energy in the range of 200 to 300 nm wavelength. The monitor must continuously monitor the water transmissivity, quartz sleeve condition, and the lamp life. The monitoring must be transmitted as 4 - 20 mA signals to the control panel.

One sensor per lamp with quartz windows must be provided to satisfactorily monitor the changes in the output of the ultraviolet lamps, lamp sleeve fouling, and the transmissivity of the water being treated. The sensor viewing port(s) must be designed to allow the replacement of the on-line sensor with a reference sensor to permit routine validation of the on-line sensor calibration. The sensor(s) must not be affected by static, electromagnetic fields, or short wave radio emissions.

The monitors must be factory pre-calibrated and sealed before they are delivered for installation on-site. A certificate of calibration must accompany each monitor.

The wet portion of the monitor must have a grade 316 stainless steel housing, Viton "O" ring, and a high purity quartz probe over the monitor site hole.

M39.4 Cleaning

An automatic cleaning mechanism must be provided for the ultraviolet unit to clean the quartz sleeves of the lamps, the UV intensity monitor probe, and the transmissivity monitor probe.

The cleaning mechanism must be PLC controlled and provide for fully automatic, unattended operation. This must be activated whenever there is a reduction in ultraviolet intensity below a pre-set level. Failure of restoring the required UV intensity level after a pre-set cleaning cycle must send an alarm signal to the SCADA. Shutdown of a particular lamp must also occur if the cleaning wiper stops moving or fails to return after reaching the end of the chamber.

The cleaning mechanism must also be able to be operated by pre-set timer and manually initiated when required. Wiping interval is the time between wiping cycles and must be easily reset by an operator whenever actual conditions warrant. The design life of the wiper or cleaning device in contact with the quartz sleeve must be in excess of two years.

The cleaning system must maintain uniform wiping tension and cleaning over the complete wiping length of the quartz sleeve. The cleaning system must maintain full efficiency throughout its life, with no deterioration in quality of cleaning.

The wiper blade brush or other cleaning device in contact with the quartz sleeve must not damage or scratch the quartz sleeve in any way.

All equipment necessary for the operation of the wiper system must be provided with the UV system i.e. compressor or hydraulic power pack.

No chemicals must be used for cleaning of the lamp tubes when used for recycled water supply. Chemical cleaning is permitted for effluent disinfection systems (subject to Supplier requirements).

M39.5 Safety equipment

Notwithstanding that the equipment has been designed to prevent the escape of UV light, the Contractor must provide safety equipment including:

- Four shields
- Four hard hats with face shields designed to block UV light in the band of 200 to 400 nm.

M40. Compressed air service

This section covers the technical requirements for Equipment for Compressed Air Service.

M40.1 General

The compressed air system must provide dry clean instrument and service air for operation and maintenance of equipment.

The compressed air system must include a minimum of two air compressor systems (one duty and one standby) unless the air receiver is sufficiently sized for pneumatic equipment (including pneumatic valves) actuated to fail position (during power failure). This is subjected to SW approval. Each compressor system must be a rotary screw compressor complete with integrated refrigerant drier and integrated oil and water separator. All compressors 15kW and larger must be fitted with a VSD to regulate delivered air pressure.

The compressors will have on board controls that will allow an external SCADA system to start and stop the compressor as long as the SCADA mode relay is in AUTO position. In the event of SCADA failing, the compressor must operate on its own pressure switches.

The compressors will be configured to restart after a power failure. Suitable on board phase sequence monitor relays will be applied if deemed necessary to achieve restarting safely.

From each compressor system air must be discharged through a set of filtering systems for the removal of traces of oil, mist, dirt and condensation to provide clean dry air. The filtered air must be delivered to the air delivery main and to a common air receiver.

When the compressors are not in operation, air must be delivered from air receiver into the air delivery mains.

The air delivery main pressure must be maintained at about 700 to 800 kPa. The pressure regulating valve must maintain a constant system supply for instrument and service air.

