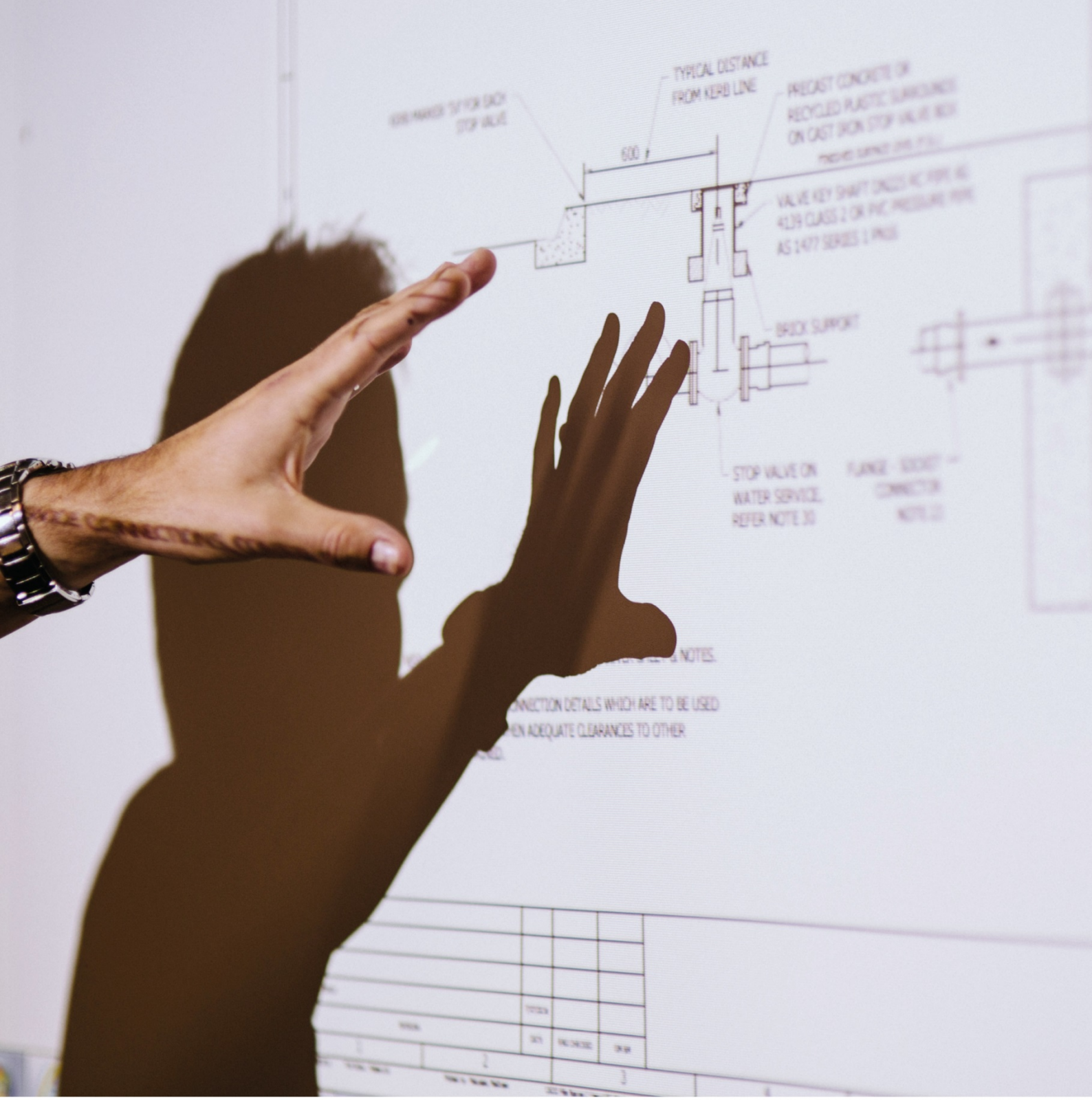

STD-SPE-M-002
TECHNICAL SPECIFICATION
PIPING AND VALVES

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WATER

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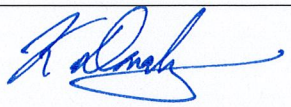
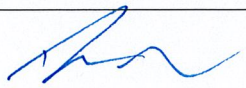
Document management

Document authorisation table

Issue	Date	Author	Reviewer	Approver
Not Issued	21/11/16	G. Last (MWH)	J. Ciccotelli (MWH)	K. Danenbergsons
1	20/06/18	 K. Danenbergsons	P. Mistri (Hatch) B. Fraser (Hatch)	 D. Eager

Version control table

Issue	Date	Reason for issue
-	21/11/16	Originally intended for upgrade projects at LMWQCC but never issued.
1	20/06/18	Major changes made to the original (MWH) document. Issued for use.

Document applicability table

Asset area	Applicable (Yes/No)	Asset area	Applicable (Yes/No)
Dams (DAM)	*	Water Network (WAT)	*
Bulk Water Supply (BWS)	*	Sewerage Network (SEW)	*
Water Treatment Plants (WTP)	Yes	Sewage Pump Stations (SPS)	*
Water Pump Stations (WPS)	*	Sewage Treatment Plants (STP)	Yes
Reservoirs (RES)	*	Recycled Water Systems (REC)	*

* Applicable for some, not all fluid/system types. Refer to Section 2 (Table 2.1) for specific applicability details.

Table of Contents

Abbreviations

ABS	Acrylonitrile Butadiene Styrene
ACT	Australian Capital Territory
ANSI	American National Standards Institute
API	American Petroleum Institute
AS; AS/NZS	Australian Standard; Australian and New Zealand 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 Thread
DN	Nominal Diameter (Number) (mm)
EN	European Standard (translated from the French/German “European Norms”)
EPDM	Ethylene Propylene Diene Monomer
FRP	Fibre Reinforced Plastic
GRP	Glass Reinforced Plastic
HDPE	High Density Polyethylene
ISO	International Organization for Standardization
kPa	Kilopascal(s)
NSW	New South Wales
l	Litre(s)
LMWQCC	Lower Molonglo Water Quality Control Centre
m	Metre(s)
mm	Millimetre(s)
MPa	Mega Pascals
MS	Microsoft Corporation
MWTT	Mean Wall Thickness Temperature

NPS	Nominal Pipe Size
OEM	Original Equipment Manufacturer
NCC	National Construction Code
P&ID	Piping and Instrumentation Diagram
PE	Polyethylene
PIPA	Plastic Industry Pipe Association of Australia
PN	Nominal Pressure (Number) (bar)
PTFE	Polytetrafluoroethylene
PVC	Polyvinyl Chloride
PVC-O	Orientated Polyvinyl Chloride
PVC-M	Modified Polyvinyl Chloride
PVC-U	Un-plasticised Polyvinyl Chloride (aka “UPVC”)
UPVC	Un-plasticised Polyvinyl Chloride (aka “PVC-U”)
WAX	Work As Executed
WSA; WSAA	Water Services Association of Australia

Definitions

Contractor	As per the definition for “Installation Contractor”
Designer	The individual person or organisation responsible for sizing, selecting and specifying individual piping system components as well as complete piping systems based on Icon Water’s specified requirements. The designer may be Icon Water personnel or an external engineering consultant, a vendor/supplier or an installation contractor.
Icon Water	The owner and operator of the piping systems described herein.
Icon Water Representative	The nominated person or organisation who has written authority to act on Icon Water’s behalf.
Installation Contractor	The person or organisation responsible for duties such as but not limited to on and off-site fabrication, construction, surface coating, delivery, testing, commissioning and handover.
Supplier	As per the definition for “Vendor”.
Vendor	The person or organisation responsible for the fabrication or manufacture and supply of equipment and components described herein.

1 Background

Rather than continuing to rely solely on specifications which vary from project-to-project, Icon Water has now standardised on requirements for all asset types and locations via a suite of technical specifications and standard drawings. This has been done to provide better clarity for designers which in-turn leads to a greater consistency in the operations and maintenance related tasks undertaken by workers at Icon Water sites. This specification for piping and valves forms part of Icon Water's suite of design infrastructure standards. It describes the minimum mandatory requirements that designers, manufacturers, equipment suppliers and installation contractors must comply with when designing, fabricating, testing, commissioning and handing over piping and valve related equipment and systems.

This specification has been drafted as the overarching document to *STD-SPE-M-004* and as such, the details included in *STD-SPE-M-004* are, and shall be based on this specification. Where any discrepancy or ambiguity exists between *STD-SPE-M-004* and this specification, then the details contained in this specification shall take precedence.

2 Scope

This specification:

a) Shall apply to the design, fabrication, installation, testing, commissioning and handover of piping and valves for use within the Icon Water's asset areas indicated in Table 2.1 below.

b) Shall not apply to pipelines, piping and valves used for the conveyance of potable water and/or sewage within Icon Water's potable water and/or sewerage networks within the limits of applicability of WSAA codes WSA 03 and WSA 02 respectively (as amended by Icon Water).

c) Must be fully complied with by designers, suppliers and installation contractors.

d) Must be read and applied in-conjunction with the documents listed in Table 4.1.1.

Table 2.1 Specific Applicability – By Asset or Fluid System Type

Item	Asset area	Applicability of this specification
1	Dams (DAM)	Applicable for all fluids and piping systems in use at Icon Water dams with the exception of designated bulk water supply pipelines (which are to comply with *STD-SPE-C-005*).
2	Bulk Water Supply (BWS)	Applicable only for ancillary piping systems such as but not limited to chemical dosing systems used as part of a bulk water supply pipeline. Otherwise, bulk water supply pipelines shall comply with the requirements of *STD-SPE-C-005*.
3	Water Treatment Plants (WTP)	Applicable without limitation.
4	Water Pump Stations (WPS)	Applicable for all fluids and piping systems not covered by the scope and intent of WSAA code *WSA 03 Water Supply Code of Australia* as amended by Icon Water in *STD-SPE-G-012*.
5	Reservoirs (RES)	Applicable for all fluids and piping systems not covered by the scope and intent of WSAA code *WSA 03 Water Supply Code of Australia* as amended by Icon Water in *STD-SPE-G-012*.

Item	Asset area	Applicability of this specification
6	Potable Water Network (WAT)	Applicable only for ancillary piping systems such as but not limited to chemical dosing systems used as part of the potable water network. Otherwise, the potable water network shall comply with the requirements of WSAA code *WSA 03 Water Supply Code of Australia* as amended by Icon Water in *STD-SPE-G-012*.
7	Sewerage Network (SEW)	Applicable only for ancillary piping systems such as but not limited to chemical dosing systems and odour control systems used as part of the sewerage network. Otherwise, the sewerage network shall comply with the requirements of WSAA code *WSA 02 Gravity Sewerage Code of Australia* as amended by Icon Water in *STD-SPE-G-011*.
8	Sewage Pump Stations (SPS)	Applicable only for ancillary piping systems such as but not limited to chemical dosing systems and odour control systems used as part of a sewage pump station. Otherwise, sewage pump station piping and valves shall comply with the requirements of WSAA code *WSA 04 Sewage Pumping Station Code of Australia* as amended by Icon Water in *STD-SPE-G-010*.
9	Sewage Treatment Plants (STP)	Applicable without limitation.
10	Recycled Water Systems (REC)	Applicable without limitation.

3 Purpose

The purpose of this specification is to provide technical requirements for the design, fabrication, installation, testing, commissioning and handover of piping and valves for use within the Icon Water's asset types and fluid systems specifically detailed in Table 2.1 above.

4 Standards and Codes

4.1 Referenced Standards and Codes

The documents listed in Table 4.1.1 are either referenced by this specification, or shall be complied with and read in-conjunction with this specification. Users of this specification shall assume that the latest issue (or issue in use at the time of contract signing for a specific project) of these documents be complied with and/or referenced unless noted otherwise.

Table 4.1.1 Referenced Documents

Item	Document number	Title
Australian standards		
1	AS 1110	ISO metric hexagon bolts and screws – Product grades A & B (all parts)
2	AS 1111	ISO metric hexagon bolts and screws – Product grade C (all parts)
3	AS 1112	ISO metric hexagon nuts (all parts)
4	AS 1167.1	Welding and brazing - Filler metals Filler metal for brazing and braze welding
5	AS/NZS 1170 Series	SAA loading code
6	AS 1252	High strength steel bolts with associated nuts and washers for structural engineering
7	AS 1289 Series	Methods of testing soils for engineering purposes
8	AS 1345	Identification of the contents of pipes, conduits and ducts
9	AS/NZS 1260	PVC-U pipes and fittings for drain, waste and vent applications
10	AS 1432	Copper tubes for water, gas and sanitation
11	AS/NZS 1477	PVC pipes and fittings for pressure applications
12	AS 1628	Water supply copper alloy gate, globe and non-return valves
13	AS 1646	Elastomeric seals for waterworks purposes
14	AS 1722.1	Pipe threads of Whitworth form – Sealing pipe threads
15	AS/NZS 2032	Installation of PVC-U pipe systems
16	AS/NZS 2033	Installation of polyethylene pipe systems
17	AS 2118 Series	Automatic fire sprinkler systems
18	AS 2239	Galvanic (sacrificial) anodes for cathodic protection
19	AS/NZS 2280	Ductile iron pipes and fittings
20	AS 2317	Collared eyebolts

Item	Document number	Title
21	AS 2419 Series	Fire hydrant installations
22	AS 2528	Bolts, studbolts and nuts for flanges and other high and low temperature applications
23	AS/NZS 2566 Series	Buried flexible pipelines
24	AS 2638.1	Gate valves for waterworks purposes metal seated
25	AS 2638.2	Gate valves for waterworks purposes resilient seated
26	AS 2648.1	Underground marking tape – Non detectable tape
27	AS 2938	Gears - Spur and helical - Guide to specification and rating
28	AS 3500	Plumbing and drainage (set as part of the NCC)
29	AS/NZS 3518	Acrylonitrile Butadeine Styrene (ABS) pipes and fittings for pressure applications
30	AS 3571	Glass filament reinforced thermosetting plastic pipe (GRP) polyester based water supply, sewerage and drainage applications
31	AS 3688	Water supply and gas systems - Metallic fittings and end connectors
32	AS/NZS 3725	Design for installation of buried concrete pipes
33	AS/NZS 3690	Installation of ABS pipe systems
34	AS 3990	Mechanical equipment – steelwork
35	AS/NZS 4020	Testing of products for use in contact with drinking water
36	AS 4037	Pressure equipment – Examination and testing
37	AS 4041	Pressure piping
38	AS/NZS 4087	Metallic flanges for waterworks purposes
39	AS 4100	Steel structures
40	AS/NZS 4129	Fittings for polyethylene (PE) pipes for pressure applications
41	AS/NZS 4130	Polyethylene (PE) pipes for pressure applications
42	AS 4343	Pressure equipment - Hazard levels
43	AS/NZS 4441	Oriented PVC (PVC-O) pipes for pressure applications
44	AS/NZS 4765	Modified PVC (PVC-M) pipes for pressure applications
45	AS 4794	Non-return valves - Swing check and tilting disc

Item	Document number	Title
46	AS 4795 Series	Butterfly valves for waterworks purposes
47	AS 4809	Copper pipe and fittings - Installation and commissioning
48	AS 4832	Cathodic protection - Installation of galvanic sacrificial anodes in soil
49	AS 6401	Knife gate valves for waterworks purposes
50	AS 60529	Degrees of protection provided by enclosures (IP Code)
51	AS ISO 7.1	Pipe threads where pressure-tight joints are made on the thread dimensions, tolerances and designation
52	HB 18 Series	Guidelines for third-party certification and accreditation
API, ASME, ASTM, BS, EN and ISO Standards		
53	API 598	Valve Inspection and Testing
54	ASME B16.5	Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard
55	ASME B31.3	Process Piping Code
56	ASME B36.19M	Stainless Steel Pipe
57	ASTM A193	Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
58	ASTM A194	Standard Specification for Carbon Steel, Alloy-Steel and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
59	ASTM D1785	Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120
60	ASTM D2466	Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
61	BS 5158	Specification for cast iron plug valves
62	BS 5353	Specification for steel plug valves
63	BS 6464	Specification for reinforced plastic pipes, fittings and joints for process plants
64	BS 7159	Code of practice for design and construction of glass-reinforced plastics (GRP) piping systems for individual plants or sites
65	BS EN 331	Manually operated ball valves and closed bottom taper plug valves for gas installations for buildings

Item	Document number	Title
66	BS EN 593	Industrial valves. Metallic butterfly valves
67	BS EN 1092	Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Steel flanges
68	BS EN 1983	Industrial valves. Steel ball valves
69	BS EN 10241	Steel threaded pipe fittings
70	BS EN 12266	Industrial valves. Testing of metallic valves. Tests, test procedures and acceptance criteria. Supplementary requirements
71	BS EN 13397	Industrial valves. Diaphragm valves made of metallic materials.
72	BS EN 16138	Industrial valves. Diaphragm valves of thermoplastic materials.
73	BS EN ISO 16135	Industrial valves. Ball valves of thermoplastic materials.
74	ISO 5208	Industrial valves – Pressure testing of metallic valves
75	ISO 5210	Industrial valves – Multi-turn actuator attachments
76	ISO 5211	Industrial valves – Part-turn actuator attachments
SafeWork Australia (and WorkSafe ACT) Codes of Practice		
77	Not provided	SafeWork Australia Code of Practice – Safe Design of Structures
78	Not provided	SafeWork Australia Guide for Safe Design of Plant
79	Not provided	SafeWork Australia Code of Practice – Managing Risks of Plant in the Workplace
WSAA codes and publications		
80	WSA 02	Gravity Sewerage Code of Australia
81	WSA 03	Water Supply Code of Australia
82	WSA 04	Sewage Pumping Station Code of Australia
83	WSA 201	Manual for the selection and application of protective coatings
Icon Water standards and work instructions		
84	SD Series Drawings	Standard Drawing Set
85	STD-SPE-C-001	Technical Specification – Civil and Structural
86	STD-SPE-C-004	Technical Specification – Survey and Tolerancing Requirements
87	STD-SPE-C-005	Technical Specification – Pipelines

Item	Document number	Title
88	STD-SPE-G-005	Supplement to WSA 201 Manual for the selection and application of protective coatings
89	STD-SPE-G-006	Approved Products List
90	STD-SPE-G-008	Technical specification - Design requirements for safe access, egress and working at heights
91	STD-SPE-G-010	Supplement to WSA 04 Sewage Pumping Station Code of Australia
92	STD-SPE-G-011	Supplement to WSA 02 Gravity Sewerage Code of Australia
93	STD-SPE-G-012	Supplement to WSA 03 Water Supply Code of Australia
94	STD-SPE-M-001	Technical Specification – Mechanical
85	STD-SPE-M-003	Technical Specification – Hydraulically Operated Automatic Water Control (Globe) Valves
86	STD-SPE-M-004	Compendium of Piping Specification Sheets
87	STD-SPE-M-005	Technical Specification - Penstocks
88	TB900-WI02	Treatment Valves and Piping Systems Identification
89	WI05.14.04	Engineering Asset Identification
90	WI07.1.1	Risk assessment tables

Note: Icon Water procedures and work instructions shall be provided, if required, on a project-by-project basis.

4.2 Governing Standard – AS 4041

Icon Water's "facilities" are to be considered a process environment and as such, the governing (i.e. "over-arching") standard which specifies the minimum requirements for the materials, design, fabrication, testing, inspection and pre-commissioning of pressure piping subject to internal pressure or external pressure is *AS 4041 Pressure Piping*. AS 4041 shall be complied with in its entirety with the following exceptions:

- **AS/NZS 4087 Flanges**: Clause 3.24.4.7 of AS 4041 discourages the use of AS/NZS 4087 PN14 and PN16 flanges. However, as per Australian water/wastewater industry standard practice, Icon Water allows the use of AS 4087 flanges for water-based fluids operating within a temperature range of 0 °C to 80 °C (depending upon flange material).
- **Metallic Piping Systems**: For metallic piping systems which require a detailed pipe stress analysis to be performed as part of the design and/or design verification process, the stress analysis requirements of ASME B31.3 Process Piping may be used in lieu of AS 4041 requirements. That is, the ASME B31.3 requirements for (i) pressure design (ii) sustained loading (iii) sustained plus occasional loading, and (iv) fatigue/flexibility analysis must be fully complied with. Note: This allows reputable, readily available pipe stress analysis software to be used for detailed pipe stress analysis tasks.
- **Plastic Piping to Australian Standards**: For plastic piping systems which are (i) manufactured to an Australian standard, and (ii) are used to convey raw water, potable water

or sewerage only, the relevant Australian standard(s) may be used in lieu of AS 4041 directly (e.g. *AS/NZS 2033 Installation of Polyethylene Piping Systems* in conjunction with *AS/NZS 4130 Polyethylene Pipes for Pressure Applications*). Note: With the exception of ABS, plastic piping manufactured to Australian standards shall not be used for the conveyance of chemicals – only metallic piping systems consisting of "listed materials and components" to AS 4041, or plastic pipe conforming to both ASME and ASTM specifications shall be used for chemicals.

