Assets Planning and Delivery Group
Engineering

DESIGN STANDARD DS 33

Water Treatment Plants - Mechanical

VERSION 1
REVISION 6

SEPTEMBER 2024

FOREWORD

The intent of Design Standards is to specify requirements that assure effective design and delivery of fit for purpose Water Corporation infrastructure assets for best whole-of-life value with least risk to Corporation service standards and safety. Design standards are also intended to promote uniformity of approach by asset designers, drafters and constructors to the design, construction, commissioning and delivery of water infrastructure and to the compatibility of new infrastructure with existing like infrastructure.

Design Standards draw on the asset design, management and field operational experience gained and documented by the Corporation and by the water industry generally over time. They are intended for application by Corporation staff, designers, constructors and land developers to the planning, design, construction and commissioning of Corporation infrastructure including water services provided by land developers for takeover by the Corporation.

Nothing in this Design Standard diminishes the responsibility of designers and constructors for applying the requirements of the Western Australia's Work Health and Safety (General) Regulations 2022 to the delivery of Corporation assets. Information on these statutory requirements may be viewed at the following web site location:

Overview of Western Australia's Work Health and Safety (General) Regulations 2022 (dmirs.wa.gov.au)

Enquiries relating to the technical content of a Design Standard should be directed to the Senior Principal Engineer, Mechanical Section, Engineering. Future Design Standard changes, if any, will be issued to registered Design Standard users as and when published.

Head of Engineering

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Users should use and reference the current version of this document.

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Any interpretation of anything in the Standards/Specifications that deviates from specific Water Corporation Project requirements must be referred to, and resolved by, reference to and for determination by the Water Corporation's project manager and/or designer for that particular Project.

REVISION STATUS

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

REVISION STATUS						
SECT.	**VER./ REV.**	**DATE**	**PAGES REVISED**	**REVISION DESCRIPTION (Section, Clause, Sub-Clause)**	**RVWD.**	**APRV.**
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49	1/0	15.08.06	All	Reformatted	EJP	AAK
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55	1/0	15.08.06	All	Reformatted	EJP	AAK
56	1/0	15.08.06	All	Reformatted	EJP	AAK
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56	**1/6**	**15.08.24**		**Added reference to SPS250.**	**BM**	**SE**
57	1/0	15.08.06	All	Reformatted	EJP	AAK
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64	1/0	15.08.06	All	Reformatted	EJP	AAK
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66	1/3	23.12.16	All	Contains previous Section 64	MB	SE
67	1/0	15.08.06	All	New section	EJP	AAK
67	1/3	23.12.16	All	Contains previous Section 65	MB	SE
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68	1/2	1.11.09	32, 33	Clause 67.1, Table 67.1 amended	EJP	SE
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DESIGN STANDARD DS 33

Water Treatment Plants – Mechanical

CONTENTS

1 SCOPE AND GENERAL

1.1 Scope

Design Standard DS 33 sets out the Corporation's mechanical design standards, guidelines and preferred engineering practices for minor and major water treatment plant for water supply applications. Section topics have been arranged in alphabetic order to assist the reader in finding relevant information.

Treatment plants of necessity comprise an assemblage of different items of plant, many of which are commonly used in other water related applications. The design factors and related criteria referenced in this Standard in many instances reside in other sections of the Corporation's DS 30 series of mechanical design standards. Accordingly, the Standard directs the Designer to relevant locations within this Standard and other mechanical design standards in the DS 30 series for many of the listed design factors. Additionally, this Standard contains specific treatment plant related design criteria. Further, this Standard is not intended for gas and high temperature or steam applications.

1.2 Purpose

The Corporation's mechanical design standards are documented in its DS 30 Standards series. Designers shall comply with these standards for the design and specification of mechanical components of assets being acquired for the Corporation.

The purpose of the DS 30 Standards series is to provide:

(a) Standards and guidelines applicable in the design of Corporation assets,

(b) Explanatory or specific design information,

(c) Information relating to Corporation preferences and practices which have evolved from over a century of experience in the water industry.

1.3 Mechanical Design Process

The Designer shall comply with the relevant mechanical design process (e.g. simple, minor, major) contained in DS 30.

1.4 Standards

All materials and workmanship shall comply with latest revisions of the relevant codes and standards.