If the duty compressor cannot maintain the air pressure in the receiver above 700 kPa the standby compressor must start automatically as a backup for the duty compressor.

When the air pressure exceeds the maximum pressure (900 kPa), the control system must generate an alarm.

The equipment must be provided with modern techniques of vibro-acoustic optimisation to reduce the overall noise level.

All pressure switches must be adjustable with minimum range of ± 20 kPa.

M40.2 Air compressor requirements

The compressor system must be provided with the following minimum requirements:

- The design capacity of each compressor must be 300% of the peak air demand for instrument air requirements and 130% for process air requirements. All values are on free Air Delivery (FAD) values at 20ºC and 0 kPa(g) pressure.

- Low pressure VSD compressor technology only must be used for process air under 2.5 bar(g). Standard compressors will only be considered in these types of applications as required by Suppliers (particularly for membrane processes).
- Capable of rapid response to load changes to meet the actual demand
- ISO8573-1 CLASS 0 certified compressors shall be used on the following applications:
  - Potable water filtration plants/sites
  - Any site or plant that applies membranes as part of the treatment process for example MBR, reverse and forward osmosis, and ultra-filtration
- ISO8573-1 CLASS 0 certified compressors are preferred for all other applications, however, oil injected style compressors will be considered where oil free air is not required as well as on an energy efficiency basis
- Efficient oil lubrication system with oil level sight glass and oil filter
- Each compressor air intake must be fitted with an inlet filter and silencer
- An unloading system must be provided for ease of starting.

The minimum expected safety features must include:

i. Low suction inlet pressure

ii. High discharge pressure

iii. Low oil pressure

iv. Motor overload.

M40.3 Refrigerated dryer

Each compressor must be fitted with an integrated refrigerated dryer with moisture separator and auto drain.

M40.4 Filters

Each compressor system must be fitted with a set of filters to provide oil free air to the degree of 0.01 parts of residual oil per million parts of air (ppm).

The first set of filters must be general purpose filters for removing liquid water and oil aerosol to 0.1 ppm and particles down to 1 micron.

The filtered air must pass through a second set of coalescing filters, removing liquid water and oil aerosol to 0.01 ppm and particles down to 0.01 micron to 99.99%.

The elements must be coalescer types, providing a long life expectancy. The filters must be complete with an element condition indicator and automatic drain.

M40.5 Air receiver requirement

The air receiver must be a freestanding vertical steel tank constructed in accordance with SafeWork NSW requirement. The Air receiver must be designed, manufactured, tested and certified to AS 1210. The receiver must be designed to withstand a maximum pressure class of 1300 kPa.

Ample height provision must be made between the floor and bottom of the receiver for the automatic drainage system specified here in.

The air receiver must be fitted with the following items:

- Inlet and outlet connection
- Spare connection
- Pressure gauge, 100 mm face and isolation cock and connection
- Pressure relief safety valve and connection
- Automatic condensate drains
- Manual drain valve and connection.

The safety valve pressure setting for the receiver must be 900 kPa.

M40.6 General features

Each compressor and all the associated equipment, the oil separator, the integral dryer, filters, and instruments, must be assembled in one compact size package for easy floor mounting in minimal space.

M40.7 Compressed air service pipework

The main compressed air supply lines (headers) must be copper tube or grade 316 stainless steel depending upon where the pipeline is installed. The compressed air feed lines to individual equipment like solenoids must be polyethylene tubing, copper tubing or grade 316 stainless steel. Copper must only be used outside of buildings in areas where H_2S is not present. All equipment must be suitable for outside use in the sunlight. The tubing fittings must be one touch push fittings suitable for a maximum pressure of 1000 kPa.

All compressed air lines must be run generally parallel to building structures in a neat and ordered fashion so as not to restrict clearance to other services. Polyethylene tubing must be run in cable tray. Grade 316 stainless steel saddles must anchor metal pipe/tube. Plastic cable ties must fasten polyethylene tubing.