- **Utilities Piping**: For piping used for the conveyance of potable water and sewage (i.e. "commercial plumbing") to and from administration buildings, workshops, safety showers and the like, the requirements of *AS 3500 Plumbing and Drainage* shall be applied in lieu of AS 4041. For the provision of fire water/systems, Australian standards such *AS 2419 Fire hydrant installations* and *AS 2118 Automatic fire sprinkler systems* shall apply in conjunction with AS 4041.
- **Welding**: Partial penetration welds for the joining of pipe and fittings etc. are prohibited unless written approval is obtained from the Icon Water Representative.

The piping specification sheets found in *STD-SPE-M-004 Compendium of Piping Specification Sheets* detail the specific requirements (as well as flange, gasket and bolting options) for each piping system and these specification sheets follow the requirements given above.

For fabrication, inspection and testing requirements to be specifically complied with in accordance with AS 4041, the "Class" of piping to AS 4041 must be determined. In order of "most harmful" to "least harmful", the four classes are Class 1, Class 2A, Class 2P and Class 3. For a particular fluid service, AS 4343 shall be used in conjunction with AS 4041 to first determine the Hazard Level and then secondly, the Piping Class. For all projects and all facilities, both the Hazard Level (to AS 4343) and the Piping Class (to AS 4041) shall be shown on a Piping Schedule (aka "Piping List") for all fluids with the exception of (i) untreated sewage (ii) raw water in an Icon Water bulk water main or dam installation, and (iii) potable-grade water.

4.3 The Use of WSAA Codes and other WSAA Publications

Unless specifically referenced by an Australian standard, and with the exception of *WSA 201 Manual for Selection and Application of Protective Coatings*, no WSAA code, product specification or other WSAA publication shall be used in-conjunction with this specification for design, selection, supply, installation, construction, testing, commissioning and hand-over purposes without the written approval of the Icon Water Principal Mechanical Engineer or their nominated representative.

5 General Requirements

This section details the general requirements for piping and valves.

5.1 Site Data

Refer to *STD-SPE-M-001* for basis of design related site data.

5.2 Asset Design Life

Refer to *STD-SPE-M-001* for asset design life requirements.

5.3 Operational Availability

Refer to *STD-SPE-M-001* for operational availability requirements.

5.4 Prohibited Materials

Refer to *STD-SPE-M-001* for a list of prohibited materials.

5.5 Work Health and Safety

Refer to *STD-SPE-M-001* for all work health and safety requirements.

5.6 Noise and Vibration

Refer to *STD-SPE-M-001* for noise and vibration requirements and limits.

5.7 Manual Handling

Refer to *STD-SPE-M-001* for manual handling requirements.

5.8 Standards, Codes and Industry Publications

All items designed, supplied and installed shall be new and in accordance with the requirements of:

- This specification
- The applicable Australian, US and international standards
- The WSAA publication titled *WSA 201 Manual for the Selection and Application of Protective Coatings* as amended by *STD-SPE-G-005*
- The relevant WorkSafe ACT, WorkCover NSW and SafeWork Australia codes of practice
- The relevant Icon Water Standards and Work Instructions

The work shall also comply with the requirements of all relevant legislation, bodies and codes.

All items shall be suitable for the purpose intended and shall be standard commercial items proven in actual service conditions in similar applications. Only manufacturers who are fully experienced, reputable and qualified in the manufacture of such items shall supply all items specified herein. All valves and ancillary items supplied shall have OEM spare parts readily available in Australia.

The vendor or contractor (as applicable) shall notify the Icon Water Representative of any ambiguity or discrepancy discovered. In the event of an ambiguity or discrepancy the Icon Water Representative shall direct the vendor or contractor as to the interpretation to be followed in carrying out the work.

Drawings are not to be scaled. Where any discrepancy exists between figured and scaled dimensions the figured dimensions shall prevail.

5.9 Protective Coatings

The following specifications shall be used for the preparation, application, testing and repair of protective coatings to all piping, valves and ancillary items:

- *WSA 201 Manual for Selection and Application of Protective Coatings*
- *STD-SPE-G-005*

The manufacturer's standard coating is not acceptable unless it is compliant with the above-mentioned documents or unless approved in writing by the Icon Water Principal Mechanical Engineer or their nominated representative.

5.10 Colour Coding

Colour coding shall be in accordance with the requirements of *STD-SPE-G-005*.

5.11 Labelling and Signage

5.11.1 Manufacturer's Nameplate

Manufacturer's nameplates shall be affixed to all valve actuators and specialty valves (e.g. control valves, pressure reducing valves, pressure sustaining valves, pressure relief valves and reduced pressure zone (RPZ) valves). The nameplate size, material and method of fixing shall be compatible with the actuator or valve material of construction and design life. The manufacturer's nameplate and method of fixing shall be designed to achieve the design life (i.e. it shall remain affixed and all information shall remain legible when clean).

The manufacturer's nameplate shall contain the following typical information as applicable:

- Manufacturer's company name
- Manufacturer's part number
- Manufacturer's serial number
- Nominal size
- Date of manufacture (i.e. month and year)
- Set pressure

5.11.2 Asset Identification Labelling

Valves and Actuators

Labels shall be affixed to actuators and valves in accordance with the specific requirements of Icon Water's Work Instructions *WI05.14.04 Engineering Asset Identification* and *TB900-WI02 Treatment Valves and Piping Systems Identification*.

Note: As per Icon Water Work Instruction *TB900-WI02 Treatment Valves and Piping Systems Identification*, asset identification numbers (i.e. valve numbers) are not required for manually-actuated valves of nominal sizes up to and including DN25.

Above-Ground and Exposed Pipework

The requirements for identification labelling are as follows:

a) All exposed and/or above-ground pipework shall be labelled in accordance with AS 1345 (as modified by this specification in Table 5.11.2.1).

b) For pipework exposed to direct sunlight, labelling shall be achieved by direct painting onto the pipe when pipework is sized DN250 or larger. Otherwise, self-adhesive labels which are warranted by the supplier as being long-life and UV resistant with a minimum average life of three (3) years when exposed to direct sunlight shall be used.

c) Pipe labels shall indicate the fluid and the direction of flow. Refer to Table 5.11.2.1 for specific requirements for common fluids found in Icon Water's facilities.

d) Labels shall be readily visible to the observer at walkway level.

e) Labels shall be located at no more than six (6) metre centres on straight runs; both sides of any wall, floor or partition through which the pipe passes; adjacent to any valve, branch line or control point and by any outlet.

f) Labels on adjacent multiple runs shall be aligned and located to be observable from one observation position.

g) Where required, hazardous and supplementary identification bands shall be placed at every pipe label.

h) Pipe labels shall be installed and checked prior to commissioning and any labels which are damaged or defective shall be replaced during commissioning but prior to project handover.

i) The identification text on pipe labels shall comprise capital letters with (i) 10 mm minimum text height for pipes up to and including DN25 (ii) 25 mm minimum text height for pipes within the range of DN32 to DN80, and (iii) 40 mm minimum text height for pipes DN100 and larger.

j) The pipe label background colour block shall not be less than 375 mm in length and shall be surrounded by a white border (except when direct painted and a white border is then not required). Directional arrows shall be placed at each end of the labels.

k) Identification markings on pipes with hazardous contents shall comply with clause 8.2 of AS 1345 if contaminated with ionizing radiation or if contaminated with biologically hazardous material. In all other cases of hazardous contents, identification markings shall be a band with equal width, alternate black (N61 to AS 2700) and yellow (Y14 to AS 2700) stripes applied all around the pipe at the pipe label. The width of the band shall be 75 mm.

l) Identification markings on pipes conveying potable water for human consumption shall have a supplementary band (B24 Harbour Blue to AS 2700) all around the pipe at the pipe label. The width of the band shall be 75 mm.

m) Pipe label colours shall be in accordance with Table 5.11.2.1. This table has been based upon AS 1345 but has been suitably modified to be consistent with the traditions used within Icon water facilities. This modified approach has been taken to avoid any confusion amongst existing operations and maintenance personnel which may in-turn lead to the introduction of a new hazard.

n) Colour banding shall be provided in accordance with the requirements of STD-SPE-G-005.

o) Specific piping P&ID line number labels are not a mandatory requirement for pipe runs which form an in-plant piping system unless requested as part of the project specific documentation package.

Buried Pipelines

Buried water, sewage and recycled water pipelines shall have continuous marking tape (in compliance with AS 2648) installed 150 mm above the pipe crown. Marker tape colours shall be “Green” for water; “Cream” for sewage and “Lilac” for recycled water. Refer to the Icon Water *Approved Products List* (*STD-SPE-G-006*) for further details.

Table 5.11.2.1 Pipe Identification Label Details for Common Fluids Used at Icon Water Facilities

Pipe Label Lettering (Pipe System Name)	AS 2700 Colours		
	Lettering	Background	Hazardous or Supplementary Band
AERATION AIR	WHITE	AQUA B25	NIL
AUXILIARY BASE	BLACK	LILAC P23	HAZARDOUS
DRY CHEMICAL SOLUTION	BLACK	LILAC P23	HAZARDOUS
INERT ASH	WHITE	BLACK	NIL
ALUMINIUM SULFATE	WHITE	GOLDEN TAN X53	NIL
ACID (AUXILIARY ACID)	BLACK	LILAC P23	HAZARDOUS
WET CHEMICAL (AUXILIARY CHEMIAL)	BLACK	LILAC P23	HAZARDOUS
FILTER BACKWASH AIR	WHITE	AQUA B25	NIL
FILTER BACKWASH WATER	WHITE	AQUA B25	NIL
COAGULANT AID SOLUTION			
CHANNEL AERATION AIR	WHITE	AQUA B25	NIL
CONDENSER COOLING WATER	BLACK	JADE G21	NIL
CARBON DIOXIDE	BLACK	SAND Y44	NIL
CARBON DIOXIDE SOLUTION	BLACK	SAND Y44	NIL
CARBON DIOXIDE GAS VACUUM	BLACK	GOLDEN YELLOW Y14	HAZARDOUS
CENTRATE	WHITE	GOLDEN TAN X53	NIL
CHLORINE GAS	BLACK	GOLDEN YELLOW Y14	HAZARDOUS
CITRIC ACID	BLACK	LILAC P23	HAZARDOUS S
CENTRATE TANK OVERFLOW	WHITE	GOLDEN TAN X53	NIL
CHLORINE SOLUTION	WHITE	BLACK	HAZARDOUS
CENTRATE SCUM	WHITE	GOLDEN TAN X53	NIL
CAUSTIC SODA	BLACK	LILAC P23	HAZARDOUS

Pipe Label Lettering (Pipe System Name)	AS 2700 Colours		
	Lettering	Background	Hazardous or Supplementary Band
CHLORINE VACUUM	BLACK	GOLDEN YELLOW Y14	HAZARDOUS
CLARIFIED WATER	BLACK	JADE G21	NIL
CHILLED WATER RETURN	BLACK	JADE G21	NIL
CHILLED WATER SUPPLY	BLACK	JADE G21	NIL
DOMESTIC WATER	BLACK	JADE G21	SUPPLEMENTARY
DEFOAMANT SOLUTION	BLACK	SAND Y44	NIL
DEWATERED SLUDGE	WHITE	BLACK	NIL
DEIONISED WATER	BLACK	JADE G21	NIL
EFFLUENT DRAIN	WHITE	BLACK	NIL
FOUL AIR	BLACK	SAND Y44	NIL
FLOOR DRAIN	WHITE	BLACK	NIL
FLOCCULANT	BLACK	SAND Y44	NIL
FLUORIDE	WHITE	MAGENTA P11	HAZARDOUS
FUEL OIL	WHITE	GOLDEN TAN X53	HAZARDOUS
FUEL OIL RETURN	WHITE	GOLDEN TAN X53	HAZARDOUS
FUEL OIL SUPPLY	WHITE	GOLDEN TAN X53	HAZARDOUS
SODIUM SILICOFLUORIDE SOLUTION (FLUORIDE SOLUTION)	WHITE	MAGENTA P11	HAZARDOUS
FIRE SERVICE WATER	WHITE	SIGNAL RED R13	NIL
FILTERED WATER	BLACK	JADE G21	NIL
FILTERED WASTE WATER	BLACK	JADE G21	NIL
GRIT OVERFLOW	WHITE	BLACK	NIL
GRIT	WHITE	BLACK	NIL
HYDRATED LIME POWDER	WHITE	BLACK	NIL

Pipe Label Lettering (Pipe System Name)	AS 2700 Colours		
	Lettering	Background	Hazardous or Supplementary Band
HYDROGEN PEROXIDE	WHITE	LILAC P23	NIL
HEAT RESERVOIR	BLACK	JADE G21	NIL
HOT WATER	BLACK	JADE G21	NIL
COMPRESSED HIGH TEMPERATURE AIR	WHITE	AQUA B25	NIL
DOMESTIC HOT WATER RETURN	BLACK	JADE G21	NIL
DOMESTIC HOT WATER SUPPLY	BLACK	JADE G21	NIL
COMPRESSED AIR INSTRUMENT	WHITE	AQUA B25	NIL
LIME AIR	WHITE	BLACK	NIL
LIME DELIVERY	WHITE	BLACK	NIL
LUBE OIL	WHITE	GOLDEN TAN X53	HAZARDOUS
LIME SLUDGE	WHITE	GOLDEN TAN X53	NIL
LIME SOLUTION	WHITE	GOLDEN TAN X53	NIL
LANDSCAPE IRRIGATION WATER	BLACK	JADE G21	NIL
METHANOL	BLACK	SAND Y44	HAZARDOUS
DILUTED METHANOL SOLUTION	BLACK	SAND Y44	NIL
MIXED LIQUOR RETURN	WHITE	GOLDEN TAN X53	NIL
MOTOR COOLING WATER	BLACK	JADE G21	NIL
NITROGEN	BLACK	SAND Y44	NIL
NUTRIENT WATER	BLACK	JADE G21	NIL
NON POTABLE WATER	BLACK	JADE G21	NIL
NON POTABLE WATER SPRAY	BLACK	JADE G21	NIL
PREAERATION AIR	WHITE	AQUA B25	NIL

Pipe Label Lettering (Pipe System Name)	AS 2700 Colours		
	Lettering	Background	Hazardous or Supplementary Band
POWDERED ACTIVATED CARBON	BLACK	WHITE	NIL
CATIONIC POLYMER	WHITE	BLACK	NIL
PRIMARY COAGULANT SOLUTION	WHITE	BLACK	NIL
PUMPED DRAINAGE	WHITE	GOLDEN TAN X53	NIL
POLYELCTROLYTE	WHITE	BLACK	NIL
PROPANE GAS	BLACK	GOLDEN YELLOW Y14	HAZARDOUS
PROCESS HOT WATER	BLACK	JADE G21	NIL
NON IONIC POLYMER	WHITE	BLACK	NIL
POLYMER POWDER	BLACK	GOLDEN YELLOW Y14	NIL
POTASSIUM PERMANGANATE	WHITE	LILAC P23	NIL
POTASSIUM PERMANGANATE SOLUTION	WHITE	LILAC P23	NIL
PROCESS SAMPLE	BLACK	JADE G21	NIL
POLYMER SOLUTION	BLACK	GOLDEN YELLOW Y14	NIL
POTABLE WATER	BLACK	JADE G21	SUPPLEMENTARY
RETURN ACTIVATED SLUDGE	WHITE	BLACK	NIL
RECLAIMED LIME	BLACK	SAND Y44	NIL
RECIRCULATED SLUDGE	WHITE	BLACK	NIL
RAW SEWAGE	WHITE	BLACK	NIL
RAW WATER	BLACK	JADE G21	NIL
RAINWATER LEADER	BLACK	JADE G21	NIL
RECLAIMED WATER	BLACK	JADE G21	NIL
COMPRESSED AIR SERVICE	WHITE	AQUA B25	NIL

Pipe Label Lettering (Pipe System Name)	AS 2700 Colours		
	Lettering	Background	Hazardous or Supplementary Band
SCUM THICKNER OVERFLOW	WHITE	BLACK	NIL
SANITARY DRAINAGE	WHITE	BLACK	NIL
SULFUR DIOXIDE GAS	BLACK	SAND Y44	HAZARDOUS
SULFUR DIOXIDE LIQUID	WHITE	LILAC P23	NIL
SECONDARY TREATED EFFLUENT	WHITE	BLACK	NIL
SCREENINGS	WHITE	BLACK	NIL
SODIUM HYPOCHLORITE	WHITE	LILAC P23	NIL
SIEVE LIQUID DISCHARGE	WHITE	BLACK	NIL
SECONDARY SCUM	WHITE	BLACK	NIL
SUBSOIL DRAINAGE	WHITE	BLACK	NIL
STORM WATER	WHITE	BLACK	NIL
STORM DRAIN	WHITE	BLACK	NIL
SCRUBBER WATER RETURN	WHITE	JADE G21	NIL
SCRUBBER WATER SUPPLY	WHITE	JADE G21	NIL
TANK DRAIN	WHITE	BLACK	NIL
TANK OVERFLOW	WHITE	BLACK	NIL
SUPERNATANT	WHITE	GOLDEN TAN X53	HAZARDOUS
THICKENER SLUDGE OR THICKENER UNDERFLOW	WHITE	GOLDEN TAN X53	HAZARDOUS
TREATED WATER	WHITE	JADE G21	NIL
UTILITY WATER	WHITE	JADE G21	NIL
VACUUM AIR	WHITE	AQUA B25	NIL
VENT	WHITE	BLACK	NIL
WASTE BACKWASH WATER	WHITE	JADE G21	NIL

Pipe Label Lettering (Pipe System Name)	AS 2700 Colours		
	Lettering	Background	Hazardous or Supplementary Band
WASTE ACTIVATED SLUDGE OR WASTE NITRIFIED SLUDGE	WHITE	BLACK	NIL
WASHWATER	WHITE	JADE G21	NIL
WASHWATER OVERFLOW	WHITE	JADE G21	NIL
WASTE WASHWATER	WHITE	JADE G21	NIL

5.11.3 Valve Operating Labels

Open/close (or on/off) position or direction of rotation shall be clearly shown for all valves and actuators in compliance with Icon Water's SD drawing series. Where operated by extension spindles or the like, position indicators shall be permanently fixed via fasteners or tack welds next to the point of operation.

5.11.4 Signage

All signs shall comply with Icon's SD series of standard drawings. Safety signage shall be provided in accordance with the relevant legislation, codes of practice and standards.

5.12 Approved Products

5.12.1 Requirements for Designers

Icon Water requires Designers to specify products and materials which are specifically listed in the Icon Water Approved Products List (*STD-SPE-G-006)*. Products and materials not specifically listed in the Icon Water Approved Products List shall not be specified by Designers unless written authorisation has been obtained from Icon Water. For most new facilities related projects or for major upgrades to existing facilities, Icon Water will provide a project specific list of products and materials to supplement the Icon Water Approved Products List. This will typically be provided early in the design phase of the project. Designers shall treat such a project specific list in the same way that they are required to treat the Icon Water Approved Products List. In some instances, the Designer will be free to nominate a particular product or material for review and acceptance by Icon Water.

Designers shall not use the words "or equivalent" in specifications or on drawings as Designers are required to specifically name the chosen product or material in sufficient detail so that it can be easily procured by the Contractor and easily checked for compliance by the Icon Water Representative during construction. Otherwise, if this cannot be done for some compelling reason, the words "or approved equivalent" shall be used.

5.12.2 Requirements for Contractors

Icon Water requires Contractors to construct in accordance with the project specific design documentation package which will include specifications and drawings. The Contractor shall only use products and materials specifically shown/detailed in the project specific drawings and specifications.

If the specifications and drawings do not nominate a product or material specifically (e.g. by make and model) then the Contractor shall refer to the Icon Water Approved Products List and only purchase and install a product or material specifically detailed in the Icon Water Approved Products List for the relevant product or material type. If the Approved Products List is "silent" then the Contractor shall contact the Icon Water Representative for a written instruction or review/approval of the Contractor's nominated product or material before proceeding with the related purchasing, fabrication or installation as applicable.

If the design drawings or specification show the words "or equivalent" when referring to a particular product or material, the Contractor shall treat this as an error on behalf of the Designer and shall interpret these words as "or approved equivalent". The words "or approved equivalent" indicate that the Contractor must use the product or material specifically nominated by the Designer unless a written approval is obtained from Icon Water prior to installation of an alternative product or material.

In the event that the Contractor installs an unapproved product, Icon Water shall consider this a defect and the Contractor shall be required to rectify such defects at their cost and to the satisfaction of the Icon Water Representative using approved products and materials. Rectification shall include but not be limited to complete removal of the product or material from the site and replacement with an approved product or material.

Icon Water is not obliged to provide retrospective approvals for unapproved products and materials already installed by the Contractor and is not obliged to provide any requested retrospective approval in a timeframe that suits the Contractor's project schedule.

The Contractor shall not be entitled to make a claim for delay or damages if they install an unapproved product or material which is rejected by Icon Water.

6 Design and Specification of Piping Systems

6.1 General

The details provided in Section 6 of this specification provide specific requirements which are reflected in the piping system specification sheets detailed in *STD-SPE-M-004.* The piping system specification sheets shall be complied with in their entirety. If however a piping system specification sheet is not available (e.g. a new fluid service is being introduced into Icon Water) or the piping system specification sheet is "silent" on a particular item then the details in Section 6 of this document shall take precedence.