Water Corporation Strategic Product Specifications (SPS), or in their absence the latest editions of Australian Standards, or Water Services Association of Australia (WSAA) Codes shall be referenced for design and specification. In the absence of relevant Australian Standards or WSAA Codes, relevant international or industry standards shall be referenced.

1.5 References

The full reference list of Australian, International, and Corporation standards and codes referenced in the DS 30 series of standards is contained in Appendix A (Corporation Standards section) of DS 30-01.

1.6 Mandatory Requirements

The use of the imperative "shall" denotes a mandatory requirement. Use of modal auxiliary verbs other than "shall" such as "will", "should", "may", etcetera indicates recommended practice.

1.7 Nomenclature

1.7.1 Definitions and Relationships

A comprehensive list of the terminology and relationships for equipment referred to in this Standard is contained in the DS 30-01 Nomenclature section.

1.7.2 Summary of Preferred Terms

A comprehensive list of preferred terms for equipment referred to in this Standard is contained in the Summary of Preferred Terms in the DS 30-01 Nomenclature section.

1.7.3 Abbreviations

A comprehensive list of abbreviations for equipment referred to in this Standard is contained in the Abbreviations sub-section of the DS 30-01 Nomenclature section.

1.7.4 Standard Units and Relationships

The units and relationships used for mechanical designs based on this Standard shall be in accordance with those specified in the Standard Units and Relationships section in DS 30-01.

1.7.5 Drawing Symbols

A comprehensive list of mechanical drawing symbols for equipment referred to in this Standard is referenced in DS 80.

2 AIR COMPRESSORS

For design criteria related to air compressors refer to the Air Compressor section of DS 35.

3 AIR CONDITIONERS

Air conditioners shall be in accordance with the Air Conditioners section of DS 35.

4 AIR VALVES

Air valve design shall be in accordance with the Air Valve section of DS 31-02

5 ALIGNMENT OF MACHINERY

Alignment of machinery shall be in accordance with the Alignment of Machinery section of DS 38-01.

6 AMBIENT CONDITIONS

The ambient operating conditions shall be determined in accordance with the Site Conditions section of DS 30-02.

7 ANCILLARY PLANT

For information relating to the design of the following pump station ancillary plant, refer to the relevant sections of DS 35 which contains the following:

(a) Air Compressors;

(b) Air Conditioning;

(c) Blowers;

(d) Cranes;

(e) Engines;

(g) Fans;

(h) Generating Sets;

(i) Sump Pumps;

(j) Surge Vessels.

8 AUTHORISED PRODUCT

Mechanical products that have been authorised for use on Corporation infrastructure are contained in the Strategic Product Register.

9 BACKFLOW PREVENTION DEVICES

Backflow prevention device design requirements shall be in accordance with the Backflow Prevention Devices section of DS 31-02.

10 BALANCING

The balancing requirements for rotating mechanical equipment shall be in accordance with the Balancing section of DS 30-02.

11 BASEPLATES

Baseplate design shall be in accordance with the Baseplates section of DS 30-02.

12 BLOWERS

Blower design shall be in accordance with the Blowers section of DS 35.

13 BUILDINGS

Building design shall be in accordance with the Buildings section of DS 30-02.

14 CHEMICAL DOSE PUMPS

Chemical dose pumps shall be in accordance with the Chemical Dose Pumps and Progressive Cavity Pumps section of DS 32.

15 CHLORINATION

15.1 General

Water disinfection practices used by the Corporation are generally via chlorine gas (bulk liquid form), hypochlorite in a diluted liquid solution or via chloramination which combines chlorine and ammonia gases to provided extended disinfection effectiveness. Chlorine is dispensed in measured quantities via a gas chlorinator and hypochlorite via dosing pumps. Other disinfection methods such as ultraviolet (UV) light are used in specific but limited applications. For general information regarding ultraviolet (UV) light disinfection refer to the Ultraviolet (UV) Light Disinfection section in this Standard.

Chlorine or chloramination are effective methods of disinfection in treating water by:

(a) Destroying a broad range of micro-organisms such as bacteria and viruses and since its introduction towards the end of the nineteenth century has led to eliminating drinking water related diseases such as typhoid fever and dysentery.

(b) Controlling some water quality aesthetics problems such as taste, odour and colour by oxidising undesirable problem-causing constituents e.g. colour producing iron and manganese

(c) Providing a residual, which continues its disinfection role in the distribution and reticulation systems, and assists in preventing formation of biological slimes and algae.