The pipelines must be graded in direction of flow and low points must be fitted with valved auto drain drip legs to remove condensate. Each auto drain must be provided with manual drain valve.

A water take off point must be provided from beneath the pipe and an auto drain to drain the occasional condensate must be provided at 50 m intervals. Also, every descending compressed air pipe or tube must have an efficient auto drain at its lowest point to prevent water remaining in the tube.

Air must be taken off from the top of the main pipe to allow occasional condensate to stay in the main pipe.

All equipment to valves and equipment must be screwed and fitted with unions to allow removal.

A suitable air service unit must be supplied and installed before all pneumatic control equipment like solenoids etc. to provide clean dry air. For pneumatic system components which need lubrication, the air service unit must be provided complete with lubricator. The air service unit must be complete with pressure regulating valve and pressure gauge.

All solenoid valves for pneumatic equipment must be provided with speed controllers for easy and stepless adjustment of the actuator movement.

Solenoid operated valves and pneumatic equipment on compressed air lines must be specially constructed for non-lubricated air service (unless accepted otherwise by Sydney Water).

M40.8 Acoustic enclosures

Noise levels must be contained by appropriate equipment design or with an acoustic enclosure.

The enclosures must form an integral part of the equipment and must not affect the safety or function of equipment. Normal operation must be possible for continuous operation without opening or moving the enclosure. The enclosure must not hinder access for maintenance.

The compressed air system must have guaranteed noise levels of less than 70 dB at a distance of 1 m. The agreed noise limit must be a maximum and not be exceeded under load conditions. Noise testing must be conducted in the factory prior to delivery to site.

M41. Pressurised water system

This section specifies the technical requirements for pressurised water system for industrial water, reclaimed effluent or site reuse water in water and wastewater treatment plants.

M41.1 Pressurised water system equipment

The system must include a packaged pressure unit consisting of:

a) Minimum two variable speed centrifugal pumps

b) Diaphragm type pressure tank(s) or hydro pneumatic tank, pipework, valves, fittings and control and monitoring instrumentation.

M41.2 Design requirement

Unless otherwise specified elsewhere in the Specification the pressurised water system must maintain minimum pressure of 60 kPa in the water reticulation system at a most disadvantageous point of use under varying flow demand conditions including maximum flow demand.

M41.3 Control of the pressurised water system

Depending on the performance required, the pumps must be switched on and off under full alteration. The pressure set points must be varied according to demand and to compensate for the head loss. Control system must be programmed to adjust for friction loss compensation. The compensation must be distributed linearly (approximately) over the flow range.

The pressure must automatically increase as system flow and consequent frictional losses increase. Pressure must be monitored on the discharge manifold of the booster set using a pressure transducer, and actual pressure is compared with set point pressure. When system pressure drops below the programmed set point, initially pump number one will start and ramp up to the speed required to maintain the set pressure. As the demand continues to increase, a set point will be reached where with one pump running at full speed, set point pressure can no longer be maintained. At this point the number one pump will be running at full speed and the second pump will start to raise pressure again to above the set point.

During periods of reduced demand, once pressure rises above set point pumps speed must be reduced to track set point pressure, down to zero flow if necessary, when all pumps must be switched off.

M41.4 Break tank

The industrial water (IW) must be the potable water collected in a break tank and then pumped into a hydro pneumatic system to serve for treatment process. The break tank must be designed as per relevant Standard requirement.

M41.5 Pumps

The design of pumps must be as per the relevant clauses of this Specification. Also, the pumps must:

a) Be direct coupled to a single speed three-phase 400 V 50 Hz motor with a speed not exceeding 3000 rpm

b) Be of the vertical multi-stage type and the shut-off head plus the maximum suction head must not exceed the pressure class of the downstream pipework and appurtenances

c) Have continuously falling head/flow curve and be able to be operated down to 300 kPa

d) Have cast iron suction and discharge heads with stainless steel body, stainless steel impeller and stainless steel shaft.