6.2 Designer Qualifications and Experience

The designer of piping systems shall meet the qualification and experience requirements detailed in Table 6.2.1.

Table 6.2.1 Designer Requirements

Item	Piping System or Fluid Type	Designer Qualifications and Experience Requirements
1	Fluids deemed to be "NHL" or "NHG" to AS 4343 with a design temperature less than or equal to 65 °C and a design pressure less than or equal to 2100 kPa. Sewage and sewage sludge (all types and forms) with a design temperature less than or equal to 65 °C and a design pressure less than or equal to 2100 kPa.	The designer, or the engineer directly supervising the designer, must be degree or diploma qualified in mechanical, civil or structural engineering from an institution recognised by the Washington Accord and have at least five years previous experience designing similar piping systems.
2	All other fluid systems and types not included in Item 1.	The designer, or the engineer directly supervising the designer, must hold either (i) chartered (CPEng) status with Engineers Australia or (ii) chartered status with an international body that Engineers Australia deems to be equivalent (e.g. the Institution of Mechanical Engineers UK), or (iii) registered professional (RPEng) status with Professionals Australia. The engineer holding such status shall certify in writing that the design complies with the relevant codes, standards, legislative requirements and the requirements of this specification.

6.3 Piping Systems Related Drawings and Documentation

The designer shall produce piping related drawings and documentation in accordance with the requirements detailed in Table 6.3.1. Drawings and documentation shall also be required to comply with the relevant Icon Water standards (e.g. *STD-SPE-G-018 Drafting Standard).*

The requirements specified in Table 6.3.1 are minimum mandatory requirements. The designer shall use their experience and judgement to determine if additional drawing types, inclusions and documentation are/is required to fully describe the piping system so that it can be constructed, operated and maintained without ambiguity or unnecessary clarifications being asked of the designer during the tendering phase or construction phase of a project.

Table 6.3.1 Minimum Mandatory Requirements for Piping Systems Drawings and Documentation

Item	Drawing or Document Type	Minimum Mandatory Requirements
1	Process Flow Diagrams (PFD)	PFDs shall be produced (or updated as appropriate) for all new water treatment plant and sewage treatment plant designs as well as for major augmentations to existing water treatment plants and sewage treatment plants. Symbols shall comply with the Icon Water SD series of drawings.
2	Piping and Instrumentation Diagrams (P&ID)	P&IDs shall be produced (or updated as appropriate) for all new, augmented or upgraded: • Water treatment plants • Sewage treatment plants • Sewage detention facilities • Water pumping stations • Reservoirs • Sewage pumping stations • Chemical storage, handling and dosing systems • Odour control units • Piping systems conveying flammable, hazardous, harmful or harmful fluids Symbols shall comply with the Icon Water SD series of drawings.
3	Hydraulic Profile Drawings	Hydraulic profile drawings shall be produced (or updated as appropriate) for all new, augmented or upgraded: • Water treatment plants • Sewage treatment plants • Sewage detention facilities • Sewage pumping stations • Reservoirs and water pumping stations (if sectional elevation drawings depicting the levels nominated below are not provided) Hydraulic profile drawings shall depict: • Finished surface levels • Top-of-concrete for all buried maintenance structures detention tanks and the like • Pump start up, shut down and alarm levels • Fill and overflow levels • Pipe invert levels • Tank floor levels • Tank maximum storage levels • Gradient of all gravity flow lines • Pump (lowest) impeller centreline level for centrifugal pumps (which are not of the submersible type)

Item	Drawing or Document Type	Minimum Mandatory Requirements
4	Piping Layout Key Plan Drawings	Piping layout key plan drawings shall define the areas covered by each piping arrangement drawing. This drawing type shall be required to be produced for all new, augmented or upgraded: • Water treatment plants • Sewage treatment plants
5	Piping Plan Drawings (or General Arrangement)	Piping plans shall be produced for all piping systems regardless of facility type. This drawing type shall outline all piping, in-line equipment and instrumentation. Depending upon the complexity of the system and the available space on the drawing sheet, elevations and details may be produced on the same sheet. All pipe runs and equipment depicted on the piping plan drawing shall be labelled to match the P&ID. For simple piping systems, a general arrangement drawing may be produced in lieu of a piping plan drawing.
6	Pipework Sections and Elevations Drawings	Drawings depicting pipework in sectional views and elevation views which cross-reference the relevant piping plan (or general arrangement) drawing shall be produced if not already included on the piping plan drawing. All pipe runs and equipment depicted on the piping plan drawing shall be labelled to match the P&ID. Depending upon the complexity of the piping system and the available space on the drawing sheet, a pipework schedule (aka “list”) may be produced on the same sheet.
7	Piping Details Drawings	Individual items of pipework or pipework assemblies which cannot be adequately detailed for construction purposes by any other means (e.g. isometric drawings, piping specification sheets, piping schedule) shall be fully detailed on a piping details drawing. For simple piping systems, and where space permits, such piping details may be produced on the piping plan drawing or general arrangement drawing.
8	Piping Isometric Drawings	For complex and large piping systems such as those found in new or augmented water treatment plants and sewage treatment plants, piping isometric drawings shall be produced to provide a pictorial view of the true representation of the route of the pipework as well as the individual components and lengths to be used for fabrication and installation.

Item	Drawing or Document Type	Minimum Mandatory Requirements
		Piping isometric drawings shall include a materials list which details each piping component, the quantity required and the acceptance (e.g. hydrostatic) testing requirements.
9	Long Section Drawings	Long section drawings shall be provided for: • Sewage pumping stations for both the incoming gravity main and the rising main. The chainage length depicted for the incoming gravity main shall be long enough to ascertain whether or not the correct design levels have been used for the pump station wet well, collection maintenance hole and emergency storage tank. The chainage length depicted for the rising main shall be the full length of the rising main. • All buried pipelines when (i) the length of the pipeline exceeds 50 metres. Otherwise, individual sectional details of buried pipework shall be provided on the applicable general arrangement, details or sectional drawings. Long section drawings shall depict: • A plan view of the alignment overlaid on contours or aerial photograph (if not included on another drawing) • The finished surface levels along the pipeline alignment • The change in vertical grade along the pipeline alignment • The pipeline size (DN), material, PN or schedule and internal diameter along the pipeline alignment • The pipeline invert level along the pipeline alignment • The pipeline chainage to match the above-mentioned attributes at appropriately (evenly) spaced intervals so as to provide sufficient resolution in determining significant changes in grade, pipe type/size/material and other necessary construction features such as road crossings and other buried surfaces which need to be considered during construction and future operations/maintenance.
10	Symbol and Legend Drawings	The designer shall reference the relevant Icon Water SD series drawings for PFD and P&ID symbols. Should a symbol not be available in the Icon Water SD series drawing set which the designer wants to use, they shall contact the Icon Water Representative to gain approval prior to submitting the relevant drawings for their milestone reviews.

Item	Drawing or Document Type	Minimum Mandatory Requirements
11	Vendor Equipment Drawings	Where manufactured equipment is required to interface with or be included as part of a piping system, vendor equipment drawings shall be provided. Such drawings shall depict: • Nozzle size, type, connection (e.g. flange) standard • Nozzle position/orientation from a fixed datum • Allowable nozzle loads* • Overall equipment dimensions • Equipment assembled mass and the mass of any sub-assemblies • Equipment material(s) of construction • Hold-down bolting requirements (e.g. type, size, spacing) Note: * Allowable nozzle loads may be detailed on a separate data sheet rather than the vendor drawing as appropriate.
12	Piping Schedule (aka “Piping List”)	A piping schedule shall be produced for all project types. The piping schedule may be produced in one of two ways – either in drawing form, whether it be its own drawing or included on a plan, general arrangement or details drawing; or in MS Excel format as a spreadsheet list. Simple upgrade projects or minor works should only require a piping schedule to be produced as part of the drawing set. Complex projects such as the major augmentation or design of new water treatment plants and sewage treatment plants should have a piping schedule provided in MS Excel spreadsheet format. The piping schedule shall depict the following details: <u>Piping schedule* in drawing format</u>: • P&ID tag or item number** (as appropriate). • Icon Water piping specification sheet material code number, and/or a full description of each component which includes: size (DN), end connection type and standard, material of construction and standard, PN rating or Schedule (as appropriate) and length or face-to-face dimension (as appropriate) • Hazard Level to AS 4343 (for fluids meeting the requirements of clause 6.2 of this specification) • Piping Class to AS 4041 (for fluids meeting the requirements of clause 6.2 of this specification) * When the piping schedule is provided on a drawing rather than in MS Excel spreadsheet format, it may be combined with the valve schedule and equipment schedule as one complete list.

Item	Drawing or Document Type	Minimum Mandatory Requirements
		** The item number shall match the same reference on the isometric drawing and/or layout drawing and/or details drawing as appropriate. <u>Piping schedule in MS Excel spreadsheet format</u>: • P&ID tag • Icon Water Piping Specification Sheet Material Code Number • End connection type/details • To/from details • Design pressure • Design temperature • Acceptance (e.g. hydrostatic) test requirement • Hazard Level to AS 4343 (for fluids meeting the requirements of clause 6.2 of this specification) • Piping Class to AS 4041 (for fluids meeting the requirements of clause 6.2 of this specification)
13	Valve Schedule (aka “Valve List”)	A valve schedule shall be produced for all project types. The valve schedule may be produced in one of two ways – either in drawing form, whether it be its own drawing or included on a plan, general arrangement or details drawing; or in MS Excel format as a spreadsheet list. Simple upgrade projects or minor works should only require a valve schedule to be produced as part of the drawing set. Complex projects such as the major augmentation or design of new water treatment plants and sewage treatment plants should have a valve schedule provided in MS Excel spreadsheet format. The valve schedule shall depict the following details: <u>Valve schedule* in drawing format</u>: • P&ID tag or item number** (as appropriate). • A full description of each valve which includes: valve type, make/model or reference to the Icon Water Approved Products List (as appropriate), size (DN), end connection type and standard, material of construction and standard, manufacturing standard, PN rating or Class (as appropriate), face-to-face dimension (as appropriate), ancillary inclusion details such as handwheels, gearboxes, actuators, extension spindles etc. * When the valve schedule is provided on a drawing rather than in MS Excel spreadsheet format, it may be combined with the piping schedule and equipment schedule as one complete list.

Item	Drawing or Document Type	Minimum Mandatory Requirements
		** The item number shall match the same reference on the isometric drawing and/or layout drawing and/or details drawing as appropriate. <u>Valve schedule in MS Excel spreadsheet format</u>: • P&ID tag • P&ID line number • Valve type (e.g. globe, gate, ball, non-return) • End connection type/details • Applicable manufacturing/dimensional standard • Materials of construction • PN rating or class (as applicable) • Design operating pressure • Design operating temperature
14	Equipment Schedule (aka "Equipment List")	An equipment schedule shall be produced for all project types. The equipment schedule may be produced in one of two ways – either in drawing form, whether it be its own drawing or included on a plan, general arrangement or details drawing; or in MS Excel format as a spreadsheet list. Simple upgrade projects or minor works should only require an equipment schedule to be produced as part of the drawing set. Complex projects such as the major augmentation or design of new water treatment plants and sewage treatment plants should have an equipment schedule provided in MS Excel spreadsheet format. The equipment schedule shall depict the following details: <u>Equipment schedule* in drawing format</u>: • P&ID tag or item number** (as appropriate). • A full description of each item of equipment which includes: type, make/model or reference to the Icon Water Approved Products List (as appropriate), size/capacity, end connection types and reference to a data sheet or vendor drawing (as applicable) * When the equipment schedule is provided on a drawing rather than in MS Excel spreadsheet format, it may be combined with the piping schedule and valve schedule as one complete list. ** The item number shall match the same reference on the layout drawing, arrangement drawing and/or details drawing as appropriate.

Item	Drawing or Document Type	Minimum Mandatory Requirements
		Equipment schedule in MS Excel spreadsheet format: • P&ID tag • Equipment type (e.g. pump, compressor, blower) • End connection type/details • Size/capacity/kW rating • Reference to a datasheet or vendor drawing
15	Design Calculations and Models	The designer shall furnish any requested design calculations, analysis and modelling upon request from the Icon Water Representative.
16	Project Specification (and Scope of Work)	When requested as part of the designer's scope of work, the designer shall produce a specification customised for the project which is based on this specification, Icon Water's SD series of drawings and any other relevant Icon Water specifications. The inclusions of such a specification will be determined on a project-by-project basis but shall include: • Reference to this specification and other relevant Icon Water specifications • Reference to specific Icon Water SD series drawings • Project specific piping system requirements • Existing Icon Water WAX drawings (if applicable) • Contractor scope of works • Work by others or excluded from the contractor scope of work
17	Project Design Report	The designer shall provide a design report which meets industry accepted norms as well as meeting the Safework Australia and Worksafe ACT requirements for safety in design. That is, the designer shall inform Icon Water (and the constructor as appropriate) via the design report, all atypical hazards associated with the fabrication, construction, installation, commissioning, testing, operation, maintenance and demolition of the piping systems so designed. Mitigation measures to reduce the level of risk to as low as reasonably practicable shall also be provided.

P&ID Line Identification

Piping shall be designated by a two element code in accordance with Icon Work Instruction *TB900-WI02 Treatment Valves and Piping Systems Identification*. This code shall consist of:

- Nominal metric diameter (DN).
- An abbreviation indicating the service.

At the discretion of the designer, a third element may be shown on P&IDs which refers to the particular piping material specification. Examples of two and three element codes are as follows:

- An example of a two element code would be “150 AA”. This refers to a DN150 pipe for Aeration Air.
- An example of a three element code would be 150 AA (211). This refers to a DN150 pipe for Aeration Air constructed of materials and components which meet the requirements of Piping Specification Sheet 211.

6.4 Fluid Codes and Piping Specification Sheets

Fluid services are each identified by a two or three character code in accordance with the following table.

Abbreviation	Valve/Pipe System
AA	Aeration air
AUA	Auxiliary acid
AB	Auxiliary base
AD	Auxiliary dry chemical solution
AI	Inert ash
AS	Antiscalant
AL	Aluminium sulphate
AW	Auxiliary chemical
BA	Filter backwash air
BW	Filter backwash water
CAS	Coagulant aid solution
CA	Channel aeration air
CC	Condenser cooling water
CD	Carbon dioxide
CDS	Carbon dioxide solution
CDV	Carbon dioxide gas-vacuum

Abbreviation	Valve/Pipe System
CE	Centrate
CW	Clarified water
CG	Chlorine gas
CI	Citric acid
CN	Calcium Nitrate
CO	Centrate tank overflow
CL	Chlorine liquid
CS	Chlorine solution
CSC	Centrate scum
CV	Chlorine gas-vacuum
CT	Caustic soda (sodium hydroxide)
CWR	Chilled water return
CWS	Chilled water supply
DS	Defoamant solution
DSL	Dewatered sludge
DMW	Domestic water
DW	Deionised water
ED	Effluent drain
FA	Foul air exhaust
FCA	Furnace Combustion Air
FD	Floor drain
FE	Flocculant (Iron Salt)
FL	Fluoride
FOR	Fuel oil return
FOS	Fuel oil supply
FW	Filtered water
FS	Fluoride solution

Abbreviation	Valve/Pipe System
FO	Fuel oil
FSW	Fire service water
FWW	Filtered waste water
GO	Grit dewaterer overflow
GR	Grit
HLP	Hydrated Lime powder
HP	Hydrogen Peroxide
HR	Heat reservoir
HW	Hot water
HTA	Compressed air – high temp
HWR	Domestic hot water return
HWS	Domestic hot water supply
IA	Compressed air - instrument
LA	Lime air
LD	Lime delivery
LP	Lime powder
LSN	Lime solution
LW	Landscape irrigation water
LO	Lube oil
LS	Lime sludge
MW	Motor cooling water
ME	Methanol
MED	Diluted Methanol solution
MLR	Mixed liquor return
NG	Natural Gas
NT	Nitrogen
NU	Nutrient water

Abbreviation	Valve/Pipe System
NW	Non potable water
NWS	Non potable water spray
PAC	Powdered Activated Carbon
PC	Cationic polymer
PN	Non-ionic polymer
PP	Polymer powder
PCS	Primary coagulant solution
PPP	Potassium Permanganate powder
PPS	Potassium Permanganate solution
PS	Process sample
PSN	Polymer solution
PW	Potable water
PA	Pre-aeration air
PD	Pumped drainage
PE	Polyelectrolyte
PG	Propane gas
PHW	Process hot water
PSC	Primary scum
RW	Raw water
RWW	Reclaimed washwater
RAS	Return activated sludge
RL	Reclaimed lime
RS	Recirculated sludge
RSW	Raw sewage
RWL	Rainwater leader
RX	Reclaimed water
SA	Compressed air - service

Abbreviation	Valve/Pipe System
SD	Sanitary drainage
SSD	Sub soil drain
STD	Storm drain
SCO	Scum thickener overflow
SDG	Sulphur dioxide gas
SDL	Sulphur dioxide liquid
SE	Secondary treated effluent
SG	Screenings
SH	Sodium hypochlorite
SL	Sieve liquid discharge
SSC	Secondary scum
ST	Storm water
SW	Sample waste
SWR	Scrubber water return
SWS	Scrubber water supply
SWW	Settled wastewater
TD	Tank drainage
TO	Tank overflow
TS	Supernatant
TU	Thickener Sludge or thickener underflow
TW	Treated water
TSC	Thickened scum
VA	Vacuum air
VE	Vent
WBW	Waste backwash water
WAS	Waste nitrified sludge/Waste activated sludge
WW	Wash water

Abbreviation	Valve/Pipe System
WWO	Wash water overflow
WWW	Waste washwater
UW	Utility water

The Piping Material Specification Code (aka “Material Code”) is also given and refers to numbers identified as "Material Code” on the Piping System Specification sheets provided in *STD-SPE-M-004.* These sheets describe the materials and components to be used for a particular piping system deemed compatible with the particular fluid service.

It should be noted that the original LMWQCC material codes (circa. 1973) are numbered 1 through 38 inclusive. These codes are now out-of-date due to some of the standards which they refer to being superseded or the materials of construction being prohibited (e.g. asbestos gaskets). Icon’s position with regards to piping upgrades or augmentations at existing treatment plants such as LMWQCC, Googong, Mount Stromlo, Fyshwick and Uriarra is as follows:

- For repairs and minor modifications to existing pipework: A like-for-like replacement of piping materials and components shall occur. In situations where the material is no longer allowed (e.g. asbestos gaskets) the installation contractor shall seek clarification from the Icon Water Representative as to the correct choice of replacement material. In situations where the complying standard for a particular material has been superseded or withdrawn, the latest standard for compliance shall be used. It shall be the designer’s responsibility to select materials for use in the piping systems that are compatible with pressure, temperature and other service conditions given.
- For major upgrades and augmentations to existing pipework: The requirements of the relevant piping specification sheets (ref: *STD-SPE-M-004*) shall be complied with.
- For new plant or facility construction: The requirements of the relevant piping specification sheets (ref: *STD-SPE-M-004*) shall be complied with.

6.5 Design Pressures and Loads

All piping systems shall be designed to withstand the maximum internal and external pressures that may be expected to occur during commissioning, testing and all operating conditions such as but not limited to normal operation, start-up conditions, shut-down conditions, deluge, bypass and water hammer.

All piping systems, including supports and support structures, shall be designed to withstand the maximum loads that may be expected to occur during transportation, handling, installation, commissioning and all imposed conditions once in operation such as but not limited to dead loads, vibration, subsidence, earthquake and wind loads.

6.6 Design Temperature

All piping systems shall be designed for the full range of expected temperatures, both that of the fluid being conveyed as well as the external temperatures imposed.

All exposed (outdoor) piping systems of metallic construction for the conveyance of water-based fluids in sizes DN50 and below shall be insulated, and if deemed appropriate, heat-traced to prevent freezing. Similarly, fluid systems which are prone to freezing at ambient temperatures (e.g. caustic solution) shall be designed so that fluid is always flowing within the piping system, is continually agitated in a storage tank or vessel, and/or is insulated and/or heat traced to avoid freezing.

6.7 Non-Preferred Sizes

Water and Sewerage Network

DN200 and DN250 are prohibited from being used within the water network and sewerage network. However, within the scope of application of this specification, DN200 and DN250 are deemed to be non-preferred sizes rather prohibited sizes. This means that they may be specified by the designer if DN180, DN225 and DN300 are not appropriate for the particular application.

Metallic Piping

Metallic piping in sizes DN90, DN125 and DN550 shall not be used unless written permission is obtained from an Icon Water Principal Engineer.

Polyethylene Piping

PE100 piping in sizes DN75, DN110, DN140, DN160 and DN200 shall not be used unless written permission is obtained from an Icon Water Principal Engineer.

6.8 Materials of Construction – Specific Design Requirements

6.8.1 Steel – Carbon, Galvanised, Alloy and Stainless

Steel piping systems, whether they be carbon, galvanised, alloy or stainless, shall be designed in accordance with the requirements of AS 4041 as amended by Section 4.2 of this specification.