Chlorine disinfection is linked with the formation of potentially harmful disinfection byproducts such as Tri-halo methanes (THMs) and, at dose rates suitable for water production, is ineffective at inactivating Cryptosporidium.

15.2 Gas Chlorination

Chlorine gas added to water forms hypochlorous acid (HOCl) which acts as an active and the cheapest drinking water disinfectant for water supplies.

Chlorine dosing upstream of water supply pumps shall only be permitted providing the dose rate into the suction manifold does not exceed 2 mg/L. Chlorine dose rates in excess of 2 mg/L are highly oxidising and will corrode exposed metals e.g. cast or ductile iron, copper alloys and stainless steel.

Whilst gas chlorination is a widely used disinfectant for drinking water it has been the subject of concerns relating to hazards involved in transportation, handling and storage and it is important these issues are dealt with proper design as covered in the following.

15.3 General Gas Chlorination Design

Gas chlorination design shall comply with AS 2927 and the relevant Corporation chlorine design standards with respect to, but not limited to the following:

(a) Site location;

(b) Design and construction of the chlorination system;

(c) Storage and handling of chlorine gas cylinders;

(d) Ventilation of chlorine facilities;

(e) Determination of fan types and performance;

(f) Pipework and valves including the following:

- Drum to manifold pipe type and configuration;

- Manifold pipework type and configuration;

- Manifold to chlorinator pipe type and configuration;

(g) Diffusers:

For information including recommended materials for diffusers refer to the Diffusers section of this Standard;

(h) Chlorinator;

(i) Fire Protection;

(j) Safety Equipment;

(k) Personnel Protection Equipment;

(l) Materials which shall comply with AS 2927 for materials designated “S” in Appendix E;

(m) Drum installations;

(n) Cylinder installations;

(o) Scales.

15.4 Corporation Standard Chlorine Designs

Design of gas chlorination systems shall be conducted in accordance with the Corporation’s Standard Chlorine Designs with respect to, but not limited to the following:

(a) P&IDs for 68 kg and 920 kg cylinders;

(b) Logic diagrams;

(c) Valve and equipment schedules;

(d) Filter general arrangements;

(e) Expansion chambers;

(f) Flexible connections;

(g) General arrangements;

(h) Isometric arrangements;

(i) System pipe supports;

(j) Chlorine dosing rooms;

(k) Gasket maintenance testing rig.

15.5 Characteristics of Gas Chlorination

Disinfection effectiveness is rated as very good for killing bacteria and viruses, and good for maintenance of a residual.

By-product formation is high for organic and brominated by-products and not relevant for inorganic by-products. This characteristic indicates the potential for formation of harmful disinfection by-products such as THMs.

The safety risk for gas chlorination is high but with a low complexity from an operational perspective.

15.6 Hypochlorite

Sodium hypochlorite (NaOCl) is a viable and acceptable alternative to gas chlorination. They both produce OCl which hydrolyses to form hypochlorous acid (HCOl). Calcium hypochlorite (CaOCl2) dosing is not preferred due to cost and reliability performance relative to sodium hypochlorite.

Sodium hypochlorite can be delivered to site as 12.5% m/m or 4.5% m/m for small facilities. Alternatively, sodium hypochlorite can be produced on site using:

- Continuous Electro-Chlorination, which uses in-line electrolysers to form chlorine from the background concentration of chloride in the water; or
- Brine Electro-Chlorination, which batches brine from salt that is delivered to site and dissolved in softened water and pumped through electrolysers to generate a 0.9% m/m sodium hypochlorite solution.

15.6.1 Sodium Hypochlorite

Sodium hypochlorite is:

(a) The second cheapest method of disinfection;

(b) Provided in a bulk liquid form comprising a 12.5% solution;

(c) Provides residual disinfection;

(d) An oxidising agent;

(e) Less hazardous compared with chlorine gas in terms of transportation, handling and storage.

Designs shall consider:

(a) The tendency for sodium hypochlorite to deteriorate rapidly in storage depending upon the ambient temperature, age of the compound, and concentration and level of impurities that may be present; and

(b) Scaling problems that sodium hypochlorite can produce particularly if it is subjected to excessive pressure reduction such as present at a venturi or orifice plate.