M41.6 Hydro pneumatic tank requirement

The hydro pneumatic pressure tank must be a freestanding vertical steel tank constructed in accordance with SafeWork NSW requirements. The pressure tank must be designed, manufactured, tested and certified to AS 1210. The pressure tank must be designed and be rated to withstand a maximum pressure of not less than 1600 kPa.

Ample height provision must be made between the floor and bottom of the tank for the drainage system specified here in.

The pressure tank must be:

- Connected to the discharge manifold
- Fitted with an isolation valve in the inlet/outlet connecting pipe
- Bladder type, pre-charged with compressed nitrogen to the required pressure
- Gas re-charging valve installed at a suitable height along with a dial type analogue pressure gauge
- Inlet and outlet BSP threaded or flanged connection
- Pressure gauge, 100 mm face and isolation cock and connection
- Pressure relief device(s) where required by AS 1210
- Differential pressure transmitter to monitor pressure as an indicator of water level
- Manual drain valve and connection.

Certificates of compliance must be provided to Sydney Water.

M42. Odour control facilities

This section of the Specification covers the general requirements for odour control related assets located at Sydney Water facilities.

Odour control facilities must also comply with the latest Sydney Water OCU Standard Specification ACP 0004 and latest IICATS and SCADA standards.

For those specific applications, the documents noted above take precedence over this Specification.

M42.1 Biofilter systems

M42.1.1 General

Biofilter systems remove and oxidise organic gases and volatile organic compounds through the action of natural occurring microorganisms as the untreated air flows through an organic filter bed. Colonies of the microorganisms are called biomass and the media used as the filter bed to sustain this biomass varies from an engineered type media to a soil and compost bed type.

Both types of biofilter systems are required to meet the following requirements:

1. Each section of the system must have an array of humidified foul air ducts that are designed to evenly distribute foul air within the section. Each section will also have installed a system by which excess water is collected and discharged via a collection sump and pumped or gravitate back to the plant.
2. The biofilter bed must be designed to produce an exit odour concentration which confirms to the lowest of:
    - No more than 1000 OU, determined in accordance with Australian/New Zealand Standard 4323.3:2001, Stationary source emissions Part 3: Determination of odour concentration by dynamic olfactometry and the odour concentration values are those determined at the second, or detection threshold.
    - As determined by dispersion modelling to not cause any predicted odour impact on any sensitive receptor in combination with all other odour sources on the plant site during normal summer operation.

The biofilter must maintain the designed odour performance throughout the life of the unit.

M42.1.2 Engineered media type

Engineered media type filter bed systems must meet the following requirements:

1. The untreated air must pass through a pre-filter preventing fats and greases from entering the biofilter
2. All collected air be passed through a humidification step where the relative humidity of the gas is raised to minimum 95% RH. This humidification step must also remove particulate matter from the air stream. Industrial water must be used for humidification.

M42.1.3 Soil and compost bed type

Whilst the Soil and Compost Bed type are no longer considered as a technology for new installations at Sydney Water's facilities, for the purposes of maintaining existing installations, Soil and Compost Beds must meet the following requirements:

1. The humidified air is to be split equally between 2 or more separate and isolatable treatment sections of the bed. This requirement permits repairs or renewal to be performed upon the system beds separately while maintaining foul air treatment.
2. That all collected air be passed through a humidification step where the relative humidity of the gas is raised to minimum 90% RH. This humidification step must also remove particulate matter from the air stream. Industrial water must be used for humidification.
3. The humidified air is to be split equally between 2 or more separate and isolatable treatment sections of the bed. This requirement permits repairs or renewal to be performed upon the system beds separately while maintaining foul air treatment.
4. The material composing the bed is to be at least 1.2 m deep and have a surface loading of no more than 1.5 m^3/minute.m^2 during normal operation. This material is to be composed of particles sized to deliver a pressure drop when new of approximately 300 Pa.
5. The moisture content of the bed is to be controlled by a timer plus either:
    - Two moisture monitors installed in each section of the biofilter bed at different depths in the bed
    - Two temperature sensors installed in each section of the biofilter bed at different depths in the bed.