The designer shall consider the galvanic series and ensure that mixed metals interaction is avoided so as to prevent premature corrosion. The specification of flange insulation kits, rubber inserts/strips between the primary pipe support and the pipework itself, and the correct materials choice for valves should be carefully considered.

Steel piping systems may have welded or mechanically coupled or flanged end connections in any size. However, threaded connections are only permitted in sizes up to and including DN80.

Carbon steel pipe may be rubber lined or polyurethane lined when abrasive slurries and corrosive fluids are being conveyed. When designing rubber lined piping systems for abrasive slurries, consideration shall be given to the fluid velocity and hence the selection of suitable bend radii.

The minimum approved schedule for stainless steel pipe conforming to ASME B36.19 is Schedule 10S. However Schedule 10S shall not be used for piping systems that require threaded connections. Schedule 40S must be substituted in its entirety or via flanged spools when only a small number of threaded connections are required. Notwithstanding this requirement, the minimum approved schedule for pump station pipework for the main flow line is Schedule 40S.

Galvanised pipe shall only be specified for temporary services and for above-ground piping and risers as part of a facility's fire water service. With the exception of temporary services, galvanised steel pipe must be fabricated in plain carbon steel form and then hot-dip galvanised after fabrication. "Cold galvanising" is not approved for new installations involving hot-dip galvanised pipe.

All pipe welds shall be full penetration welds unless approval in writing is obtained from the Icon Water Representative.

Ductile Iron

Ductile iron pipes shall be internally cement lined and shall be in compliance with AS/NZS 2280. A seal coat shall be specified for the cement lining in potable water applications where detention times are calculated as being of such a duration to cause a change in the fluid pH due to leaching. Similarly, seal coats shall be specified when the fluid aggressivity warrants such use.

Ductile iron fittings shall be either FBE or Rilsan coated internally and externally and shall also comply with AS/NZS 2280.

Flanged pipe shall be Flange Class. Pipe supplied with socket and spigot ends shall be specified as PN35. Fittings shall be either PN16 or PN35 depending upon the application.

Polyethylene sleeving shall be applied externally for all pipe DN225 and larger when installed in buried applications unless (i) the manufacturer warrants that sleeving is not required based on soil resistivity testing either they or their nominated representative have conducted along the pipe route, or (ii) when specifically noted by Icon Water in the project documentation package.

6.8.2 Copper

Copper tubes shall be seamless, and designated Type B to AS 1432.

Copper and copper alloy fittings shall be in accordance with AS 3688.

Joints shall be made by either press-fit or brazing. Press-fit systems, and the tooling employed, are/is limited to those shown in the *Approved Products List STD-SPE-G-006*. Brazed joints shall only be made using silver brazing alloy complying with alloy designation B4 of AS 1167.1 Table 2.

The installation of copper piping systems shall be in accordance with AS 4809. In particular, copper pipes shall be protected from direct contact with dissimilar metals such as pipe hangers/clips or flange-to-flange connections with say steel or ductile iron. In such instances, rubber or PVC insulating strips (for hangers and clips) and flange insulating kits or “Copamate” flange adaptors (for flange-to-flange connections) shall be employed.

6.8.3 Polyvinyl Chloride (PVC)

PVC pressure pipes manufactured to Australian standards AS/NZS 1477, AS/NZS 4441, AS/NZS 4765 for PVC-U, PVC-O (Series 2 only) and PVC-M (series 2 only) respectively, shall only be specified for the conveyance of water and sewage and not for any other fluid. PVC pipes manufactured to the above-mentioned Australian standards shall be de-rated for temperature in accordance with PIPA 003 guidelines and shall be installed and tested in accordance with AS/NZS 2032 and shall have a minimum pressure rating for pressure piping systems of PN16.

PVC pressure pipes for applications other than the conveyance of water and sewage (e.g. chemicals) shall be specified to American standards (e.g. ASTM D1785) or ISO standards and de-rated for temperature in accordance with the manufacturer’s recommendations. PVC fittings to match American standard PVC pipe shall also be specified to American standards (e.g. ASTM D2466). Specific design may be conducted in accordance with the relevant sections of ASME B31.3 and installation and testing in accordance with AS/NZS 2032 as appropriate.

Regardless of whether or not the PVC pipe specified is in accordance with Australian or American standards, all PVC pipe exposed to direct sunlight in an outdoors environments shall be painted in accordance with coating system specification “ACL” (acrylic latex) to *WSA 201 Manual for the selection and application of protective coatings* as amended by STD-SPE-G-005. Unless noted otherwise in the project specific documentation, PVC piping installed within an indoor environment not in direct sunlight need not be painted unless deemed necessary for aesthetic reasons.

When specifying stub flanges with loose backing rings, stainless steel 316 backing rings shall be selected for piping exposed to environments deemed to be “High”, “Immersion” or “Extreme” in accordance with Table 2.1 Exposure Class Details of *WSA 201 Manual for the selection and application of protective coatings*. Otherwise, hot-dip galvanised backing rings may be used.

For PVC pipe specified to American standards, jointing shall be achieved through solvent cementing only. Threaded fittings (up to and including DN50) and flanged end fittings may be solvent cemented to the pipe. There are no limitations (other than what the manufacturers can offer to the market) on end connection types for PVC pipe manufactured to Australian standards.

For DN80 and above, any pipe support other than a continuous support shall provide a bearing surface of 120° under the base of the pipe. The designer shall determine whether rubber strips need to be installed between the support and the pipe to avoid chafing damage to the pipe.

PVC shall not be used for construction of the main flow line within valve chambers.

PVC shall not be used for construction of pump manifolds or for pipework directly connected to pumps of compressors or any other equipment driven by rotational or translational motion unless (i) the pumps are classified as “dosing pumps” or (ii) the fluid being conveyed is incompatible with metallic pipe systems and the use of suitably lined metallic pipe is not cost effective.

PVC for gravity sewerage applications shall be specified in accordance with AS/NZS 1260 and shall have a minimum stiffness rating of SN10 for pipes up to and including size DN100, otherwise the minimum stiffness rating shall be SN8. Jointing may be by either rubber ring joints or solvent cement joints.

For systems which will experience low frequency, high amplitude pressure cycling, the designer shall take into consideration the fatigue response of the material and select the most appropriate PN rating based on not just the design pressure but also the number of fatigue cycles.

6.8.4 Polyethylene

Polyethylene piping systems shall utilise compound PE100 and be constructed of fittings and pipe complying with AS/NZS 4129 and AS/NZS 4130. Carbon steel, FBE or Rilsan coated ductile iron or stainless steel fittings may also be utilised for polyethylene piping systems provided that corrosion/erosion will not negatively impact the design life.

For polyethylene pressure piping systems which will experience long term exposure to direct sunlight, designers shall specify polyethylene which is coextruded with a white outer sheath (aka “white poly”) so as to reduce the amount of de-rating required for temperature.

PN8 (SDR 21) is the minimum allowable nominal pressure rating (diameter to thickness ratio) for gravity flow systems. PN16 (SDR 11) is the minimum allowable nominal pressure rating (diameter to thickness ratio) for pressure piping systems.

Polyethylene pipe and fittings shall be de-rated for the Mean Wall Thickness Temperature (MWTT) in accordance with AS/NZS 2033. Similarly, polyethylene fabricated fittings shall be de-rating in accordance with either the manufacturer’s recommendations, or, if the manufacturer is “silent” on such de-rating provisions, then de-rating shall be in accordance with PIPA guidelines.

Polyethylene pipe for above-ground applications shall be either continuously supported (preferred) or with support spacings which comply with the requirements of Table 6.1 of AS/NZS 2033. All other installation and testing details shall be specified by the designer to be in accordance with AS/NZS 2033 unless noted otherwise in this specification. The designer shall determine whether rubber strips need to be installed between the support and the pipe to avoid chafing damage to the pipe.

The location and type of support selected must take into account provision for thermal movement. If the supports are to resist thermal movement, an assessment of the stress induced in pipes, fittings and supports may need to be made.

Screwed compression fittings shall not be used for anything other than temporary piping systems unless written approval is obtained from the Icon Water Principal Mechanical Engineer or their nominated representative. End connections shall either be as detailed in Table 6.9.5.2.

When specifying stub flanges with loose backing rings, stainless steel 316 backing rings shall be selected for piping exposed to environments deemed to be “High”, “Immersion” or “Extreme” in accordance with Table 2.1 Exposure Class Details of *WSA 201 Manual for the selection and application*

of protective coatings as well as all buried applications. Otherwise, hot-dip galvanised backing rings may be used.

Polyethylene shall not be used for construction of the main flow line within valve chambers.

Polyethylene shall not be used for construction of pump manifolds or for pipework directly connected to pumps or compressors or any other equipment driven by rotational or translational motion.

For systems which will experience low frequency, high amplitude pressure cycling the designer shall take into consideration the fatigue response of the material and select the most appropriate PN rating based on not just the design pressure but also the number of fatigue cycles.

Table 6.9.5.2 Allowable End Connection Types for Polyethylene Piping Systems

Item	End Connection Type	Allowable Applications
1	Screwed compression fittings	Temporary water supplies only unless written approval is obtained from the Principal Mechanical Engineer or their nominated representative.
2	Butt-weld	All applications with the limitation that butt welding shall not be conducted in trenches (i.e. polyethylene shall be pre-strung by butt-welding outside of the trench first).
3	Electrofusion couplings	Above ground applications without limitation. Below ground applications when no other means is available to provide a final joint closure.
4	Mechanical (restrained) couplings	Below ground applications when butt welding or butt-welding stub flanges (for flanging) cannot practicably be pre-installed prior to performing a final joint closure.
5	Flanging (via butt-welded stub flanges)	All applications without limitation .

Note: With the exception of screwed connections in other piping materials up to and including DN80, Icon Water only permits valves with flange-flange end connections or for fitting between flanges (e.g. wafer-lug) as a mandatory requirement.

6.8.5 Acrylonitrile Butadiene Styrene (ABS)

ABS pressure pipes and fittings shall comply with AS/NZS 3518 and shall be of series 1 dimensions and compound class ABS160 only.

ABS pipes and fittings shall be de-rated for temperature in accordance with the manufacturer's recommendations.

Installation of ABS piping systems shall be in accordance with AS/NZS 3690.

The minimum nominal pressure rating of ABS pipes and fittings shall be PN15.

ABS pipe exposed to direct sunlight in an outdoors environment shall be painted in accordance with coating system specification "ACL" (acrylic latex) to *WSA 201 Manual for the selection and application of protective coatings* as amended by STD-SPE-G-005. ABS piping installed within an indoor environment not in direct sunlight need not be painted.

Jointing shall be achieved through solvent cementing only. Threaded fittings (up to and including DN50) and flanged end fittings may be cold solvent welded.

When specifying stub flanges with loose backing rings, stainless steel 316 backing rings shall be selected for piping exposed to environments deemed to be “High”, “Immersion” or “Extreme” in accordance with Table 2.1 Exposure Class Details of *WSA 201 Manual for the selection and application of protective coatings*. Otherwise, hot-dip galvanised backing rings may be used.

For sizes DN80 and above, unless the pipe is continuously supported, all pipe supports should provide a bearing surface of 120° under the base of the pipe. The designer shall determine whether rubber strips need to be installed between the support and the pipe to avoid chafing damage to the pipe.

ABS shall not be used for construction of the main flow line within valve chambers.

6.8.6 Glass Reinforced Plastic (GRP)

GRP pipes and fittings which are to be used for the conveyance of potable water, drainage and sewage shall comply with the AS 3571 series of Australian standards. For the conveyance of other fluid types, the designer shall nominate a suitable international standard for approval by the Icon Water Principal Mechanical Engineer or their nominated representative prior to commencing design work.

The designer shall ensure that the correct resin type, internal/external corrosion barriers and pipe manufacturing requirements are specified when conveying fluids other than potable water, drainage and sewage and the designer shall base such requirements on BS 6464.

Pipe supports should provide a bearing surface of 120° under the base of the pipe. The designer shall determine whether rubber strips need to be installed between the support and the pipe to avoid chafing damage to the pipe.

Buried GRP pipe for waterworks purposes shall be installed in accordance with AS/NZS 2566. Above-ground GRP for anything other than fluids determined to be “NHL” to AS 4343 shall be installed in accordance with the manufacturer’s recommendations and BS 7159.

6.9 Flanges

6.9.1 Types and Standards

Table 6.8.1.1 details the allowable complying standards for flanges. For specific application details, refer to *STD-SPE-M-004.* AS/NZS 4087 is the default flange standard for use within the Icon Water asset base for water-based fluids and raw sewage unless detailed otherwise in Table 6.8.1.1.

Table 6.8.1.1 Requirements for Flanges – Complying Standards

Item	Flange Standard	Applications and Details
1	AS/NZS 4087	With the exception of above-ground piping located within the boundaries of a water treatment plant or sewage treatment plant, AS/NZS 4087 PN16 flanges shall be used for fluids within a design temperature range between 0 °C to 80 °C that are primarily water-based or sewage-based with a design pressure less than or equal to 1600 kPa. Higher nominal pressure ratings such as AS/NZS 4087 PN35 shall be used when the design pressure warrants such use and the design temperature is between 0 °C to 80 °C.

Item	Flange Standard	Applications and Details
2	AS 2129	Shall be used for: • Piping located within the boundaries of a water treatment plant or sewage treatment plant. • Any water-based or sewage applications which are not within a design temperature range of 0 °C to 80 °C. • For fluids which are not primarily water-based (e.g. chemicals, lubricants, diesel, gas, compressed air) regardless of the design temperature. • Situations when equipment or flanged piping is not able to be procured with AS/NZS 4087 connecting flanges.
3	ASME B16.5	Shall be used when mating to specialty mechanical equipment or process equipment supplied with ASME B16.5 flanges (when such flanges cannot be supplied with AS/NZS 4087 or AS 2129 dimensions and drilling patterns).
4	Other	Other flange standards such as EN, AWWA, ISO and JIS shall not be used without the written approval of the Icon Water Principal Mechanical Engineer or their nominated representative. In particular, flanged valves with EN 1092 drilling patterns, whilst somewhat compatible in some sizes and some PN ratings with AS 4087 and AS 2129 flanges, must have additional written approval.

AS 2129 flanges may be mated with compatible AS/NZS 4087 flange drilling patterns. However, the pressure rating shall be reduced to the lowest of the two flange ratings. For example, an AS 2129 Table E flange mated to an AS/NZS 4087 PN16 flange at a design temperature of 20 °C shall result in a flange rating of 1400 kPa (i.e. the rating of the AS 2129 Table E flange).

All flanges shall be specified as being circular unless written approval is obtained from the Icon Water Principal Mechanical Engineer or their nominated representative.

Upon installation, flange bolt holes shall straddle flange vertical and horizontal centrelines.

Raised face flanges shall be used for all metallic piping materials except when mating to flat face cast iron equipment flanges or flat face plastic piping flanges. In such instances, a flat face to flat face mating configuration shall be employed. Note: This may require the raised face portion of a steel pipe flange to be machined flat.

The selection/use of weld neck, slip-on, screwed and loose backing ring flanges shall be as specified for the particular application in *STD-SPE-M-004.*

When loose backing rings are specified for plastic piping, they shall be of stainless steel 316 when used in conditions categorised as “High”, “Immersion” or “Extreme” to Table 2.1 (Exposure Class Details) of *WSA 201 Manual for the selection and application of protective coatings*. Otherwise, hot dip galvanised backing rings are acceptable.

When loose backing rings are specified for stainless steel piping, stainless steel shall be the default flange material. However, hot dip galvanised backing rings are preferred for dry environments not deemed to be particularly aggressive as the use of hot dip galvanised bolting is preferred by Icon Water maintenance staff. As at the time of drafting this specification, hot dip galvanised backing flanges are used on stainless steel pipework for the vast majority of applications at Mount Stromlo Water Treatment Plant and for indoor-located blower pipework at LMWQCC.

UniFlanges, Adapta-Flanges or similar joints secured by set screws are not acceptable unless written approval is obtained from the Icon Water Principal Mechanical Engineer or their nominated representative. It should be noted that such approval will not be forthcoming unless the application involves an upgrade/augmentation of an existing asset and no other option is practicable with regards to a final end connection detail.

Where radiographic inspection is required for the purposes of verifying fabrication and installation integrity or for ongoing operational condition assessments, weld-neck flanges shall be used.

Welded steel plate flanges shall not be used in size where the flange thickness is less than 12 mm. In such instances, boss flanges (slip-on) or weld neck flanges shall be used.

6.9.2 Flange Gaskets and O-Rings

The gasket and/or O-ring material shall be suitable for contact with the fluid being conveyed, the operating conditions and the environment.

Gasket materials/types shall be limited to the selections provided in Table 6.10.2.1 so as to reduce the stock-holding requirements by Icon Water. Additional materials/types shall not be used unless written approval is obtained from the Icon Water Principal Mechanical Engineer or their nominated representative.

Table 6.10.2.1 Approved Flange Gasket Materials/Types

Item	Gasket Material/Type
1	EPDM rubber, black, full face, 3.0 mm thickness
2	Compressed aramid fibre with nitrile binder (or non-Asbestos fibre), 1.5 mm thickness
3	PTFE (aka “Teflon”), 1.5 mm thickness
4	Spiral wound with stainless steel 316 winding, graphite filler and carbon steel outer ring to suit ANSI/ASME Class 150 and Class 300 flanges

All gaskets for raw sewage, potable water and raw water shall be supplied and installed in accordance with AS 1646.

For all flanges of size less than or equal to DN600 and with a nominal pressure rating less than or equal to 1600 kPa (e.g. AS/NZS 4087 PN16, AS 2129 Table D, AS 2129 Table E etc.) a single 3 mm thickness EPDM rubber gasket shall be inserted between each pair of mating flange faces when the fluid service is (i) water-based (ii) within an ambient temperature range of 0 °C to 80 °C, and (iii) free of chemicals which are incompatible with EPDM.

For ductile iron or steel flanges with a nominal pressure rating greater than 1600 kPa or for AS/NZS 4087 PN16 flanges larger than DN600, a single 1.5 mm thickness non-asbestos compressed fibre gasket shall be inserted between each pair of mating flange faces when the fluid service is (i) water-based (ii) within an ambient temperature range of 0 °C to 80 °C and (iii) free of chemicals which are incompatible with compressed fibre.

For flanges which are for a chemical service or contain chemical additives or contaminants, the gasket material must provide excellent compatibility with the fluid for the life of the piping system. PTFE shall be the default gasket material unless it is incompatible with the fluid service and in such instances other gasket materials such as Viton may be selected as appropriate based on a written approval from the Principal Mechanical Engineer or their nominated representative.

Spiral-wound gaskets shall be selected for high temperature and high pressure services as appropriate.

Where gaskets are required for flat-faced flanges, a full-face gasket shall be used of a type to match the drilling of the connecting flanges.

Insertion rubber gaskets are strictly prohibited.

6.9.3 Flange Bolting

Refer to *STD-SPE-M-001* for general mechanical equipment (not flange) bolting requirements.

Hot-dipped galvanised bolts shall be AS 1110 property class 4.6 for AS/NZS 4087 PN16 flanges in sizes up to and including DN600 or AS 1110 property class 8.8 for AS/NZS 4087 flanges of ratings greater than PN16 or for PN16 flanges in sizes larger than DN600. Similarly, A4-50 and A4-70 stainless steel 316 bolts shall be used for AS/NZS 4087 PN16 flanges (up to and including DN600) and AS/NZS 4087 flanges with ratings greater than PN16 (or PN16 in sizes greater than DN600) respectively if hot-dipped galvanised bolts are not appropriate. Refer to Table C1 of AS/NZS 4087 for more detailed requirements for bolting of AS/NZS 4087 flanges which shall be complied with.

When galvanised bolts are used, they shall be specified with extra clearance to take into account the coating thickness.

Hot-dipped galvanised bolts shall not be specified for use with incompatible materials such as stainless steel flanges.

The use of high strength bolts to AS 1252 is strictly prohibited for flange bolting due to the oversized head which can cause "fouling" with pipe welds or valve bodies.

ASTM A194 Grade 2H stud bolts shall be specified in-conjunction with ASTM B16.5 carbon and alloy steel flange bolting.

ASTM A193 Grade B7 stud bolts shall be specified in-conjunction with ASME B16.5 stainless steel bolting.

AS 1110 property class 4.6 bolts shall be specified for use with AS 2129 Table D and E flange types when EPDM rubber gaskets are used. AS1110 property class 8.8 bolts shall be specified for use with AS 2129 Table F and H flanges. When stainless steel bolting is required, substitute AS 1110 property class 4.6 bolts with A4-50 stainless steel 316 bolts and substitute AS 1110 property class 8.8 bolts with A4-70 stainless steel 316 bolts.

AS 2528 studbolts may be specified in lieu of AS 1110 bolts for services involving high temperature and high pressure.

AS 1110 Grade 4.6 bolts shall utilise AS 1112 Grade 5 nuts. AS 1110 Grade 8.8 bolts shall utilise AS 1112 Grade 8 nuts.