15.6.2 Calcium Hypochlorite

Calcium hypochlorite shall not be used at new dosing facilities; instead, small dosing facilities will use sodium hypochlorite (either generated on site by electro-chlorination or delivered).

Calcium hypochlorite is:

(a) Approximately twice the cost of sodium hypochlorite for small quantities;

(b) Generally supplied in powder or granular form which is mixed with water to form a solution;

(c) Provides residual disinfection;

(d) An oxidising agent;

(e) Less hazardous compared with chlorine gas in terms of transportation, handling and storage;

(f) Relatively stable when stored in dry form.

Calcium hypochlorite can be hazardous when stored in conjunction with organic compounds as they can be subject to a chemical reaction and subsequent combustion. It also produces an exothermic reaction when mixed with water and accordingly to reduce heat generated, the calcium hypochlorite should be added in measured quantities to the water and not the reverse.

15.6.3 Characteristics of Hypochlorite

Disinfection effectiveness is very good for bacteria and viruses, and good for maintenance of a residual. By-product formation is high for organic, brominated and inorganic by-products. This characteristic indicates the potential for formation of harmful disinfection by products such as THMs. The safety risk is medium with a low complexity from an operational perspective.

Hypochlorites can cause problems with standard Viton® materials causing premature failure of components. Viton® based components used for hypochlorite service shall be stabilised with carbon black.

15.7 Chlorine Buildings

Chlorine building design shall comply with the requirements of DS 70-01.

15.8 Chlorine Container Emergency Shutoff Devices Chlorine

Chlorine container emergency shutoff devices shall comply with the requirements of DS 70-03.

15.9 Chlorine Container Floor Scales

Chlorine container floor scale design shall comply with the requirements of DS 70-05.

15.10 Chlorine Leak Detectors

Chlorine leak detectors shall comply with the requirements of DS 70-02.

16 COATINGS

Coatings design shall be in accordance with the Coatings section of DS 30-02.

17 COMPRESSED AIR

Compressed air design requirements shall be in accordance with the Compressed Air section of DS 35.

18 CONDITION MONITORING AND PROTECTION

Condition monitoring and protection design shall be in accordance with the Condition Monitoring and Protection section of DS 30-02.

19 CONFINED SPACE

Confined space design shall be in accordance with the Confined Space section of DS 30-02.

20 CORROSION

For general information regarding corrosion mitigation refer to the Corrosion section in DS 30-02 and the Glossary.

21 CRANES

Crane design shall be in accordance with the Cranes section of DS 35.

22 DIESEL ENGINES

Diesel engine design requirements shall be in accordance with the Diesel Engines and Diesel Engine Driven Plant sections of DS 35. Diesel storage shall be in accordance with Diesel Systems design standard DS77.

23 DIFFUSERS FOR CHLORINE INJECTION

23.1 General

Diffusers shall be designed to ensure proper mixing. The design shall be sufficiently pressurised to avoid gassing off.

23.2 Materials

Designers shall consider the following requirements:

(a) Diffusers shall be designed considering both the injected chemical and chemical concentration to determine the correct diffuser material selection. For example, Designers should consider following information relating to materials used for chlorine injection diffusers for large water mains;

(b) Since chlorine dosing may produce residual chlorine concentrations of up to 3,000 mg/L this means that specialty materials are required for the dosing equipment exposed to these high concentrations;

(c) 316 stainless steel for instance is unsuitable for chlorine dosing pipework (the Nickel Development Institute recommends it as suitable for residual chlorine concentrations only up to 5 mg/L). The Corporation has experienced failure of 316 stainless steel where it has been used in dosing applications, where high chlorine concentrations were present;

(d) The Corporation has experienced satisfactory operation with materials such as PVC-U and alloys such as 2RK65, SAF 2507 and Hastelloy C-22® as dosing diffusers or sparges;

(e) Elastomeric seals used in this application are usually EPDM, but this material is not resistant to fluorosilicic acid (FSA), so when this is dosed in combination with chlorine, PTFE seals are recommended.

24 DESIGN PROCESS

24.1 General

The design process shall be in accordance with Process Engineering design standard DS81. The water treatment plant (WTP) process designers shall determine the plant processes, the expected life of the plant, and the stages for its expected development. The process design (read together with the system requirements provided by the asset planner) shall form the basis for the mechanical and electrical WTP design.