These control systems must manage the flow of irrigation water over the surface of each section of the bed. The use of moisture monitors will require a control loop which maintains a predetermined moisture content in the bed at each sensor. The use of temperature sensors will control the temperature difference between the inlet humidified air and each position in each section of the biofilter bed to be no more than one centigrade degree (1 °C). These control functions are to be programmed into the plant SCADA.

M43. Equipment installation

M43.1 General

This clause sets out the requirements for the installation of equipment not specifically stated elsewhere in this Specification. Installation of structural steel and aluminium members must comply with relevant sections of Sydney Water Technical Specification – Civil (CPDMS0023).

Equipment must be installed on concrete plinths with a minimum height of 100 mm. The concrete plinths must be constructed on or integrated in prepared foundations or dowelled into existing concrete. A grouting allowance of 20 mm to 50 mm between the concrete plinth and equipment baseplate, stand, feet or pedestal must be provided.

M43.2 Equipment alignment

Equipment must be properly aligned to the prescribed centre lines and elevations and set and adjusted on stainless steel packers and shims.

To assist levelling and alignment, adjusting nuts with washers must be installed on the anchor rods/bolts under the equipment baseplate, stand, feet or pedestal.

The equipment must be installed free of any undue stresses, strains or vibrations and be accessible for maintenance.

All mechanical equipment must be set, levelled, aligned and inspected with precision tools (steel straight edge, dial indicator and graduated machinist levels).

Specifically, all direct driven equipment must be aligned by the use of a dial test indicator or laser alignment. Both the driver and the driven shafts must be rotated simultaneously to each of the four positions at 0°, 90°, 180° and 270° at which readings must be taken. The maximum allowable out-of-alignment tolerance must be 50 µm (0.050 mm) unless specified otherwise in individual equipment installation instructions. An alignment record sheet must be completed for each coupling aligned. This alignment procedure must also conform to the equipment manufacturer's instructions. All alignments must be inspected and approved by the relevant equipment supplier's representative. Inspections by the equipment supplier must be coordinated and documented. The “as installed” alignment records must be kept for future inclusion in the Operating and Maintenance Manuals.

M43.3 Installation of pumping units

This clause sets out specific requirements for the installation of pumping units in water and recycled water pumping stations**,** dry mounted submersible pumps in dry wells of conventional sewage pumping stations, returned activated sludge (RAS) and waste activated sludge (WAS) pumps, and pumping units whose installation is not mentioned elsewhere in this Specification.

The pumping units must be installed using stainless steel grade 316 nuts, washers and holding down anchor rods set in chemical masonry anchors. The chemical anchors and anchor rods must be suitable for dynamic loads, e.g. “Hilti HVU” system or equivalent. Only anchor rods that are part of the chemical anchoring system provided by the manufacturer must be used.

The holding down anchor rods must be set into the chemical anchors in concrete base or plinth to a depth and min. distance from concrete edges as recommended by the equipment and anchor manufacturers. The depth of embedment in concrete and min. distance from edges must be shown in detail design drawings.

The chemical anchors must be stored and installed strictly in accordance with manufacturer's instructions using adhesive capsules for each hole and appropriate tools and equipment. The capsules must be within the expiry period to maintain maximum anchorage strength.

The installer must wait for the appropriate curing time, as recommended by the manufacturer of the chemical anchors before fully tightening the holding down nuts.

To assist levelling and alignment, adjusting nuts with washers must be installed on the anchor rods under the equipment baseplate, stand, pedestal or feet. However, after the packers and shims (if required) are installed and prior to grouting, the adjusting nuts and washers where used must be backed off all the way to the concrete plinth. The aim is that tightening the nuts above the baseplate, stand, feet or pedestal must clamp it to the packers tightly. Correct tightening torque must be obtained from the pump supplier.