Refer to Table A1 of AS 2129 for more detailed requirements for bolting of AS/NZS 2129 flanges; these requirements shall be complied with.

Black bolts shall only be used when replacing black bolts in existing assets. The designer shall consider the specification of longer bolts which can have threaded zinc anodes attached hand-tight for the purposes of increasing the design life in environments where corrosion issues have previously led to premature bolt replacement or severe flange degradation. When black bolts are replaced in below ground installations, they shall be coated with an approved petrolatum primer, mastic and petrolatum based tape for corrosion protection purposes.

Flange jointing sets shall include all bolts, nuts, washers and flange gaskets or insertions necessary for joining together the flanges of the specific diameter and pressure rating.

Washers shall be specified under all nuts. In addition, washers shall be specified under bolt heads for connection to items with protective coatings.

Where dissimilar metals would otherwise be in contact, insulating washers and sleeves detailed in *STD-SPE-G-006 Approved Products List* shall be specified for all connections.

Bolts shall be specified to the nearest standard length with a minimum of two threads projecting and a maximum of 5 threads projecting.

Threaded End Connections

Threaded end connections shall only be specified for the materials noted in this specification for sizes up to and including DN80. If a threaded end connection is specified, it shall be BSP taper in accordance with AS ISO 7-1.

6.10 Pipe Couplings, Unions and Dismantling Joints

Pipe couplings, unions and dismantling joints shall be specified to allow for ease of installation and removal of plant or equipment without the need to disturb adjacent pipework, or to fully-dismantle individual sections of pipework.

Pipe couplings and dismantling joints shall be of the fully-restrained (thrust) type for all applications other than direct buried applications. For metallic piping systems, restraint shall be provided via flanging and tie-rods or via lugs welded to the pipe either side in-conjunction with tie rods. Gripping teeth or gripping rings incorporated into pipe couplings (e.g. “Hawle” or “Teekay”) are acceptable for plastic piping systems as a means of providing restraint but they are not acceptable for metallic piping systems without the written approval of the Icon Water Principal Mechanical Engineer or their nominated representative. Note: The use of non-axially restrained joints can be a safety issue when pipework is dismantled and specific isolations need to be performed prior to maintenance action.

Couplings, unions and dismantling joints shall achieve their pressure rating in the assembled condition.

Where angular or lateral pipe loads are experienced, these shall be appropriately restrained using pipe supports or other restraint systems.

Victaulic couplings may be used for restrained pipe coupling. They shall be installed so that a minimum gap of 3 mm is left between adjacent pipe ends to allow for expansion. The seals shall be selected for the service required. Victaulic couplings on steel pipe may be of either the rolled grooved type or shouldered type. Machined grooved-types are not acceptable.

6.11 Expansion Joints and Flexible Rubber Couplings

Where pipework is exposed or subjected to temperature variations, the installation shall include expansion loops, braided stainless steel hose, reinforced “mining” hose or expansion joints to take account of thermal expansion.

Expansion joints as well as associated anchors and guides shall work as a complete system and shall be as recommended by the expansion joint manufacturer to accommodate movement due to the thermal and/or operational loads.

The materials of construction shall be compatible with the relevant pipework and equipment, material to be conveyed and the environmental conditions. Metal bellows shall be specified with flanges suited to the body of the joint, and tied or hinged where required.

Expansion joints shall not be used to correct pipe misalignment. Pipework adjacent to the expansion joint shall be adequately supported and restrained for the intended service and shall not rely on the expansion joint to provide such support/restraint other than that required to compensate for intended movement(s).

Braided stainless steel hose, reinforced “mining” hose or flexible rubber couplings shall be specified for pipework where vibration, differential settlement or loading may be a problem. Flexible rubber couplings shall meet the following requirements:

a) Flexible rubber couplings for suction and discharge connections to mechanical equipment shall have integral rubber flanges. They shall have individual solid steel ring reinforcement with a carcass of high grade woven synthetic fibre.

b) Couplings shall be single arch, and shall be equipped with galvanised steel split flange retaining rings. Couplings shall have filled arches if used on sludge pipelines. Couplings shall be selected to match piping and/or equipment connections size and meet the operating conditions.

c) Flexible rubber couplings installed adjacent to a wafer type or other through-bolted type valves or fittings shall be equipped with a steel spacer flange to prevent distortion of the rubber coupling flange. Tie rods (or control units) consisting of at least two bolts shall be provided where necessary to limit extension of the coupling.

6.12 Filters

Filters shall be designed and specified to operate satisfactorily over the full range of flows, pressures and concentrations in all climatic conditions.

Filter units shall be provided for removing fine particulates from air (and other gases) or liquid streams.

Filter elements shall be fitted in housings which shall allow even flow across the filter area while providing ease of access for replacement of the filter elements. Replacement of elements shall be possible without the use of special tools.

The filter units shall have provision for fitment of a differential pressure gauge or switch. A gauge shall provide an indication of filter blockage and a switch shall provide an alarm.

6.13 Strainers

Strainers shall be designed and specified to operate satisfactorily over the full range of flows, pressures and concentrations in all climatic conditions.

Strainers shall be provided for screening of fluids to the required particle size. Y-strainers shall be specified when low concentrations of particles are expected. Basket strainers (aka “dirt boxes”) shall be specified when medium to high concentrations of particles are expected or when a longer duration between cleaning/flushing cannot be avoided (e.g. a remote site).

A means of de-pressurising and draining the strainer shall be provided.

All components shall be specified with lifting lugs if they have to be lifted by crane or other mechanical lifting equipment for installation or maintenance as per the specific requirements of *STD-SPE-M-001*. Appropriate handles shall be specified where components are to be designed to be handled by personnel.

The equipment supplied shall be designed such that safe and easy access can be provided for inspection, maintenance and removal of all equipment. Sufficient supports shall be provided to enable one strainer to be maintained in-situ or removed for maintenance without disrupting the operation of the system.

6.14 General Piping Arrangement and Requirements – Above and Below Ground

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

Pipework subject to blockages shall 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.

The high points of all pipes routes shall have provision for venting entrapped air.

Pipework shall be arranged in such a way that access to all parts of the plant is not impeded. This means that all pipe runs shall be along walls, or at a height of 2.1 metres or more above floor level, or in pipe trenches and pits in the floor. Where installed at heights less than 2.1 metres above floor level, adequate stairs (or ladders) and platforms shall be provided to provide access over the pipes and to both sides of each pipe. Other options shall be subject to the acceptance of the Icon Water Representative.

Pipes under roads shall be designed and constructed to withstand the traffic loading. Wherever possible all pipework shall be graded to have a constant slope, with no high or low points.

The minimum cover for buried pipelines not subject to vehicular loads shall be 600 mm in non-trafficable areas and pipelines under roads shall be 900 mm unless concrete encasement is used. If concrete encasement is used, a thickness of 150 mm shall be specified as an absolute minimum. Specific design shall be undertaken for the selection of the embedment material, in accordance with AS 2566.2 (or AS/NZS 3725 for reinforced concrete pipes).

If the designer specifies that any steel pipeline be protected by a cathodic protection system, the detailed design and construction of the cathodic protection system shall comply with the requirements of AS 2832.1, AS 2239 and AS 4832.

Anchor block and thrust block design shall proceed with the minimum required bearing area at each thrust block location being determined from the maximum design pressure for the pipework (including surge) and the maximum allowable lateral bearing capacities given in the geotechnical report.

6.15 Pipe Racks and Supports

Should “off-the-shelf” proprietary supports or support structures not be readily available or appropriate for the application, then these items shall be purpose-designed in accordance with (i) the AS/NZS 1170 series of standards, and (ii) either *AS 3990,* or *AS 4100*. Pipe and valve supports must also meet the requirements specified in *AS 4041*.

Supports and support structures for piping and valves shall be fabricated, assembled and installed to meet the requirements of *STD-SPE-M-001* as well as this specification. Note: The Icon Water standard (SD series) drawing set already has a number of pre-designed supports which should be reviewed for their appropriateness prior to either purchasing “off-the-shelf” proprietary supports or purpose-designing new supports.

Piping shall be properly supported on racks or by anchor brackets, saddles or concrete supports. In no case shall the support spacing exceed (i) the support spacing for steel pipe detailed in Table 3.28.2 of AS 4041 (ii) the support spacing for copper, copper alloy and PVC-U given in AS 3500 (iii) the support spacing for polyethylene pipe detailed in AS/NZS 2033, or (iv) the pipe manufacturer’s recommended spacing for pipe materials not covered by points (i) through (iii) inclusive above.

Hangers, supports or pipe racks shall be provided in each direction and at each change in direction.

The designer shall specify either stainless steel 316 or FRP for operating environments deemed to be “High”, “Immersion” or “Extreme” in accordance with Table 2.1 Exposure Class Details to *WSA 201 Manual for the selection and application of protective coatings*. Otherwise, hot dip galvanised steel may be used as a material for pipe supports. Regardless of the material of construction chosen, the designer shall specify appropriate isolating materials (e.g. rubber, PVC or PE strips) between the primary support and the pipe to avoid galvanic corrosion due to mixed metals interaction.

6.16 Valves – Design and Selection Requirements

6.16.1 General

The number of different types and makes of valves used shall be kept to a minimum. All valves of the same size, duty and type shall be identical.

For valves up to an including DN80, either threaded BSP outlets or flanged valves shall be specified. Otherwise, for valves of sizes larger than DN80, only flanged outlets shall be specified. The specification of socket, spigot or Victaulic-type end connections is not acceptable.

For water and sewage services, valves shall be designed and manufactured in accordance with the latest editions of the relevant Australian standards. For other services, Australian standards shall be used where applicable. If an Australian standard is not applicable or is not an industry norm, the following standards may be specified (which are listed in order of preference): ASME, ISO, BS, and EN.

All parts of valves shall be suitable for the design and maximum (emergency) flows, pressures and temperatures and other duty conditions.

The designer shall select valve materials best suited for the service conditions and resistant to corrosion.

The designer shall select materials to ensure that the galvanic potential between adjacent parts does not exceed 300 mV. Where necessary, parts shall be electrically insulated from each other to achieve this requirement. Stainless steel of grade 303, 416, or other “free machining” grades shall not be used.

Flanges shall be either raised or flat face type and faced parallel and square by machining.

All valves shall have proven record of reliable operation in intended environment. Spare parts shall be readily available.

Valves shall be of standard and proven design to give optimum performance in meeting the specified operating conditions.

Unless noted otherwise, all actuated valves shall be fitted with suitable manual operating elements, such as hand wheels or levers. Failure of the actuator or its gearing shall not prevent manual operation of the valve.

Spindle caps and keys for valve operation shall be designed in accordance with the relevant Australian standards.

All isolating valves (e.g. gate, butterfly, knife gate, plug, globe, ball, diaphragm etc.) shall close in a clockwise direction with the exception of gate valves installed within the water supply network – these shall close in an anti-clockwise direction.

All isolating valves shall be capable of opening and closing against a full unbalanced head and maximum flow and shall open and close smoothly without vibration or cavitation. The direction to turn the valve open and close shall be indicated on the valve manual operating element, or when a valve is to be operated via an extension spindle, a stainless steel plate fitted adjacent to the top of the spindle.

All above-ground gate valves shall be fitted with non-rising spindles; all gate valves located within chambers shall be fitted with rising spindles (so the valve position can be seen without having to enter the chamber).

All manually operated valves shall open and close applying a maximum force of 160 N on the operating element to overcome their normal running torque. Their cracking (on-seating and off-seating) torque and associated force under maximum differential head conditions shall be stated on the design drawings. The hand-wheel diameter shall not exceed 600 mm.

All isolating valves shall be bi-directional (i.e. capable of operation with flow in both directions and pressure on either side of valve).

The size, shape, strength and rating of all valve parts shall be sufficient to provide an ample factor of safety under all working conditions.

The designer shall specify that drainage holes shall be drilled or formed in any external pockets on the valve body or associated equipment, when necessary, to prevent moisture ponding. These shall be purpose built and designer by the valve manufacturer, not the designer.

All valve parts requiring grease lubricating (e.g. gearboxes) shall be specified with grease nipples.

The valve leakage rates shall not exceed that specified in the relevant standard and this Specification.

Valve assemblies exceeding 25 kg shall be specified with adequate geometry/body-space for lifting or with dedicated lifting attachments. The lifting attachments (if fitted) shall be designed to withstand the total assembled mass of the valve, including the gearbox and actuator. Where provided, eyebolts shall comply with AS 2317.

The valve internal surfaces shall be devoid of sharp protrusions which may initiate secondary cavitation at high velocities.

All valve materials, linings, coatings, lubricants etc. for potable water applications shall comply with AS/NZS 4020.

Isolating and control valves may be electrically, hydraulically or pneumatically actuated or operated by portable actuators.

All valves fitted with electric actuators shall include position transmitters and torque and limit switches. All pneumatically-actuated valves shall have limit switches and a manual override. Where specified, manually-operated valves shall also be fitted with limit switches. The position transmitters and limit switches shall comply with this specification and Icon's electrical, instrumentation and control suite of standards.

Unless stated otherwise, all isolating valves DN400 or larger up to PN16, and DN300 or larger for PN21 and above, shall be fitted with bypass arrangements, which may be integral with the valve (preferred) or external.

Manually operated gate, butterfly and knife gate valves larger than DN300, or valves which require more than 200 turns from the fully closed to fully open position, shall be specified to have an adapter on the valve spindle for connection of a portable electric actuator. This spindle shall be in the vertical position.

6.16.2 Marking

Unless specified otherwise in the relevant standards, as a minimum the following lettering shall 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 rating (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)
- Valve mass

All lettering shall be in legible block type letters projecting not less than 3 mm. The lettering shall be as large as practicable but not less than 6mm high for sizes DN 80 to DN 150, 10mm high for DN 200 to DN 300, 20mm high for DN 350 to DN 600 and 25mm 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 shall be shown on an engraved stainless steel nameplate or a permanent label. This nameplate or label shall 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 shall be positioned to be clearly visible after installation.

Nameplates shall have minimum 3 mm (text height) etched or engraved letters. Labels shall be printed with minimum 3 mm (text height) letters.

Buried valves shall be provided with a 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 detailed above, the nameplate shall also clearly designate the valve type and seal material.

Gate Valves

All gate valves DN80 and larger shall be double flanged of either metal seats or resilient seats.

Resilient seated valves shall be used in preference to metal seated types for all gate valve applications up to and including DN600 unless higher temperatures, velocities, pressures or specific fluid properties require the use of metal seated alternatives. For example, in scouring applications where high velocities are normal, metal seated valves shall be specified.

Gate valves used for sewerage or water service shall be manufactured, tested and supplied in accordance with AS 2638.1 or AS 2638.2. For other services, ASME or ISO standards are preferred.

All valves shall be of the required rating, suitable for installation in horizontal, vertical or inclined pipelines with their spindle in vertical, horizontal or inclined positions.

All gate valves shall be specified for isolation purposes only and will in normal operation be either fully open or fully closed.

A gate guide system shall be provided on 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 shall be provided on metal seated gate valves DN700 and above and on all metal seated valves installed in vertical or inclined pipelines (or with their spindle in the horizontal or inclined position). The guide liners and gate slippers shall be recessed into the valve body and gate and held in position to resist loads imposed.

All gate valves DN600 PN16 and above and DN400 PN21 & PN35 and above shall be fitted with gearboxes. Gearboxes may also be considered for DN450 and DN500 PN16 gate valves if the effort on the operating element required to overcome their normal running torque exceeds 160 N.

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

6.16.3 Knife Gate Valves

All knife edged gate valves shall be either double flanged or wafer-lugged. Wafer-type knife gate valves shall not be used.

Knife gate valves used for water or sewage service shall be manufactured and tested in accordance with AS 6401. For other fluid services, ASME, ISO standards or MSS (e.g. MSS SP81) are preferred.

The designer shall ensure that when a knife gate valve is specified for operation in a horizontal orientation, the manufacturer warrants its use for such an orientation.

Valve spindles shall be specified as being encased in a shroud for safety and to prevent the ingress of foreign objects, dirt and residue etc.

External packed glands (for the gate) shall be self-aligning.

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

Knife gate valves shall preferably be drop tight in the closed position. In any case the maximum leakage rate shall not exceed values specified in AS 6401.

6.16.4 Ball Valves

Ball valves of thermoplastic materials shall conform to BS EN ISO 16135.

Steel ball valves shall conform to BS EN 1983.

Manually-operated ball valves for gas applications shall conform to BS EN 331.

Ball valves shall be of one, two or three piece construction. One piece construction shall only be specified for tapping points and sample lines of sizes DN25 and below unless Class 1 fluids require a robust, well-constructed one-piece ball valve to minimise the likelihood of leakage. Two piece construction shall be specified for non-critical applications; three-piece construction shall be specified for pipework where Icon Water maintenance staff have deemed it necessary to be able to replace the valve ball and seats without dismantling the pipework.

6.16.5 Plug Valves

All plug valves shall be of either the eccentric plug type or lubricated plug type. All valves shall be specified (i) to modulate the flow of water or recycled effluent, or (ii) for flow control in sewage and wastewater applications. Where plug valves are specified for modulation of air or gas flow they shall be of the eccentric plug type.

Plug valves shall be of the double-flanged type. Valve bodies and plugs shall be of the same material (except cast iron and carbon steel bodies where the plug shall be of grade 316 stainless steel construction).

All plug valves shall be manually operated by means of a lever or via a gearbox. Plug valve bores may be less than 100% of the pipe area to which the valve is fitted.

Eccentric Plug Valves: The requirements for eccentric plug valves are as follows:

a) Eccentric plug valves shall be of the non-lubricated eccentric type with a resilient faced plug or a replaceable, resilient seat in the body. Eccentric plug valves for digester gas service shall have grade 316 stainless steel plugs and a suitable resilient seating material (e.g. Buna N, Hycar etc.).

b) Unless otherwise shown in project specific documentation, all valves for sizes DN80 and larger shall have worm gear operators, nickel or stainless steel seats and flanged ends. Valves DN65 and smaller shall have operating levers, nickel or stainless steel seats, and screwed ends. Resilient facing shall be suitable for the intended service.

c) All submerged and buried valves shall be equipped with worm-gear operators, lubricated and sealed to prevent entry of dirt and water into the operator. All shaft bearings shall be of stainless steel, furnished with permanently lubricated bearing surfaces. The operator shall clearly indicate the valve position. All valves up to and including DN500 in size shall have an unobstructed port area of not less than 80 % of the full pipe area, and not less than 70 % for larger valves, unless otherwise specified.

Lubricated Plug Valves: The requirements for lubricated plug valves are as follows:

a) Lubricated plug valves shall be of the tapered plug type, worm-gear operated for sizes DN80 and larger, and lever operated for sizes DN65 and smaller.

b) Lubricated cast iron plug valves shall conform to BS 5158 for valves up to PN25 rating. Lubricated steel plug valves shall conform to BS 5353.

c) Manually operated closed bottom taper valves shall conform to BS EN 331.

d) All valves shall be specified with a fitting designed to provide for the application of a sealant through a check valve protected passage in the spindle (or through a stainless steel tube for worm-gear operated valves). Provision shall be made by ducts or grooves to insure the maintenance of a closed pressurised sealant system between all contacting surfaces of moving

parts. Plugs shall be held toward their seats by factory-adjusted gland assemblies set for proper sealing and operating torque. The gland assemblies shall be adjustable from the valve exteriors and shall utilise either spring washers or gland deflection to allow plug unseating when pressurised sealant is injected.

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

6.16.6 Butterfly Valves

For water and sewage service, all resilient seated butterfly valves DN80 and larger shall be manufactured, tested and supplied in accordance with AS 4795. Where metal seated valves are specified, they shall comply with the same standard as far as practicable.

For fluid services other than water and sewage, butterfly valves complying with BS EN 593 may be specified.

Double-flanged butterfly valves shall be specified by default with the exception that lugged-type butterfly valves may be specified in sizes up to and including DN300 in lieu of double-flanged valves. Wafer type butterfly valves shall not be specified without the written approval of the Icon Water Principal Mechanical Engineer or their nominated representative.

All butterfly valves shall be capable of opening and closing against the full unbalanced head and the expected maximum velocity.

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

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

Unless otherwise shown in project specific documentation, all valves shall be specified with gear boxes, input shafts and actuators on the left hand side when viewed from the upstream face. All valves shall be specified with actuator input stops.

All butterfly valves shall have a basic position indicator for local operation. Buried or submerged butterfly valves and those fitted with extension spindles shall be specified with remote position indicators at the operating position. For buried valves the indicator shall be housed in the surface box. The position indicator shall be sealed against ingress of moisture and contaminants and shall provide indication of the valve disc in the fully open, intermediate and fully closed positions.

Butterfly valves shall be supplied with a locking device which shall enable locking of the valve shaft to the valve body in either the open or closed position (i.e. to facilitate safe pipeline inspection and allow repair work to the gearbox or actuator when the pipeline is under pressure). The locking device shall be manually fitted. It shall be capable of withstanding the full stall torque of the actuator or twice the rated input torque of the valve or the gearbox (where installed) required for valve operation.