In addition to the design criteria contained in this Standard, the Designer should also refer to the relevant parts of DS 30-02, DS 31-01, DS 31-02, DS 32, DS 35, DS 38-01 and DS 38-03.

24.2 Mechanical Design Process

The Designer shall comply with the relevant mechanical design process requirements contained in DS 30.

25 DISINFECTION

For gas and hypochlorite chlorination, and UV light disinfection refer to the respective Chlorination and Ultra-Violet Light (UV) sections of this Standard.

26 EMERGENCY SAFETY SHOWERS AND EYEWASH STATIONS

Purpose-designed emergency safety shower and eyewash stations shall be provided for treatment plant and other work areas where potential exists for persons to encounter dangerous chemicals.

Unless otherwise specified, emergency safety shower and eyewash stations shall comprise a plumbed, stainless steel, free-standing stainless steel combination safety shower and eye/face wash configured for hand and foot operation.

The safety shower and eyewash station design shall comply with the requirements of DS 79-02 and shall be installed in accordance with the manufacturer's recommendations.

27 FANS

Ventilation fan design shall comply with the Fans section of DS 35.

28 FASTENERS

Structural fasteners shall comply with DS 30-02 and bolting shall comply with DS 38-01. Flange fasteners and bolting shall comply with DS 38-03.

29 FINANCIAL IMPACT STATEMENT

For information relating to the Corporation's Financial Impact Statement refer to that section contained in DS 30-02.

30 FLANGES FOR PIPEWORK

Flanges design shall be in accordance with the Flanged Connections section of DS 31-01.

31 FLEXIBLE COUPLINGS

Flexible coupling design shall comply with the Transmission Drives section of DS 30-02.

32 FLUOROSILICIC ACID (FSA) STORAGE AND DOSING FACILITIES

Fluorosilic acid storage and dosing facilities design shall comply with the requirements of DS 71-01 and FSA Dosing contained in the Chemical Dose Pumps section of DS 32.

33 GEARBOXES

Gearbox design shall comply with the Transmission Drives section of DS 30-02.

34 GENERATING SETS

Generating sets shall be in accordance with the Generating Sets section contained in DS 35. Diesel storage shall be in accordance with Diesel Systems design standard DS77.

35 GUARDS

Guards for rotating machinery or hazardous equipment shall be in accordance with the Guards section of DS 30-02.

36 HANDRAILS

Handrails shall comply with the requirements of the relevant parts of the Stairways, Walkways and Ladders section contained in DS 30-02.

37 INSTALLATION

Installation shall comply with the relevant requirements contained in DS 38-01.

38 ISOLATING VALVES FOR PIPEWORK

Pipework isolating valves shall be in accordance with the Isolating Valve section of DS 31-02 and the Valves section of this Standard.

39 LUBRICATION

Lubrication and lubricants shall be in accordance with the Lubrication section of DS 30-02.

40 MAGNETIC FLOWMETERS

Magnetic flowmeter design requirements shall be in accordance with the Magnetic Flowmeters section of Field Instrumentation design standard DS 40-09.

41 MATERIALS

For general information regarding materials refer to the Materials section contained in DS 30-02 and the Glossary (DS30-01). Materials for specific pump components are detailed in the relevant sections for water, borehole and sewage pumps contained in DS 32.

42 MIXERS

Aerator and mixer design requirements shall be in accordance with the following requirements.

42.1 Scope

42.1.1 Agitation Type Mixers

Mixers used for water treatment are generally of the mechanical agitation type and this section will essentially focus on them.

42.1.2 Static Mixers

Static or motionless mixers are also available but are restricted to blending and dispersing treatment chemicals into water pipelines as described in Chemical Dosing design standard DS78. Advantages claimed are low cost, significant energy savings, easy installation and minimal maintenance. This section will not deal any further with static or motionless mixers as this is covered in DS78.

42.2 General

There are four different types of mixing available using mechanical agitation. The type of mixing required will depend upon the application and desired outcome. The four mixing types are:

(a) Agitation which essentially is pure turbulence;

(b) Homogenisation which is a combination of turbulence and flow whereby turbulence is the greater component;

(c) Suspension which is a combination of turbulence and flow whereby flow is the greater component;

(d) Flow creation which is essentially pure flow.