The packers must be located on both sides of the anchor rods along the width of the baseplate, stand, feet or pedestal. Where slots are provided in the baseplate, stand, feet or pedestal for the anchor rods, packers must be installed along the slots and the width of the baseplate, stand, feet or pedestal. The packers must be placed as close as possible to the holding down anchor rods such that tightening the holding down nuts will not twist, bend or misalign the baseplate, stand, feet or pedestal and the tightening force is directly applied to the packers A square stainless steel washer of size 50 x 50 x 3 mm must be provided under the nuts above the baseplate, stand, feet or pedestal. Typically, some part if not most of the stainless steel packer would be directly under the square washer.

Packers must be of sufficient size to sustain an effective load bearing area. They must be of one-piece construction and rectangular in shape. Round packers and packers fabricated from multiple smaller packers are not acceptable. The combined height of a packer and shims must not exceed the maximum grouting allowance.

Height of packer must be location specific.

Packers must be placed on concrete surfaces that are even, rough and clear of all debris. Concrete surfaces must be scabbled to a depth of 3 to 5 mm. This scabbling must be continued for all concrete surfaces where subsequent grout will be applied.

Shims must be of the same width and length as the packer. The maximum number of shims at any one point must not exceed two with maximum thickness of individual shims not exceeding 2 mm. If the total thickness required is more than 4 mm, the shims must be replaced with a single machined plate.

The space between the underside of the baseplate, stand, feet or pedestal and the concrete floor / plinth must be filled with non-shrink epoxy grout Conbextra EP65 Plus, or equivalent.

The face of pump flanges (both suction and discharge) must be plumb and square to the direction of flow. Pump suction and discharge flanges must not be stressed due to the installation of downstream and upstream pipework and appurtenances.

M43.4 Specific requirements for submersible sewage pumps

Submersible sewage pumps are installed on pump pedestals, rather than on baseplates or feet.

Packers must suit the dimensions of the pump pedestal.

Packer width must be equal or slightly larger than the dimension between the edge of the slot for hold down anchors and the edge of the pedestal (nearest edge parallel to the slot).

Packer height and length of 32 mm (H) and 50 mm (L) are generally considered adequate for most applications, however these dimensions must be checked for their suitability with the pump pedestal for each installation.

Packer dimensions must be specified in the design drawings.

The space between the underside of the pedestal and the concrete floor / plinth must be filled with non-shrink epoxy grout Conbextra EP65 Plus, or equivalent.

The face of pump pedestal must be plumb and square to the direction of sewage flow.

M43.5 Grouting

After final alignment non-shrinking grout must be provided under all equipment baseplates, feet and supports when mounted on a concrete base or plinth and where fastened to concrete walls, ceilings and floors. Grouting surfaces must be graded so that there is no low points which can accumulate water or dirt and to achieve drainage to the floor drain and away from the equipment baseplate or feet so that cleaning around the equipment can be easily carried out. The grout must be suitable for dynamic loads and permanent submergence in case of submerged installation. The installer must follow the grout manufacturer’s instructions.

M43.5.1 Epoxy grout

The epoxy grout must be an epoxy resin based product designed for free-flow grouting of gaps of widths from 20 mm to 50 mm. A suitable grout must be Fosroc Conbextra EP65 Plus® or alternative accepted by Sydney Water. The components must be supplied from the manufacturer in the correct mix proportions designed for whole pack mixing so that reproducible flow and mechanical properties are assured. Product packs must be mixed near the application site to avoid product going ‘off’ prior to pouring.

The grout must extend 30 mm sideways and minimum 10 mm upwards all around the baseplate, stand, feet or pedestal. All sharp edges must be provided with a 5 mm x 45 degrees bevelled edge within the formwork.

Only epoxy grout Conbextra EP 65 Plus or equivalent (with written acceptance from Sydney Water) must be used under all pumping units.