Alternatively, where not readily accessible (e.g. in buried installations) and where approved by the Icon Water Representative, butterfly valves may be fitted with a locking mechanism consisting of a locking pin and a padlock fitted between the actuator and the valve to prevent its unintentional operation. The locking pin shall be of stainless steel grade 316 and shall be capable of withstanding the full stall torque of the actuator or twice the rated operating torque of the gearbox.

All buried valves and valves fitted with extension spindles, and other butterfly valves where specified, shall be fitted with a torque-limiting device. The torque limiting device shall be incorporated in the input shaft of the gearbox (for hand operated valves) or valve actuator to limit the input to the valve. The torque-limiting device shall be fully enclosed, adjustable and set by the manufacturer to the nominated torque. The device shall be tamper proof and the set torque shall be permanently marked on a stainless steel plate attached with stainless steel screws to the torque limiting device.

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

Resilient seated butterfly valves shall be specified for isolation only and will normally be either fully open or fully closed during operation. They shall provide drop tight sealing from both sides when closed.

Metal seated valves may be used to assist pump starting and stopping, control water hammer surges in the pipework or throttling of flow and may operate in any position between fully open to fully closed. Valves shall be designed and selected such that they can control over the required range of flow and pressure as specified without any vibration, noise, cavitation or any damage to any components. Unless specified otherwise, the permissible leakage rate in metal seated butterfly valves shall be as provided in relevant standards.

Seal-on-Body Type Butterfly Valves: Shall be specified with a solid synthetic resilient seal, either clamped, bonded or vulcanized to the body. The valve seal shall extend over the flanges forming integral flange gaskets so that separate gaskets or O-rings are not required. Their shaft shall be positioned concentric to the valve bore. The valve disc shall be manufactured from stainless steel or aluminium bronze.

Seal-on-Disc Type Butterfly Valves: Shall be specified with a solid synthetic resilient seat fixed on the valve disc. The seal for valves DN750 and above shall be readily replaceable on site without requiring the removal of the valve from the pipeline. The seal shall be of a low profile and resistant to high velocities and cavitation damage. Additional requirements are as follows:

a) The seating ring shall be manufactured from stainless steel grade 316 or another suitable corrosion and cavitation resistant material. The seating ring shall be securely fixed to the body to prevent the valve from leaking past the seat.

b) In order to minimise galvanic corrosion, the valve disc, seal ring and fasteners shall be manufactured from stainless steel. The ductile iron body, seat ring mating face and tapped holes shall be sealed against moisture ingress.

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

d) The shafts of seal-on-disc butterfly valves shall be positioned double or triple eccentrically to the valve body to minimise the seal to seat contact when closing and opening and to achieve better sealing properties.

Seal-in-Body Type Butterfly Valves: Shall be specified with a solid synthetic resilient seat securely fixed inside the valve body. The seal for valves DN750 and above shall be readily replaceable on site without requiring the removal of the valve from the pipeline. The seal shall be resistant to abrasion caused by the disc movement, high velocities and cavitation. Additional requirements are as follows:

a) The seating ring shall be securely fixed to the disc and manufactured from stainless steel grade 316 or other suitable corrosion and cavitation resistant material.

b) In order to minimise galvanic corrosion, the valve disc, seating ring and fasteners shall be manufactured from stainless steel. The ductile iron body, seal ring mating face and tapped holes shall be sealed against moisture ingress. All wetted ductile iron or carbon steel surfaces and interfaces shall be fully coated and sealed respectively to eliminate contact with moisture.

c) The shafts of seal-in-body butterfly valves shall be positioned eccentrically to the valve body to minimise the seal to seat contact when closing and opening and to achieve better sealing properties. The design of eccentric seal-on-body butterfly valves shall include all necessary provisions to prevent inadvertent positioning of the valve disc away from its body seats when removing and re-installing the gearbox. For that reason the gearbox shall fit onto the valve shaft and valve body in only one way.

Globe Valves

Globe valves shall only be specified for fluids which do not contain solids of a concentration which will build-up, partially of fully block or damage the seating/sealing elements.

For water service in sizes up to DN65, all globe valves shall be metallic complying with AS 1628. For other services, ASME, EN or ISO standard valves may be specified.

6.16.7 Diaphragm Valves

Diaphragm valves shall be specified for flow throttling of sludge and scum.

Metallic diaphragm valves shall be weir or full bore type and conform to BS EN 13397 with a cast iron body and bonnet and an elastomer diaphragm suitable for the indicated use for valves rated up to PN16.

All manual diaphragm valves shall 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 shall have a distinctive visual indicator.

Diaphragm valves made of thermoplastic materials shall conform to BS EN 16138.

All solids carrying lines shall be equipped with full bore valves. Weir type valves may only be specified for use on air or water pipelines.

Diaphragm valve pneumatic actuators shall be "air to close and spring to open" unless a safety-in-design review results in an outcome where an alternative is required. The actuators shall be of the diaphragm type and shall be purpose designed to suit the associated valve, the maximum line pressure anticipated and the supply air pressure. A Manual override, position indicator and position transmitter shall be provided.

6.16.8 Needle Valves

Needle valves specified for use in steam lines, gas lines and instrument lines shall be manufactured from bar stock and shall have threaded BSP ports.

Needle valves specified for use in potable water lines shall have Watermark certification and threaded BSP ports.

Needle valves shall not be specified for fluids with a viscosity greater than 5 cP nor shall they be specified for fluids containing any solid contaminants.

6.16.9 Solenoid Valves

Solenoid valves for water service shall be equipped with a dampening device to prevent water hammer.

All solenoid coils shall be continuously rated for 240 VAC or 24V DC with protection to IP65 in accordance with AS 1939. 240 VAC shall be used for non-critical applications.

All solenoid valves shall be specified with a manual override with a detent as a means of operating the valve in the case of power failure.

The valve body shall be de-zincification resistant brass or stainless steel.

Solenoid valves shall be of the normally closed type (i.e. energise to open) unless a safety-in-design review deems this inappropriate.

The solenoid coils must be fully encapsulated and shall be of Class B, E or F insulation.

Solenoid valves shall not be specified for fluids containing any solid contaminants.

6.16.10 Non-Return Valves

For water and sewage services, all non-return valves DN80 and larger shall be double flanged as well as manufactured, tested and supplied in accordance with AS 4794.

All non-return valves for clean water applications shall be of a short bodied tilting disk type.

Non-return valves for sewage and sludge applications shall be of a full bore, long bodied swing check type. Non-return valves for aeration services shall be double-leaf check valves.

Other types of non-return valves such as ball check, nozzle check and piston check shall be specified for applications where tilting disk and swing check type valves are inappropriate.

All non-return valves shall be suitable for horizontal, vertical or inclined installation. Hinge pins shall always be installed horizontally.

Tilting disc and swing type non-return valves shall be specified with a hinge pin (spindle) extended through the valve body on one or both sides where required based on pressure, flow and water hammer considerations. The extended hinge pin shall be fitted with a lever arm with adjustable counterweight.

For swing and tilting disc check valves, a counterweight guard shall be provided where a counterweight has been specified.

Unless instructed otherwise by the Icon Water Representative, non-return valves installed on the discharge sides of pumps shall be specified with limit (i.e. “no-flow”) switches. The limit switch and counterweight can be installed on the same or opposite sides of the valve. The control system shall stop the pump if there is no flow detected through the associated non-return valve by its limit switch (i.e. if the valve closes or does not open when the pump operates).

6.16.11 Hydraulically Operated Automatic Control Valves

Hydraulically operated automatic control valves include, but are not limited to pressure reducing valves, pressure sustaining valves, flow rate control valves, pump control valves and altitude valves.

The designer shall specify requirements for these valves in accordance with *STD-SPE-M-003*.

6.16.12 Air/Vacuum Valves

For clean water and sewage applications, refer to the Approved Products List *STD-SPE-G-006* for acceptable makes and models. For applications which are not water or sewage related, the air/vacuum valve chosen shall comply with either ASME, BS EN or ISO standards.

Valve wetted materials shall be compatible with the fluid service.

All air/vacuum valves shall be installed such that the spigot (i.e. branch pipe) is at least half the nominal diameter of the header (i.e. run pipe) wherever practicable.

Air/vacuum valves shall be sized and selected in strict accordance with the manufacturer’s recommendations. The oversizing of valves shall be avoided.

For critical services where failure or inadvertent isolation of an air/vacuum valve may lead to pressure transients under certain conditions, two or more air/vacuum valves shall be installed at each location.

An isolation valve shall be provided between the header pipe and the air/vacuum valve. This isolation valve shall be a ball valve for spigot sizes DN80 and below. For DN100 to DN250, either a lugged butterfly valve or double-flanged gate valve shall be specified. For sizes greater than DN250, a double-flanged gate valve shall be specified for isolation purposes.

6.17 Valve Actuation – Design and Selection Requirements

6.17.1 Manual Actuation

Manual operation of valves shall be effected by one or more of the following means:

- A handle/lever fixed directly to the spindle of the valve or to a gearbox fitted to and driving the valve spindle.
- A spindle key attached to the valve spindle that will allow operation through a portable tee-key.
- A chain wheel mounted to the valve spindle or gearbox that will allow operation of overhead valves from floor level. Unless otherwise required, chains shall extend to within 300 mm of operating floor level.

Handles shall be handwheels for valves with linear, screw operated spindles or quarter turn valves fitted with gearboxes or powered actuators. Lockable lever handles may be fitted to quarter turn valves that do not require gearboxes.

All manual operators shall be sized to limit the force required to operate the valve over its operating range (including on and off seating). Where this condition cannot be met or when the hand wheel size exceeds the maximum allowable diameter, gearboxes shall be used.

6.17.1.1 Valve Gearboxes

Valve gearboxes shall be sized such that the input torque required to operate the valve under the worst conditions of differential head, unseating force, or emergency flow shall be no greater than 160 Nm.

Gearboxes shall be capable of withstanding the thrusts generated by an output torque equal to 1.5 times the minimum strength test torque given in the relevant standards.

All gears and gearboxes shall comply with AS 2938 and the American Gear Manufacturers Association (AGMA) Standards. Their input and output bearings shall be of corrosion resistant materials. Mounting flanges for actuators shall comply with ISO 5211.

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

Gearboxes shall incorporate adjustable mechanical position stops to limit excessive valve travel. The stops shall only restrict travel if the actuator travel limit stops fail.

Gearboxes shall be manufactured with an enclosure rating of IP68 in accordance with AS 60529 and be suitable for continuous immersion to a depth of 5 metres. Mounting flanges shall comply with ISO 5210 or ISO 5211, as applicable (using an adaptor piece if necessary).

The gear boxes for all valves shall be self-locking in all positions.

Gearboxes shall 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 shall be shown on an engraved stainless steel nameplate. This nameplate shall be permanently attached with a mechanical fasteners. The plate shall be in a location that is clearly visible after installation.

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

6.17.2 Electric Actuation

Electric actuators shall have the functionality of both local (manual) and remote control capability, with local control being integral to the actuator where applicable.

Actuator control boards shall have the functionality to be supplied by an external 24V supply.

Unless the result of a safety-in-design review shows otherwise, in the event of a power failure, the actuator shall be able to retain the last operating state or set point.

As a minimum, the following control and monitoring signals shall be available from the actuator control board:

- Valve available;
- Valve in remote/local control;
- Valve fault;
- Valve fully open;
- Valve fully closed;
- Valve % open (for modulating valve actuators);
- Remote open;
- Remote close.

For gate valves, the operating speed of the actuator/gearbox assembly shall result in an opening and closing speed of 200-300 mm per minute.

The available torque operating margin shall be at least 25% greater than the required seating or unseating torque (whichever is the greater) of the valve. The safety margin of motor power available for seating and unseating the valve shall be sufficient to ensure normal operation with the supply voltage 10% below nominal without nuisance tripping of the actuator.

Each actuator shall be specified as being supplied with its own programming tool.

6.17.3 Pneumatic Actuation

Where pneumatic actuators are used for opening and closing valves the pneumatic cylinders shall have aluminium bodies, steel shafts and grade 316 stainless steel trim/fastenings and shall be suitable for operation from a compressed air system with a pressure range between 550 kPa and 700 kPa. Pneumatic cylinders shall be of the double acting type with the direction of operation determined by a solenoid operated spool valve.

Quarter-turn pneumatic actuators shall be of the compact rack and pinion type complete with double piston, internal air ports, adjustable travel stops and shall be grease lubricated for life. The air control solenoid shall be able to be mounted directly to the body of the actuator or separately in a remote box.

Quarter-turn actuators shall be capable of having accessories such as solenoid control valves, limit switch units, de-clutching manual override gearboxes, electro-pneumatic positioners and high visibility indicators attached directly to the body of the actuator. The pistons shall have anti-friction pads to ensure no metal-to-metal contact between pistons and the bore of the actuator. The body and all the fittings on the actuator shall be pressure rated to 1000 kPa. The available torque operating margin shall be at least 30% greater than the required seating or unseating torque (whichever is the greater) of the valve. The materials of construction shall be:

- Body material: Aluminium
- Piston material: Aluminium
- Piston shaft material: Grade 316 Stainless Steel
- Bearing material: Polymer

- Spring material: Spring Steel
- Fasteners material: 316 Stainless Steel
- Coatings: Anodised
- O-rings and seals: Nitrile

Linear pneumatic actuators shall be diaphragm or piston style pneumatic actuators suitable for the automation of diaphragm, gate or knife gate valves. The air control solenoid shall be mounted either directly or via a bracket to the body of the actuator.

Linear pneumatic actuators shall be capable of having accessories such as solenoid control valves, limit switch units, electro-pneumatic positioners and high visibility indicators attached directly to the body of the actuator or separately in a remote box. The pistons and stems shall have suitable sealing arrangements such as O-rings. The body and all the fittings on the actuator shall be pressure rated to 1000 kPa.

For gate valves, the operating speed of the actuator assembly shall provide a valve opening and closing speed of 200-300 mm per minute.

The available force operating margin shall be at least 30% greater than the required seating or unseating force (whichever is the greater) of the valve. The materials of construction shall be:

- Body material: Cast Iron/Aluminium/GRP
- Piston material: Carbon Steel/Aluminium
- Diaphragm material: Nylon Reinforced Neoprene
- Piston Rod/Shaft material: Grade 316 Stainless Steel
- Shaft seal material: Nitrile
- Spring material: Spring Steel
- Fasteners material: 316 Stainless Steel
- Coatings: Anodised for Aluminium); refer to *STD-SPE-G-005* for approved coatings for other materials.
- O-rings and seals: Nitrile

Air solenoid valves shall be 24VDC spool type control valves with 5 port, 2 way configurations and changeable with an adaptor plate.

Air solenoid valves shall provide a high flow capacity to give the pneumatic actuator a sufficient response time.

Air solenoid valves shall be suitable for mounting directly onto actuators or in a remote box. Speed controllers with operating times of 0.25 to 240 seconds and silencers shall be standard items with the supply of such valves. The solenoid coils shall be field replaceable. The valves shall be provided with a manual override and an energised indicator light. The materials of construction shall be:

- Body material: Aluminium/Stainless Steel grade 316
- Spool material: Aluminium/Stainless Steel grade 316
- Coatings: Anodised
- O-rings: Nitrile
- Bactericidal lubricant: BK Standard Pipe Jointing Lubricant or approved equivalent

6.17.4 Portable Valve Actuators

Portable valve actuators shall preferably be of the electric type with sufficient torque to operate the nominated valves including off-seat torque loads. Cordless drives are preferred.

Portable actuators shall be designed to minimise the physical manual handling loads associated with holding and operating the equipment.

Gearboxes shall be adequately rated for maximum torque and shock loads in operation. Torque shall be adjustable to avoid over-driving valves when closing on the seat.

The actuators shall be provided with attachments as follows to maximise the potential applications for the portable actuator:

- Drive heads to suit different size valve spindle keys or handles.
- Bracing/support arms to assist operators to resist torque reactions without undue strain.
- Telescopic drive extensions to operate valves in pits or high positions from floor level.
- Alternative mains power drives for locations where power is readily available if higher torque is required.

7 Piping and Valve Fabrication, Manufacture, Construction, Installation and Testing

7.1 Fabrication and Installation

Section 7 refers predominantly to metallic materials of construction. Where Section 7 is “silent” on specific requirements for plastic piping systems, refer to the relevant Australian standard.

7.1.1 Workshop Requirements

Adequate undercover workshop facilities shall be provided. Ample storage, handling, machining and testing facilities shall be provided to ensure a safe, efficient and continuous piping spool preparation for welding, assembly and testing. The surface preparation and painting of the spools shall be done in separate area.

Stainless steel fabrication shall be carried out in an area where contamination from carbon steel grindings and items is completely prevented.

An area shall be provided for non-destructive testing. This area shall be located at a safe distance from the piping spool fabrication. The area shall comply with all statutory and safety requirements.

7.1.2 Preparation and Welding

All welding (including welder qualifications, welding supervision, testing and inspection) and associated procedures shall be in accordance with AS 4041 and the welding standards referenced by AS 4041.

No welding shall proceed until the Icon Water Representative has reviewed and accepted (in writing) the welding procedures and qualifications etc. proposed by the Contractor.

The cutting of pipe may be done either by mechanical means or by flame cutting, depending on the type of material to be cut. For carbon steel, flame (or arc) cutting and bevelling is acceptable only if the cut is reasonably smooth, true and all oxides are removed from the flame cut surfaces by grinding. After flame cutting the bevel end, preparation shall involve grinding back to bright and sound metal.

For stainless steel, plasma cutting and grinding back to bright sound metal is required if the pipe ends cannot be machined. Flame cutting is strictly prohibited.

All welding areas shall be adequately protected against inclement weather conditions.

All weld end preparations and adjacent areas 50 mm either side of the weld preparations shall be thoroughly cleaned and degreased prior to welding. Any supplier applied coating shall be removed for a margin of 50 mm from each shop weld joint. All uncoated surfaces of the spool shall be surface prepared and painted immediately after all non-destructive testing of the welds has been completed.

Use of permanent internal backing rings is prohibited. Consumable inserts shall not be used.

Defective or damaged prepared weld ends (bevels) shall be examined and repaired. Use of hot or cold hammering as a means of repair is prohibited.

All welds shall be full penetration welds unless specifically shown otherwise on the project specific “Issued For Construction” drawings.

7.1.2.1 Misalignment Tolerance

All piping fit-ups shall be subject to the bore misalignment tolerances indicated in Table 7.1.2.1.1.

Table 7.1.2.1.1 Allowable Misalignment Tolerance – Piping Fit-Up

Nominal Diameter (DN)	Misalignment Tolerance (mm)
≤150	1.0
200 - 300	2.0
≥350	2.5

Misalignment should be minimised wherever possible by rotating the pipe/fitting for best fit and/or by grinding the bore as required.

7.1.2.2 Slip-On Flanges

Slip-on flanges shall be positioned so that the end of the pipe is recessed from the face of the flange a distance equal to the lesser of the pipe wall thickness or 9 mm. Seal welding for slip-on flanges shall be carefully applied in order to avoid refacing the flange. Internal and external welds shall be as identified in AS 4041.

Pipes for insertion in slip-on flanges shall be cut square within 0.5 mm.

7.1.2.3 Socket Welding

Socket-welded joints are not preferred for Class 1 and Class 2 piping applications and shall not be installed unless specifically shown on the project specific “Issued For Construction” drawings.

7.1.2.4 Threaded Connections

Reaming shall be used to de-burr inside the ends of threaded pipes.

All threaded connections shall be gauge checked or chased after galvanising.

Threaded connections shall not be seal welded except where specified in project specific documentation.

Threaded joints in a piping system shall be made up using PTFE pipe tape or thread seal compound installed on the male end except for stainless steel piping where a nickel-based jointing compound or nickel-powder impregnated PTFE tape shall be used.

7.1.2.5 Flanged Connections

Unless otherwise indicated on the project specific drawings, the bolt holes of all flanges shall straddle the vertical centreline. The maximum angular deviation of bolt holes shall not exceed 1.5 mm measured across the bolt pitch circle.

The flange faces shall be square to the pipe run in which they are fitted.

Flanged facings and type shall suit the type of flange supplied with the mating pipe flange or mating equipment flange (i.e. raised face to raised face or flat face to flat face). Note: In some instances, this may require the removal of a raised face from an existing flange when bolt-up to a mating flat face flange is required.

7.1.2.6 Branch Connections

Fabricated branch connections shall be in accordance with the requirements of AS 4041.

All cuts shall be carefully bevelled and accurately matched to form a suitable preparation for welding and to permit full penetration of welds between the branch and the run pipe at all points.

All reinforcement pads for pressure openings or each segment of build-up type reinforcement pads for pressure openings shall be provided with ¼ inch (6 mm) BSP threaded hole for testing and venting. The vent hole shall be sealed after completion of the pressure test with grease or silicon sealant to prevent ingress of moisture.

Branch connections, vent nozzles, trunnions and other attachments including reinforcing pads shall not be welded over or near longitudinal or circumferential welds. The minimum distance between the weld in the pipe and the weld at the fitting shall be 50 mm measured between the heat affected zones. For reinforcing pads, the minimum distance measured between the heat affected zones of the weld in the pipe and fillet weld of the pad shall be 25 mm.