42.3 Macro and Micro-Mixing

Mixing by mechanical agitation causes different results on the fluid depending on the type of mixing used. For example, where the mixing has a high flow, low turbulence and therefore low shearing effect, it produces a macro-mixing result. On the other hand, where the mixing has a high turbulence and therefore high shearing stress effect on the medium, it produces a micro-mixing result.

42.4 Mixer Arrangement

Mixing in water treatment processes is generally achieved via a conventional (dry) type electric motor driven mixer, which is vertically oriented and either flange mounted above the tank for large types or clamped to the tank for small types.

The mixer comprises an electric motor with or without a gearbox (depending on whether there is slow or high speed requirement) coupled to a shaft and impeller assembly. The type of mixing provided is a function of the impeller diameter, blade pitch and propeller speed.

42.5 Mixing Parameters

Mixer design and selection for water treatment applications generally requires specialised expertise by the mixer supplier and therefore it is important that the Designer provides basic information to the supplier which will allow optimal design of the mixing system. Typical information required by the mixer designer is shown in the table below:

Table 42.1 - Information to be Provided for Mixer Design

Component	Specific Information
Type of tank	Contact zone, anaerobic, aerobic , flocculation
Mixing outcome required	Homogenisation, suspension, flow creation
Product type	Type of chemical solution
Treatment process	pH correction, flocculation
Flow rate	Process flow rate through the tank
Flow path	Identify process flow path
Fluid concentration	g/L or %

Fluid characteristics	Characteristics likely to affect mixing or other critical aspects e.g. stratification, solidification, etc.
Tank shape	Circular, square, rectangular, annular
Tank dimensions	Vertical and horizontal measurements
Obstacles	Pipes, columns, baffles, benching
Flow nozzles	Position of inlets, up flows and outlets
'G' value of fluid	Factor determining the amount of mixing required

42.6 Mixer Selection

The following parameters provide selection criteria for the mixer:

a) The tank dimensions, fluid concentration and mixing type required determine the mixer impeller diameter and number of impellers;

b) The tank type, fluid concentration and mixing type required determine the mixer power required;

c) The tank shape, tank dimensions and obstacles determine the mixer position, orientation and accessories required for the installation.

42.7 Mixer Design Considerations

The following design considerations should be considered in designing the mixing system:

a) Avoid flow orientations which produce short-circuits;

b) Orient mixers to take account of the tank inlet and outlet, which if ignored could produce undesirable effects such as short-circuiting; and

c) Orient mixers to avoid dead zones that can be produced by obstructions such as columns or by jet intersections with mixers in parallel that interfere with each other reducing performance at the extremities.

42.8 Mixer Technical Specification Requirements

The following mixer features should be provided:

a) Squirrel cage electric motor to AS 60529 IP 56 rating for indoor applications. Weatherproof for outdoor applications;

b) Where fitted, gearboxes shall comply with the Transmission Drives section of DS 30-02;

c) The mixer shaft, coupling, fasteners and impeller assembly shall be manufactured from a corrosion resistant material compatible with the product to be mixed but in any event shall be stainless steel of minimum grade 316 to ASTM A276/A276M;

d) Occupational health and safety and permissible environmental noise level requirements shall comply with the Noise section of DS 30-02.

42.9 Accessory and Control Requirements

Control functions should incorporate interlocks to shut down mixers on emptying tanks.

43 NOISE LEVELS

Occupational health and safety and permissible environmental noise level requirements shall comply with the Noise section of DS 30-02.

44 NON-RETURN VALVES

Non-return valve design requirements shall be in accordance with the Non-Return Valve section of DS 31-02 and the Valves section of this Standard.

45 OCCUPATIONAL SAFETY AND HEALTH

Occupational Safety and Health standards shall comply with the relevant section of DS 30-02.

46 OPERATION AND MAINTENANCE MANUALS

Comprehensive operation and maintenance manuals shall be provided for all mechanical plant and equipment supplied for the treatment plant which shall comply with the following:

46.1 Format and Language

The manuals shall be provided in the English language in clear diagrammatic and text format.

46.2 Content

Manuals shall contain all the relevant information required to correctly transport, unpack, assemble, install, commission and maintain the plant or equipment in operational service including:

(a) Detail of plant and equipment features;

(b) Assembly and installation instructions;

(c) Testing and commissioning procedures;

(d) Safety instructions;

(e) Operation;

(f) Operational adjustments;

(g) Maintenance requirements and service intervals;

(h) Trouble shooting guidelines;

(i) Performance and technical specifications;

(j) Lubricant specifications and capacities required;

(k) Complete list of parts and associated exploded views or sectional diagrams and reference part numbers.