M43.5.2 Chemical grout

The chemical grout must be a non-shrink, premixed, prepacked, fine graded siliceous based or non-catalysed iron aggregate cementitious grout. The grout must be free from gas producing agents, oxidising catalysts and inorganic accelerators, including chlorides. The addition of potable water only must be sufficient to achieve fluid consistency as specified below. A suitable grout must be Australian Master Builders Masterflow 870A or equivalent. Such grout must provide performance characteristics when mixed to fluid consistency of 25 to 30 seconds (flow cone method, AS 1478.2 - Appendix C).

M43.6 Conformance with regulating authorities

It is a requirement of this specification that all equipment and plant installed, is in accordance with the regulations, ordinates, by-laws and requirements of all relevant statutory authorities. Plant and equipment inspections must be carried out by relevant statutory authorities where required.

M44. Technical data labelling

This clause sets out the requirements for the labelling of equipment not specifically stated elsewhere in this Specification. Also refer to Sydney Water's Technical Specification – Commissioning, transitioning assets into operation (D0001440).

Labels must be fixed to all items of equipment for both custom build and proprietary items. Labels must be grade 316 stainless steel plate and fixed by oval head stainless steel screws.

The label (or nameplate) must be suitably engraved to provide information of a descriptive and technical nature relating to the item of equipment.

The information given on the label must include but is not limited to typical data as listed below:

a) Equipment number:

b) Name of equipment: e.g. Screw Conveyor, Axial Flow Fan, Torque Flow Pump, etc

c) Name of manufacturer:

d) Model Number:

e) Serial Number: As appropriate

f) Rated Speed: If 2 speed, state both speeds. If variable speed, state upper and lower limits

g) Capacity: Depends on the equipment type, e.g. pumps - litres/sec, hoppers - m^3, etc

h) Rating: kW or as appropriate.

The information to be supplied depends on the equipment item, e.g. for a gearbox, provide reduction ratio; for a motor, show voltage, full load current, winding connections, etc.

The labels must replace or be in addition to nameplates of other materials, should these be supplied as part of the equipment.

The label dimensions must be selected to be suitable for the information contained thereon.

The label must be affixed to the specific item of equipment so that it may be conveniently read when in the installed position and must be attached to a principal component of the equipment item so that it is not misplaced or inadvertently discarded on a replacement part during overhaul.

M45. Commissioning

Commissioning of the works must comply with Sydney Water's Technical Specification – Commissioning, transitioning assets into operation (D0001440).

Ownership

Ownership

Role	Title
Group	Asset Lifecycle
Owner	Engineering Manager
Author	Milan Rubcic, Technical Director – Mechanical Engineering
BMIS Number	BMIS0209

Change history

Version No.	Prepared by	Date	Approved for use	Issue date
12.0	M Rubcic / J Smith	30 June 2022	Norbert Schaeper	30 June 2022
11.0	M Rubcic / J Smith	20 December 2019	Ken Wiggins	20 December 2019
10.0	M Rubcic / J Smith	14 August 2019	Norbert Schaeper	14 August 2019
9.0	M Rubcic / Z Dunn	22 February 2017	Ken Wiggins	22 February 2017
8.0	M Rubcic / Z Dunn	21 April 2015	Ken Wiggins	21 April 2015
7.0	M Rubcic / Z Dunn	4 April 2014	Peter Gillman	4 April 2014
6.0	M Rubcic / Z Dunn/ P Rabaud	17 October 2012	Peter Gillman	22 October 2012
5.0	M Rubcic / Z Dunn/ P Rabaud	20 August 2011	Peter Gillman	21 September 2011
4.0	M Rubcic / Z Dunn	30 August 2010	Peter Gillman	30 August 2010
3.0	M Rubcic / Z Dunn	14 May 2010	Peter Gillman	31 May 2010
2.0	M Rubcic / Z Dunn	18 February 2009	Peter Gillman	18 February 2009
1.0	M Rubcic / Z Dunn	13 August 2008	Peter Gillman	5 September 2008