7.1.2.7 Cold Bending

Pipe DN40 and smaller shall be bent only where cold bending is indicated on the project specific drawings. In all other cases, butt weld or screwed elbows shall be used depending on piping class.

Cold bending shall be carried out using pipe bending machines otherwise presses and dies shall be employed to prevent flattening.

Unless otherwise noted, the centreline radius of bends shall be five nominal pipe diameters. Butt welds in the arcs of bends or for the addition of pulling legs shall not be permitted.

All bends shall be smooth, free from cracks and surface defects, without buckles and they shall be within tolerance limits (e.g. ovality) identified in AS 4041.

Cold or hot bending of stainless steel pipe is strictly prohibited.

7.1.2.8 Mitre Bends

Segmented bends shall be manufactured by butt welding together segments of pipe, shaped to produce the required bend. Wherever possible, the segments shall be taken from the same length of pipe. However, the segments shall be limited to applications detailed on the project specific piping drawings.

The change of centreline (or maximum segment angle) at butt welds in segmented bends shall not exceed 30 degrees.

7.1.2.9 Preheat and Treatment

Preheat and inter-pass treatment temperature control and heat treatment shall be in accordance with AS 4041.

7.1.2.10 Post Welding Treatment – Stainless Steel

All welds shall be cleaned, pickled and passivated on completion of welding in accordance with the details contained in Appendix C of this specification. If post-weld heat treatment has taken place, the piping shall be marked after heat treatment with the words “DO NOT WELD”.

For piping, both the internal and external surfaces of the weld and heat affected zone shall be cleaned, pickled and passivated unless noted otherwise in the project specific documentation. The Contractor may propose alternative remedies to the Icon Water Representative for review and acceptance but shall not commence fabrication utilising such alternative remedies until written acceptance has been received.

7.1.2.11 Stainless Steel

Direct contact between carbon steel and stainless steel is not permitted. Procedures shall be employed which prevent such contact and the resultant contamination of the stainless steel.

Tools and grinding discs containing carbon steel shall not be used on stainless steel. Tools used for fabrication of stainless steel shall be clearly identified and labelled, used only for fabrication of stainless steel piping and piping components. They shall be stored separately to avoid accidental switching with tools previously used on carbon steel fabrication work.

7.1.2.12 Painting of Piping

Piping shall be painted in accordance with *WSA 201 Manual for Selection and Application of Protective Coatings* in-conjunction with *STD-SPE-G-005*.

Flange gasket faces shall be protected against damage and paint deposits during blasting, cleaning, surface preparation and painting.

The following pipework need not be painted:

- Stainless steel
- Insulated carbon steel piping (prime coated only prior to installation of insulation);
- GRP
- ABS which is located indoors or not directly exposed to sunlight
- Polyethylene
- PVC which is located indoors or not directly exposed to sunlight.

7.1.2.13 Material and Pipe Spool Identification

All pipes and fabricated fittings shall be tagged or marked using an approved system and procedure.

The pipeline number shall be hard stamped on the rim of the flange or a flanged fabricated spool. For non-flanged fabricated spools, markings shall be hard stamped on the bevel edge of the fitting for thick walled fittings and at least 50 mm away from the bevel edge for thin walled fittings.

All markings shall be hard stamped using a low stress die.

Piping spools shall be marked/stamped after fabrication and prior to corrosion protection.

In addition, metal tags stamped with the pipeline number shall be securely tied to each spool.

Material identification shall be maintained throughout the fabrication, installation, up to and including final inspection. In particular, an approved system shall be used to clearly identify the material of all pipes and fittings of ABS and PVC (all variants) construction due to their visual similarity.

7.1.2.14 Factory Inspection and Testing

All fabrications shall be inspected and tested in accordance with the requirements of AS 4041 for the particular piping classification (e.g. 1, 2A, 2P or 3).

Inspection shall include 100% visual examination and any other additional examination necessary to ensure compliance with this specification.

Inspection and testing shall be carried out before any painting or coating is applied.

Non-destructive testing of welds shall be carried out after final heat treatment is completed.

7.1.3 Storage and Handling

7.1.3.1 General

All piping components shall be stored in a clean area away from the fabrication and construction activities and handled such that no damage or mixing of materials occurs. Materials shall be stored on pallets and not on the ground. End caps shall be kept on all components. Threaded ends shall be protected by end caps.

Hooks shall not be used for lifting. Pipes shall not be rolled off or dropped onto the ground or dragged over the ground.

Flange facings shall be protected from damage. Covers shall be securely fastened to flange facings during handling, transportation and storage at site.

7.1.3.2 Stainless Steel Materials

Stainless steel materials must be stored on non-metallic pallets.

End caps shall be kept on piping components until immediately prior to installation.

All flanges and flanged connections shall be sealed with blinds to prevent ingress of water, moisture and foreign matter. Threaded ends shall be capped with a plastic cap and sealed.

Stainless steel piping and components shall be stored in separate areas away from storage areas for carbon steel and other materials to avoid direct contact causing galvanic corrosion.

Steel wire slings shall not be used for handling and transporting stainless steel materials. Canvas or nylon slings shall be used.

The surfaces of components shall be cleaned with acetone and then rinsed with demineralised water to remove deposits of foreign materials.

7.1.3.3 Lined Steel Pipes

Pipes and piping components shall be handled in such a way that the lining and other materials are not damaged.

For cement lined pipe, airtight end covers shall be fitted at all times to ensure a moist atmosphere inside the pipe and for retaining any broken pieces of the lining.

Lined pipe shall not come into contact with sharp edges and shall always be supported uniformly along its length.

The lined pipe shall be stored under cover to protect it from exposure to high temperatures.

7.1.3.4 Repair of Coatings and Linings

Damage caused to the coatings or linings of pipework before acceptance of delivery at site shall be repaired by the supplier using the appropriate repair procedures in accordance with manufacturer guidelines.

7.1.4 Installation

All piping and accessories shall be supplied and installed by the installation contractor. All pipes installed by the installation contractor shall be installed as per the relevant Australian Standards.

Pipes and fittings shall be in their correct position, grade and alignment before joints are made as no springing of joints shall be allowed.

7.1.4.1 Pipes built into structures

The outside surfaces of all pipes and special castings to be built into structures shall be thoroughly cleaned immediately before installation. Pipes passing through water retaining walls and floors shall, unless shown otherwise in the project specific drawings:

- Be built into the structure in-situ.
- Employ the use of a puddle flange and suitable waterstop (i.e. hydrophilic sealant material) or puddle flange and suitable link-seal arrangement.
- Shuttering shall be formed closely to the pipe and concrete and shall be placed and compacted thoroughly around the pipe and puddle flange.

7.1.5 Buried Piping and Pipelines

7.1.5.1 Handling and Storage

Pipes and fittings shall be handled, transported and stored in accordance with the manufacturer's instructions and in a manner not to damage the pipes, joints, internal linings or external coatings.

Where pipes are to be stacked, they shall be arranged so that the sockets and spigots are not loaded and there shall not be excessive load on the lower layer.

Rubber rings for flexible joints (and all rubber flexible joints) shall be stored in an unstressed condition in a cool and dry place not exposed to direct sunlight.

PVC pipes shall be handled carefully and stored away from direct sunlight.

Before a pipe is lowered into the trench, it shall be thoroughly examined to ensure that the internal lining and the outer coating are undamaged. Where necessary, the interiors of pipes and fittings shall be carefully brushed clean. Any damaged parts of the coating or lining shall, before a pipe is used, be made good as directed by the Icon Water Representative.

Pipe laying shall not commence until the bottom of the trench and the pipe bed has been inspected.

At the end of each day's laying, the end of the pipe shall be sealed to prevent ingress of trench material or water.

In the case of drinking water pipes, should the ends of pipes not be sealed at the end of each day's laying, Icon Water shall require that disinfection be conducted at the Contractor's expense if not already stipulated in the project specific documentation. Disinfection shall only be conducted by suitably qualified and experienced Contractors.

7.1.5.2 Excavation of Trenches

The line, level and grade of the trenches shall be such as to allow pipelines to be laid as specified herein or as shown on the project specific drawings.

Trenches for pipelines shall be excavated to a width and a depth sufficient to enable the pipe, joint, bed, haunch or surround shown in the project specific drawings to be accommodated. Additional excavation shall be provided at the joints to allow for jointing of the pipes.

The width of the trench shall not exceed the limiting width between the faces of the soil that has been used in the structural design of the pipeline (i.e. as per the details shown on the project specific drawings).

Unless shown otherwise on the project specific drawings, the minimum cover for pipelines not subject to vehicular loads shall be 600 mm in non-trafficable areas and pipelines under roads shall be 900 mm unless concrete encasement is used. If concrete encasement is used, a thickness of 150 mm shall be specified as an absolute minimum.

Safety protection measures shall be erected and maintained at all unattended excavations and shall include, but not limited to the following:

- Safety and stock proof fencing, or
- Installation of trench covers, or
- Temporary backfilling of all excavations, irrespective of excavation depth.

The installation contractor shall avoid disturbing the finished trench formation. Any wet or soft materials in the trench shall be excavated and made good to the satisfaction of the Icon Water Representative.

7.1.5.3 Pipe Laying and Jointing

Pipes and fittings shall be laid true to the lines, levels and grades shown in the project specific drawings. Pipe laying shall normally commence at the downstream end with their sockets facing upstream.

Pipes shall be laid with the barrels firmly and evenly bedded on the bedding material. Socket holes shall be formed in the bedding material and trench bottom to accommodate pipe joints, if any, to ensure effective bedding and even bearing along the full length of the pipeline.

For laying of PE or GRP pipes, only those installers who have completed an approved training and accreditation program shall be utilised.

7.1.5.4 Pipe Laying Tolerance – Gravity (Non-Pressure) Pipelines

The installation contractor shall construct gravity (non-pressure) pipelines to the tolerances detailed in Icon Water specification *STD-SPE-C-004 Survey and Tolerancing Requirements*.

7.1.5.5 Pipe Laying Tolerance – Pressure Pipelines

The installation contractor shall construct pressure pipelines to the tolerances detailed in Icon Water specification *STD-SPE-C-004 Survey and Tolerancing Requirements*.

7.1.5.6 Cutting of Pipes

Pipes shall be cut by methods recommended by the manufacturer which provide clean and square cuts of the pipe barrels and of the linings, if any, without damage to the pipes or linings. The ends shall be ground or machined to the required chamfer where necessary.

Concrete pipes shall be cut to a square and even finish without splitting or fracturing the wall of the pipe. Reinforcement shall be cut back flush with the concrete and bare metal protected with a protective coating approved by the Superintendent.

Witness marks on the unmarked length of any cut pipes shall be reinstated. Do not score pipes when reinstating the witness mark.

7.1.5.7 Jointing of Pipes

Joints shall be made strictly in accordance with the manufacturer's instructions. The installation contractor shall use all equipment, machinery and apparatus recommended by the manufacturer in the methods of assembling joints.

Before making any joints, all jointing surfaces shall be thoroughly cleaned and dried, and maintained in such condition until the joints have been completely assembled. Pipes shall be securely fixed in position to prevent movement during and after the making of the joints.

7.1.5.8 Rubber Ring Joints

The rubber rings shall be inspected for flaws before making each joint. Jointing fluid shall be applied in accordance with the manufacturer's recommendation.

Gradual change in alignment or grade shall be made by deflecting pipes at the joints. Deflection shall be effected after the joint is made. The maximum deflection at each joint shall not exceed the manufacturer's recommendation.

For pipelines of diameter that permit man entry, the joint shall be inspected internally immediately after jointing to ensure the correct joint geometry is achieved.

7.1.5.9 Flanged joints

Flanges shall be used for all buried valve installations. Flanged joints in other buried pipe applications shall not be used without prior approval of the Icon Water Representative.

UniFlanges, Adapta-Flanges or similar joints secured by set screws are not acceptable.

7.1.5.10 Corrosion Protection of Pipes and Fittings

Pipes and fittings shall be protected from corrosion as specified in the project specific drawings and specification documents.

Polyethylene sleeving complying with the requirements of AS 3680 shall be applied in accordance with AS 3681 externally for all pipe ductile iron pipes and fittings DN225 and larger when installed in buried applications unless (i) the manufacturer warrants that sleeving is not required based on soil resistivity testing either they or their nominated representative have conducted along the pipe route, or (ii) when specifically noted by Icon Water in the project documentation package.

Buried steel pipes shall be either concrete encased, fusion-bonded PE coated, or wrapped by an approved corrosion taping system. The application of the wrapping system shall be carried out strictly in accordance with the manufacturer's instructions in regard to surface preparation and the application of primer, mastic filler and tape.

Where a cathodic protection system is specified for a steel pipeline, the construction of the cathodic protection system shall comply with the requirements of AS 2832.1, AS 2239 and AS 4832.

7.1.5.11 Pipe Embedment and Compaction

Immediately following trench excavation, the bottom of the trench excavation shall be carefully trimmed true to grade and level. It shall be raked over to remove any protruding stones or hard material. Holes so formed shall be filled with bedding material and compacted to the correct level.

Where the pipe invert is at or below the natural water table level, a geotextile filter fabric shall be placed around the pipe embedment.

Bedding shall be placed and compacted to support the pipe uniformly along the whole length of the barrel with chases provided for sockets and couplings. Where extremely poor ground conditions are encountered, which have not been previously assessed through a geotechnical investigation, the installation contractor shall notify the Icon Water Representative so that a suitable mitigation measure can be designed/proposed (e.g. a bridging layer or piles).

Bedding material shall be placed in the excavation up to the level of the pipe barrel and shall be tamped in layers not exceeding 150 mm thick, to provide a dense well-compacted bed free from soft spots throughout the length of the pipeline.

After the pipes have been properly bedded, embedment material shall be carefully placed into the space between the pipe and the sides of the trench to the top of the overlay. The material shall be carefully deposited in layers not exceeding 150 mm thick before compaction. The placing and the compaction of the material shall proceed equally on both sides of the pipe up to a level 300mm above the top of the pipe. Material grading for the haunch, side and overlay zones to be in accordance with AS 3725.

Where concrete bedding, haunching or surround is used, the concrete shall be vibrated into place under the pipe and the concrete shall be in full contact with the underside of the barrel of the pipe throughout its length. The concrete shall be placed in one operation and there shall be no horizontal construction joint in the concrete. The pipe shall be anchored against flotation.

Unless specified otherwise on the project specific drawings and documentation, pipe embedment materials shall be compacted to the minimum standards detailed in Table 7.1.5.11.1.

Table 7.1.5.11.1 Pipe Embedment – Minimum Compaction Standards

Material Type	Test Method	Minimum Compaction % - Trafficable areas	Minimum Compaction % - Non-trafficable areas
Compaction sand or processed aggregates	Density Index (ID) AS1289.5.6.1	75	70

Flooding shall not be used for compaction.

The location for field compaction tests shall be agreed with the Icon Water Representative. The frequency of testing shall be one test at the spring line of the pipe for each 50 lineal metres of pipe laid or part thereof.

Compaction testing shall be performed by an Independent Testing Authority (NATA Registered). All tests performed, including location details and results for each in-situ test shall be recorded.

7.1.5.12 Trench Fill and Compaction

For trench fill above the embedment, excavated material utilised shall be free from organic matter and having a particle size no larger than 20 mm. The material shall be suitable to allow compaction as specified without causing damage to the pipeline. If the material removed during excavation does not comply, non-cohesive material shall be imported for use. Trench fill shall be free from boulders, large rocks, logs, stumps, tree loppings, builders refuse, broken concrete and other similar material.

Unless specified otherwise on the project specific drawings and documentation, trench fill material shall be compacted to the following minimum standards:

Table 7.1.5.12.1 Trench Fill – Minimum Compaction Standards

Material Type	Test Method	Minimum Compaction % - Trafficable areas	Minimum Compaction % - Non-trafficable areas
Non-cohesive (granular)	Density Index (ID) AS1289.5.6.1	75	70
Cohesive	Dry density ratio (RD)AS1289.5.4.1 and AS1289.5.1.1	98	95

The location for field compaction tests shall be agreed with the Icon Water Representative. The frequency of testing shall be one test in each 300 mm layer of fill for every 50 linear metres of pipe laid or part thereof.

Compaction testing shall be performed by an Independent Testing Authority (NATA Registered). All tests performed, including location details and results for each in-situ test shall be recorded.

7.1.5.13 Pressure Pipeline Thrust and Anchor Blocks

The installation contractor shall provide concrete thrust/anchor blocks in accordance with the project specific drawings and documentation. Note: Locations include, but are not limited to valves, flexibly jointed bends, tees, enlargers and reducers in pipes where the joints do not provide any axial restraint (e.g. socket-spigot joints).

The thrust/anchor blocks shall bear against undisturbed material normal to the direction of the thrust over the bearing area. The minimum required bearing area at each thrust block location shall be determined from the maximum design pressure for the pipework (including surge) and the maximum allowable lateral bearing capacities given in the geotechnical report.

Concrete thrust and anchor blocks shall be cured for a minimum of seven (7) days before subjecting to any thrust load. Unless otherwise noted, Class N25 concrete shall be used for anchor/thrust blocks.

Adequate temporary anchorage shall be provided as required to restrain the pipe when under test.

7.1.5.14 Pipeline Marking Tape

For all pipelines, marking tape shall be laid on top of the pipe embedment material before backfilling. For non-metallic pipes, the marking tape shall be of the detectable type. At valves and hydrants, the tape shall be connected to the metal surface fitting. Non-detectable marking tape (for metallic pipes) shall comply with AS 2648.1. The tape width shall be 100 mm minimum.

All marking tape (including the warning message detailed on such tape) shall be in accordance with the Icon Water Approved Products List (*STD-SPE-G-006*).

7.1.6 Pipework and Pipeline Examination and Testing

7.1.6.1 Above-Ground Pressure Piping and Pipelines – Metallic Materials of Construction

The Contractor shall conduct examination and testing in accordance with the requirements of AS 4041 for the class of piping encountered. In particular, the requirements detailed in Table 7.1.6.1.1 shall be complied with and these are referenced to Table 1.5 of AS 4041.

Table 7.1.6.1.1 Pipework and Pipeline – Examination and Testing Requirements

Examination or Test Type	Specific Requirements
Visual	100% of all joints shall be visually examined regardless of piping class.
Penetrant (only applicable for welded joints)	Class 3: Not required. Class 2A and 2P: Not required if 10% radiographic inspection is conducted. Otherwise, 10% of all welded joints shall be penetrant tested. Class 1: Not required as all Class 1 piping requires 100% radiographic or ultrasonic inspection.
Magnetic Particle (only applicable for welded joints)	Class 3: Not required.

Examination or Test Type	Specific Requirements
	Class 2A and 2P: Not required if 10% radiographic inspection is conducted. Otherwise, 10% of all welded joints shall be magnetic particle tested. Class 1: Not required as all Class 1 piping requires 100% radiographic or ultrasonic inspection.
Radiographic or Ultrasonic (only applicable for welded joints)	Class 3: Not required. Class 2A and 2P: 10% radiographic inspection of all welded joints is a minimum requirement. Class 1: 100% radiographic or ultrasonic inspection.
Pressure Tests	Hydrostatic testing shall be conducted for all above-ground pressure piping in accordance with Clause 6.7 of AS 4041 with the following exceptions: • For instrument air and service air piping, an initial service leak test in accordance with Clause 6.9 of AS 4041 is acceptable in lieu of hydrostatic testing. • For fluid services which are incompatible with residual fluid (e.g. clean water) being present within the piping system after completion of hydrostatic testing, pneumatic testing using either air or an inert fluid such as nitrogen in accordance with Clause 6.8.1 of AS 4041 is acceptable in lieu of hydrostatic testing. The installation contractor shall be responsible for the provision of any temporary supports or anchors (if required) during hydrostatic testing. The installation contractor shall be responsible for ensuring all joints and concrete anchor blocks have achieved the required strength prior to testing.

7.1.6.2 Below Ground Pressure Piping and Pipelines – Metallic Materials of Construction

The same requirements as detailed in the previous section for above-ground installation for metallic piping materials shall apply with the following additions/modifications:

- The hydrostatic test requirements detailed in Clause 6.3 of AS/NZS 2566 Part 2 shall be substituted in lieu of AS 4041 requirements for buried flexible pipelines.
- Deflection testing in accordance with Clause 6.5 of AS/NZS 2566 Part 2 shall also be conducted.

The installation contractor shall be responsible for the provision of any temporary supports or anchors (if required) during hydrostatic testing.

The installation contractor shall be responsible for ensuring all joints and concrete anchor blocks have achieved the required strength prior to testing.

7.1.6.3 Above and Below Ground Pressure Piping – Non-Metallic Materials of Construction

The Contractor shall perform inspection and testing in accordance with the relevant standard for the particular non-metallic pressure piping material as per Table 7.1.6.3.1.