47 PENSTOCKS

Penstocks design requirements shall be in accordance with Penstocks contained in the Miscellaneous Valves and Appurtenances section of DS 31-02 and the relevant parts of the Penstocks section of DS 34.

48 PIPEWORK

48.1 General

Pipework and fittings shall be designed in accordance with relevant parts of the Pipework section of DS 31-01, the Corrosion section of DS 30-02 and the following.

Pumps and ancillary equipment should be fitted with bends, dismantling joints or loose flanges to facilitate removal. Restrained joints and pipework supports shall be used where required.

48.2 Plastic Pipe Structural Integrity

Refer to the Structural Integrity section relating to PVC-U Pipe (and ABS) contained in DS 31-01 for information on factors that should be considered.

48.3 Security of Supply

Service pipework for water and air should be ring mains with isolating valves to enable feeding from the reverse direction as a redundancy measure to allow continued operation in event of equipment failure, repairs or maintenance.

48.4 Pump and Ancillary Equipment

Pumps and ancillary equipment shall be fitted with bends, dismantling joints or loose flanges to facilitate removal. Restrained joints shall be used where required.

48.5 Pipework Service and Materials

The following table identifies the process pipework service, code and appropriate pipe materials.

Table 48.1 –Process Pipeline Service, Code and Material

Service	Code	Material
SERVICE PIPELINES		
Fire services water	XW	Copper, MSCL
Fuel oil	FO	316L SS, PTFE, NBR
Compressed air[1]	CA	Copper, PE[2], SS
Instrument air[1]	IA	Copper, PE, SS
Plant (blower) air[1]	PA	PE, SS
Aeration Air	AA	PE, SS
Scour Air	SA	PE, SS
Service water	SW	Copper, MSCL, PE, PVC-U
WATER PIPELINES		
Backwash outlet	BWO	MSCL
Backwash recovery water	BRW	MSCL
Backwash water	BWW	MSCL
Backwash sludge	BSL	MSCL
Clarifier sludge	CSL	MSCL, PE, PVC-U, PVC-M
Filtered water	FW	MSCL, PE, PVC-U, PVC-M
Lime sludge	LSL	Carbon steel rubber lined, PE
Raw or bore water	RW	MSCL, PE, PVC-U, PVC-M
Potable water	PW	Copper, MSCL, PE, PVC-U, PVC-M
Sample water	SAW	Copper, MSCL, PE, PVC-U
Sludge/waste	SL	MSCL, PE, PVC-U, PVC-M
CHEMICAL		
Aluminium sulphate	XAS4	PE, PVC-U
Ammonia solution	XNHS	PE, PVC-U
Anhydrous ammonia	XNH3	PE, PVC-U
Carbon dioxide	XCO2	PE, PVC-U
Chlorine dioxide	XCLD	PVC-U
Chlorine gas	XCL2	PVC-U
Chlorine solution	XCLS	PVC-U
Ferric chloride	XFCL	PVC-U
Ferric sulphate	XFS4	PVC-U
Fluorosilicic acid	XFSA	PVC-U (jacketed outside bund)
Flocculant (Polyelectrolyte)	PLY	PE, PVC-U

Service	Code	Material
Polyelectrolyte dosing	PY	PE, PVC-U
Garnet	GAR	PE
Hydrochloric acid	XHCL	PVC-U
Ion exchange resin	IER	PVC-U
Lime water	XLW	PE, PVC-U
Milk of lime slurry	XLS	Carbon steel rubber lined, PE
Oxygen	XO2	PVC-U
Ozone	XO3	PVC-U
Pellets	PEL	PE, ABS
Poly – aluminium chloride	XACL	PVC-U
Potassium permanganate	XPPS	PVC-U
Powdered activated carbon	PAC	PVC-U
Sodium carbonate solution	XSCS	PVC-U
Sodium chloride/brine	XSCL	PVC-U
Sodium hexametaphosphate - Calgon	XSP	PVC-U
Sodium hydroxide	XSHO	PVC-U, SS 304L, PP
Sodium hypochlorite	XSHC	PVC-U
Sodium fluoride solution	XSFS	PVC-U
Sodium silicate solution	XSSS	PVC-U
Sulphur dioxide	XSO2	PVC-U
Sulphuric acid	XS4A	SS 316L (Concentration dependent), PTFE, PTFE lined steel, PVDF, PP (concentration dependent)

NOTES:

1. Refer Air Compressor and Associated Pipework section of DS 35.
2. For PE grades refer to the Polyethylene Pipe section of DS 31-01

48.6 Pipework Identification

The Designer shall identify the process pipework in the design via a “line number” designation. Line numbers shall be generated in accordance with DS 81 (see also drawing GB72-60-0.4).