Table 7.1.6.3.1 Non-Metallic Above and below ground Piping – Inspection and Testing Requirements

Pressure Piping Material	Specific Inspection & Testing Requirements
PVC-U to ASTM D1784 and D1785	100% visual inspection of all joints. Hydrostatic testing in accordance with clause 7.2 of AS/NZS 2032.
PVC to AS/NZS standards (e.g. PVC-U, PVC-O, PVC-M)	100% visual inspection of all joints. Hydrostatic testing in accordance with clause 7.2 of AS/NZS 2032. For below-ground installations, deflection testing in accordance with clause 6.5 of AS/NZS 2566 Part 2 shall also be conducted.
Polyethylene to AS/NZS standards (e.g. PE100)	100% visual inspection of all joints. Hydrostatic testing in accordance with clause 7.2 of AS/NZS 2033. For below-ground installations, deflection testing in accordance with clause 6.5 of AS/NZS 2566 Part 2 shall also be conducted.
GRP to Australian or International Standards	100% visual inspection of all joints. Hydrostatic Testing in accordance with clause 6.3 of AS/NZS 2566 Part 2. For below-ground installations, deflection testing in accordance with clause 6.5 of AS/NZS 2566 Part 2 shall also be conducted.
ABS to AS/NZS or International Standards	100% visual inspection of all joints. Hydrostatic Testing in accordance with Clause 7.2 of AS/NZS 3690. For below-ground installations, deflection testing in accordance with clause 6.5 of AS/NZS 2566 Part 2 shall also be conducted.

The installation contractor shall be responsible for the provision of any temporary supports or anchors (if required) during hydrostatic testing.

The installation contractor shall be responsible for ensuring all joints and concrete anchor blocks have achieved the required strength prior to testing.

7.1.6.4 Gravity (Non-Pressure) Pipelines – Above or Below Ground

For gravity (i.e. non-pressure) pipelines, the following requirements for examination and testing apply for all pipe materials with the exception of pipes not deemed to be flexible (e.g. reinforced concrete):

- 100% visual examination of all joints.
- Leakage testing in accordance with clause 6.4 of AS/NZS 2566 Part 2.
- Deflection testing in accordance with clause 6.5 of AS/NZS 2566 Part 2.

The installation contractor shall be responsible for the provision of any temporary supports or anchors (if required) during leakage testing.

The installation contractor shall be responsible for ensuring all joints and concrete anchor blocks have achieved the required strength prior to testing.

7.1.7 Cleaning and Disinfection

All pipes shall be cleaned so that they are free of foreign material both internally and externally.

The installation contractor shall notify the Icon Water Representative in writing of their intention to flush a piping system or pipeline. No flushing shall commence until written approval has been received from the Icon Water Representative.

The installation contractor shall take all necessary safety precautions prior to commencing works. This shall include but not be limited to the erection of safety barricades, advising personnel and putting in place a means to “catch” the cleaning medium including any debris and foreign matter.

Unless noted otherwise in the project specific documentation, all piping systems and pipelines shall be flushed using clean water at an adequate and approved velocity until all foreign matter is removed and a clean sample is obtained. Air or nitrogen may be used as a cleaning medium when clean water is deemed impracticable if prior written approval is provided by the Icon Water Representative.

Notwithstanding the abovementioned cleaning requirements, piping or pipelines used for the conveyance of potable (drinking) water shall be cleaned and disinfected in accordance with the requirements of AS 3500.1 if (i) pipe end caps are left off after the end of a day’s pipelaying, or (ii) if specifically detailed in the project specific construction documentation. Disinfection shall only be conducted by suitably experienced and approved Contractors.

7.2 Valve Manufacture, Inspection, Installation and Testing

7.2.1 Manufacture

Valve castings shall be sound and clean. Structural defects in ductile or cast iron valve components shall not be repaired and used in valve assembly. No welding (or weld repairs) is/are permitted on cast components unless specific written approval has been obtained from the Icon Water Representative.

Drainage holes shall be drilled or formed in any external pockets on the valve body or associated equipment, when necessary, to prevent moisture ponding prior to coatings being applied. Such holes shall be designed and provided for by the valve manufacturer and not the Installation Contractor.

All internal and external fasteners shall be made of grade 316 stainless steel and shall have standard ISO thread to AS 1110, AS 1111 and AS 1112. All stainless steel bolt threads shall be coated with anti-seize lubricant.

All valve parts requiring grease lubricating (e.g. gearboxes) shall be fitted with grease nipples.

The valve leakage rates shall not exceed that specified in the relevant standard and this Specification.

7.2.2 Procurement Acceptance

7.2.2.1 Inspection & Testing of Critical Valves

"Critical" valves are defined as valves that meet one or more of the following criteria:

a) A long lead time item, typically in excess of sixteen (16) weeks.

b) A bespoke/customised design manufactured by casting and/or welded fabrication methods.

c) A valve where stringent sealing/shut-off requirements must be met.

d) A valve where stringent valve characteristics (i.e. pressure drop versus percentage open) must be met.

Should a valve meet the criteria of being a "critical" valve, unless noted otherwise in the project specific documentation, it shall require that each individual valve be inspected by the Icon Water Representative and tested (with the Icon Water Representative witnessing such testing) in accordance with the requirements of the relevant standard. For example, the relevant Australian standards or API 598, EN12266, ISO 5208 etc. The project specific documentation will provide details of whether full compliance with the relevant standard is required or whether a reduced set of requirements need to be complied with. The Icon Water Representative shall require sufficient notice for each inspection and test requiring witnessing. In the case of valves manufactured and tested outside of Australia, a four (4) week notice period shall be required, otherwise for valves manufactured and tested in Australia, ten (10) working days' notice shall be sufficient.

The manufacturer/supplier shall also forward all necessary quality assurance documentation (e.g. material certificates) as nominated in the relevant standard to the Icon Water Representative.

7.2.2.2 Testing and Certification of Gate Valves

The requirements for testing and certification of gate valves for water and sewage service are as follows:

a) Gate valves shall be subject to full production and type tests in accordance with AS 2638.1 or AS 2638.2, as applicable. Type and production test certificates shall be supplied with each valve. Test certification shall comply with relevant parts of SAA HB 18.

b) The duration of the valve body and valve seat production tests for valves up to DN750 shall comply with the relevant standards. For larger valves the tests duration shall be a minimum of 10 minutes.

c) Permissible seat leakage for metal seated valves up to DN900 shall be as specified in AS 2638.1. For larger valves the leakage shall not exceed 10ml/min. No leakage is allowed for resilient seated valves.

The requirements for testing and certification of gate valves for services other than water and sewerage shall be as per the relevant API, ASME, EN or ISO standard).

Notwithstanding the above-mentioned requirements, all valves shall be provided with material certificates certified to EN10204 3.1. Testing shall be performed by a NATA approved agency.

7.2.2.3 Testing and Certification of Knife Gate Valves

The requirements for testing and certification of knife gate valves for water and sewage service are as follows:

a) All knife gate valves shall be subject to production tests and, if specified, full type tests in accordance with AS 6401. The tests shall include a body test and a gate leakage test. For bi-directional valves, the gate leakage test shall be conducted on both sides of the gate.

b) In order to demonstrate that the products consistently conform to the requirements of relevant standards, newly produced and modified valves shall also be subject to type tests in accordance with AS 6401.

c) Type and production test certificates shall be supplied with all valves. Test certification shall comply with relevant parts of SAA HB 18.

The requirements for testing and certification of gate valves for services other than water and sewerage shall be as per the relevant API, ASME, EN or ISO standard.

7.2.2.4 Testing and Certification of Butterfly Valves

The requirements for testing and certification of butterfly valves for water and sewerage service are as follows:

a) Butterfly valves shall be subject to full production and type tests in accordance with AS 4795.

b) Type and production test certificates shall be supplied with all valves. Test certification shall comply with relevant parts of SAA HB 18.

The requirements for testing and certification of gate valves for services other than water and sewerage shall be as per the relevant API, ASME, EN or ISO standard.

7.2.2.5 Testing and Certification of Non-Return Valves

The requirements for testing and certification of non-return valves for water and sewerage service are as follows:

a) All non-return valves DN375 and larger shall be subject to full production and type tests in accordance with AS 4794. Type and production test certificates shall be supplied with all valves. Test certification shall comply with the relevant parts of SAA HB 18.

b) The duration of the valve body and seat hydrostatic tests for valves up to DN750 shall comply with the relevant standards. For larger valves the tests duration shall be a minimum of 10 minutes.

c) The allowable seat leakage for valves up to DN750 shall be as specified in AS 4794. For larger valves, the leakage shall not exceed 30 millilitres per hour for each 25 mm of valve diameter.

The requirements for testing and certification of gate valves for services other than water and sewerage shall be as per the relevant API, ASME, EN or ISO standard.

7.2.3 Installation

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

- Above ground/floor;
- Above ground/floor with extension spindle;
- In pit/chamber;
- In pit/chamber with extension spindle;
- Buried with extension spindle.

All valves shall be installed so that they are easily accessible for operation and maintenance. Adequate dismantling means, such as load bearing dismantling joints or flanged pipe elbows, shall be provided close to each valve to facilitate its dismantling and re-installation.

Unless stated otherwise in this Specification, union joint valves may be used only on sizes DN50 and smaller.

Butterfly and short bodied tilting disc non-return valves shall 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 shall be installed with their shafts/hinge pins horizontal and the bottom of their discs shall open in the direction of flow. The valve discs shall operate freely from open to close into adjacent pipework. Disc clearance dimension shall be stated for each butterfly and non-return valve. Sufficient space must be allowed around non-return valves to remove the hinge pins.

During installation of butterfly valves, their discs shall be in fully open position.

Isolating valve operating elements, such as hand wheels, levers and removable keys shall be easily accessible and preferably positioned either (i) horizontally 1100 mm to 1300 mm above floor level, or (ii) vertically with the hand-wheel centreline 1000mm to 1400 mm above floor level. Subject to Icon Water's written acceptance, other positions may also be considered. Note: Where necessary, individual operating platforms shall be provided.

Valves installed at heights may be fitted with bevel type gearboxes, chain wheels and chains. Each chain wheel operated valve shall be equipped with a chain guide to permit rapid handling of the operating chain without "gagging" of the wheel and it shall also permit reasonable side pull on the chain. Operating chains shall be hot dipped galvanised and shall be looped to extend within 900 mm of the floor below the valve.

Manual operation of the valves shall be carried out with ease and without the need for any other extra equipment (Ref: Section 6.19.1). All valves shall be capable of being removed from their location in a pipeline without obstruction by the pipeline or other equipment.

All buried isolating valves and those installed under, and operated from individual platforms or valve chamber covers shall be fitted with spindle caps and, where necessary, extension spindles.

The extension spindles shall comprise a rigid shaft capable of transmitting the maximum torque requirement of the valve. The extension spindles for gate valves shall be manufactured, tested and supplied in accordance with AS 2638.2 or AS 2638.1, as applicable. No welding of spindle cast components is permitted.

In buried valve installations, extension spindles shall be enclosed in a rigid tube or shroud which is connected to the gearbox. The spindle cap shall be protected by a surface box.

For valves installed below operating platforms, their (extension) spindles shall end approximately 50 mm below the platform level and the platforms shall be provided with adequate keyholes directly above the spindles to enable operation with removable keys. The extension spindles shall be fitted with supporting brackets.

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

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

8 Appendices

8.1 Appendix 1 - Legacy Water Codes

Abbreviation	*Valve/Pipe system*	*Abbreviation*	*Valve/Pipe system*
AA (AUA)	Auxiliary acid	LS (LSN)	Lime solution
AB	Auxiliary base	LW	Landscape irrigation water
AD	Auxiliary dry chemical solution	MW	Motor cooling water
AL	Aluminium sulphate	PAC	PAC (Powdered Activated Carbon)
AW	Auxiliary chemical	PC	Cationic polymer
BA	Filter Backwash air	PN	Non-ionic polymer
CAS	Coagulant Aid solution	PP	Polymer Powder
CC	Condenser cooling water	PCS	Primary coagulant solution
CD	Carbon dioxide	PPP	Potassium Permanganate powder
CDS	Carbon dioxide solution	PPS	Potassium Permanganate solution
CDV	Carbon dioxide gas-vacuum	PS	Polymer Solution or Process sample
CE (CW)	Clarifier Effluent (Clarified Water)	PSN	Polymer Solution
CG	Chlorine gas	PW	Potable Water
CL	Chlorine liquid	RW	Raw water
CS	Chlorine solution	RX (RWW)	Reclaimed washwater
CV	Chlorine gas-vacuum	SL	Sludge
DR	Drainage	SA	Compressed air - service
ED	Effluent drain	SD	Sanitary drainage
FD	Floor drain	SSD	Sub soil drain
FE	Flocculant (Iron Salt)	STD	Storm drain
FL	Fluoride	TD	Tank drainage
FL (FS)	Fluoride solution	TO	Tank overflow
FO	Fuel oil	TS	Supernatant
FSW	Fire service water	TU	Thickener Sludge or Thickener Underflow

Abbreviation	*Valve/Pipe system*	*Abbreviation*	*Valve/Pipe system*
FW	Filtered water	TW	Treated water
FWW	Filtered Waste Water	VA	Vacuum air
HP	Hydrogen Peroxide	VE	Vent
HR	Heat reservoir	WW	Wash water
HW	Hot water	WWW	Waste washwater
LA	Lime air	WWO	Wash water Overflow
LD	Lime delivery		

8.2 Appendix 2 - Legacy Sewage Codes

Abbreviation	*Valve/Pipe system*	*Abbreviation*	*Valve/Pipe system*
AA	Aeration air	MLR	Mixed liquor return
AI	Inert ash	NS	Return nitrified sludge (Refer to RAS)
AL	Lime ash	NT	Nitrogen
AS	Antiscalant	NU	Nutrient water
BA	Filter backwash air	NW	Non-potable water
BW	Filter backwash water	NWS	Non-potable water spray
CA	Channel aeration air	PA	Pre-aeration air
CD	Carbon dioxide	PD	Pumped drainage
CE	Centrate	PE	Polyelectrolyte
CI	Citric acid	PG	Propane gas
CG	Chlorine gas	PHW	Process hot water
CL	Chlorine liquid	PS	Process sample
CO	Centrate tank overflow	PSN	Polymer Solution
CS	Chlorine solution	PSC	Primary scum
CSC	Centrate scum	PW	Potable water
CT	Caustic soda (sodium hydroxide)	RAS	Return activated sludge
CV	Chlorine gas -vacuum	RL	Reclaimed lime
CWR	Chilled water return	RS	Recirculated sludge
CWS	Chilled water supply	RSW	Raw sewage
DS	Defoamant Solution	RWL	Rainwater leader
DMW	Domestic water	SA	Compressed air – service
DW	Deionised water	SCO	Scum thickener overflow
FA	Foul air exhaust	SD	Sanitary drain
FD	Floor drain	SDG	Sulphur dioxide gas
FE	Flocculant (Iron Salt)	SDL	Sulphur dioxide liquid

Abbreviation	*Valve/Pipe system*	*Abbreviation*	*Valve/Pipe system*
FL	Fresh lime	SE	Secondary treated effluent
FOR	Fuel oil return	SG	Screenings
FOS	Fuel oil supply	SH	Sodium hypochlorite
FW	Filtered water	SL	Sieve liquid discharge
GO	Grit dewaterer overflow	SSC	Secondary scum
GR	Grit	ST	Storm water
HP	Hydrogen Peroxide	STD	Storm drain
HR	Heat reservoir	SWR	Scrubber water return
HTA	Compressed air – high temp	SWS	Scrubber water supply
HWR	Domestic hot water return	SWW	Settled wastewater
HWS	Domestic hot water supply	TD	Tank drainage
IA	Compressed air - instrument	TO	Tank overflow
LD	Lime delivery	TS (TSC)	Thickened scum
LO	Lube oil	TW	Treated water
LS	Lime sludge	VE	Vent
LW	Land scape irrigation water	WB (WBW)	Waste backwash water
ME	Methanol solution	WB (WAS)	Waste nitrified sludge/Waste activated sludge
MED	Diluted Methanol Solution		

8.3 Appendix 3 – Requirements for Pickling and Passivating Stainless Steel

A3.1 Introduction

This section covers the requirements for the internal cleaning of piping system by pickling and passivation.

The pickling operation shall include degreasing, acid wash, rinsing, passivating, drying and application of a protective coating.

The pickling operations shall be performed in a continuous manner, particularly the rinsing and passivating stage following the acid cleaning cycle.

The cleanliness required shall be such that the treated piping shall be free from dirt, grease, oil, moisture, mill scale, fluff or any other form of contamination.

A3.2 Degreasing

Large and loose scales and foreign material can be removed by hand or power tool prior to cleaning.

Degreasing of the piping surfaces shall be performed to remove all traces of oil and grease prior to pickling.

Degreasing shall be performed using heavy duty alkaline or detergent cleaning solutions maintained at 80 – 90^{o}C (176 – 194^{o}F) for one or more hours depending on the degree of contamination.

Tri-chloroethylene or an approved alternative may be used as a solvent, care should be exercised that the area is adequately ventilated to clear toxic vapours. (Contractor to ensure solvent is suitable for the pipe being cleaned).

The Contractor shall propose degreasing solutions to the Icon Water Representative for approval.

The piping surfaces should be thoroughly rinsed or flushed with potable water for at least 15 minutes to remove any traces of the degreasing solution.

A3.3 Passivation and Pickling

A3.3.1 General

The internals of all nominated stainless steel pipework shall be pickled and passivated by the Contractor in accordance with ASTM A380. All pickling and passivation shall be followed by removal of all residues using fresh clean water with a pH value between 6 and 7. For stainless steel lines the maximum chloride content shall be not greater than 30ppm. All outside pipe weld surfaces shall be pickled and passivated using pickling paste.

The pickling shall be carried out in accordance with the above code, specifically as follows:

- Pickling applies to chromium-nickel grades, AISI 300 Series, and chromium grades, AISI 400 Series, containing 17% or more chromium – except the free-machining grades.
- An acid solution made of 10 to 25 percent by volume (150 to 350g per litre) of nitric acid (70%), and 2 to 4% by volume (25 to 50g per litre) of hydrofluoric acid (60%) is to be used.
- Immerse the specimens in this solution at room temperature to 54.4°C (130°F) for 10 minutes, or until clean.

Instruments and other inline items instruments shall be removed or isolated as per project procedures.

A3.3.2 Acid or Pickling Cleaning

Acid cleaning may be carried out to remove oxide and scales internally from pipe systems or equipment.

The Contractor shall prepare a procedure and specification for acid cleaning in accordance with ASTM A380.

Certain proprietary brands of de-scaling paste, solvents or solutions are available, they are acceptable provided laboratory tests, and user's list can be furnished to prove such a product will perform an efficient pickling job. The Contractor shall submit documentation to the Icon Water Representative for approval.

A3.3.3 Typical Acid Cleaning Procedure

Depending on the amount of piping to be subject to acid cleaning, it can be sprayed, circulated or immersed in a 10% solution of inhibited hydrochloric acid at a temperature not exceeding 66^{o}C for one hour or longer until the oxide scale is completely removed.

The inhibitor concentrations shall be in accordance with the supplier's recommendations.

The piping shall be dipped with vents open at high points to prevent trapping any air and to allow the escape of hydrogen gas during the pickling operation.

The acid shall be made fresh for each pickling operation. The strength of the acid shall be monitored to maintained the required concentration.

The acid solution shall be replaced if the Ferric Iron (FE +++) content exceeds 0.4% by weight, in order to avoid excessive metal loss.

Piping shall be rinsed/flushed thoroughly with potable water as rapidly as possible after the acid cleaning operation to rid the surfaces of all traces of excess acid or iron salts and to prevent the formation of after rust. (High pressure water and adequate draining are required to facilitate rapid rinse/flush operation).

All dead ends should be opened long enough to flush out all entrapped acid.

The rinse shall continue for at least 10 minutes after the pH of the waste water equals the pH of the incoming water.

A3.3.4 Passivation

Passivation of internal surfaces shall be performed as rapidly as possible after the rinse/flush cycle.

Passivating solutions/solvents containing 3% phosphoric acid shall be flushed through the pipework at a temperature between 60^{o}C and 80^{o}C for at least one hour.

Certain proprietary brands of pickling solution are claimed to passivate the metal in the same reaction as for pickling. If this claim can be substantiated by laboratory reports and proven field use, a separate passivation cycle will not be necessary. The Contractor shall submit documentation to the Icon Water Representative for approval.

A3.4 Protective Coating and Fluid

Internally cleaned surfaces may be required to be coated with a rust preventative fluid which will not require removal before start up.

Pre-approved/acceptable preventative fluids are:

- Shell Ensis Series (consult Shell for specific details),
- Mobil Mobilarma 522 and 524

Note: Other preventative fluids may be nominated by the Contractor for approval by the Icon Water Representative.

A3.5 Transportation of Grit Blasted and Pickled Piping

All treated piping shall be protected to prevent damage prior to transit and during storage.

Pipe and equipment ends shall be securely plugged and sealed with plastic caps and taped.

Flange gasket surfaces shall be protected with bolt-on wooden blanks. In addition a corrosion preventative fluid shall be applied to the gasket surfaces. When wooden blanks are used, a plastic sheet shall be placed between the flange and blank to prevent the preventative compound soaking into the wood.

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