48.7 Process Pipework Colour Marking

Process pipework identification shall be in accordance with drawing EG71-1-1 and the Chemical Pipe Identification requirements of Chemical Signage, Labelling and Markers design standard DS79-04. Pipework identification for materials that are not practical to paint, such as stainless steel and polyethylene, shall be via colour banding and not fully painted. Exposed PVC pipework shall be painted to prevent ultraviolet degradation.

49 PITS AND CHAMBERS

Wherever operationally practicable, the use of below ground pits to house valves and equipment should be avoided e.g. raised sections of pipeline are preferred for maintainable items so that dosing points and flow meters are at ergonomic height and accessible without confined space entry requirements. Where provision of a below ground pit is an essential operational requirement, it shall comply with the requirements of Pits and Chambers section of DS 30-02 and, where valve related, the Valve Pit and Chambers section of DS 31-02.

Pits may have hazards associated with them including confined spaces, engulfment and falls risk. Falls risk may be controlled using handrails or covers. An alternative to using handrails is to extend the pit walls above ground level by a height equivalent to a handrail. In addition to controlling falls risk, covers on pits may provide security and shading benefits. Design of covers needs to consider ventilation, lockable hasps, lifting point/lug/handle, and whether Operations require a viewing flap. The general preference is to construct covers from aluminium chequer plate as it is light weight to minimise manual handling issues, and this material generally provides good corrosion resistance.

50 POWDER OR GRANULE BATCHING SYSTEMS

Batching systems are used for various chemicals including Powdered Activated Carbon, polyelectrolyte, citric acid, sodium fluoride, and salt (sodium chloride). Load in shall be from the delivered bags into a hopper suspended over the batching unit.

Delivery bag size must minimise manual handling, minimise lifecycle NPV cost (i.e. including capital cost, chemical cost, delivery cost, O&M cost) and consider shelf-life (e.g. time after which caking of the bagged product may occur). Similarly, hopper size must consider shelf-life and optimising time between load-in operations (e.g. to allow multiple bags to be loaded to achieve tolerable minimum duration between load-in operations).

Design must consider management of dust especially health risks (from inhalation) and explosion risks. Dust management shall include:

- Load-in operation from small bags by vacuum loader systems with suitable capacity to transfer contents of each bag that efficient use is made of the Operator’s time.
- Dust extraction filters on any vents.

The batched product may also have a maturation time (in case of polyelectrolyte) and a maximum storage (“use by”) time before it degrades (e.g. polyelectrolyte, citric acid).

A storage area with adequate capacity shall be provided to allow for minimisation of the delivery component of the chemical costs.

Facility layout must consider human factors such as avoiding potential for confusing similar coloured powders e.g. if polyelectrolyte and citric acid were co-located, then an operator might mistakenly load polyelectrolyte powder when preparing for Clean-In-Place of a membrane system i.e. the result would be to foul the membranes rather than clean them.

51 PREVENTION OF FALLS

Designers shall comply with the requirements of S151 – Prevention of Falls standard and in particular with respect to Clause 8.7.

52 PROGRESSIVE CAVITY PUMPS

Progressive cavity pump (helical rotor) design requirements shall be in accordance with the Progressive Cavity Pump section of DS 35.

53 PUMPS

Pump station and pumpset design requirements shall be in accordance with DS 32.

54 PUMP STATIONS

Pump stations and associated pipework for use in water treatment plants shall comply with the relevant sections of DS 31-01, DS 31-02 and DS 32.

55 QUALITY

Quality requirements shall be in accordance with the Quality section of DS 30-02.

56 SAND AND MULTI-MEDIA FILTRATION VESSELS

Sand and multi-media filtration vessels are used by the Corporation for the removal of solid and organic particulate matter from suspension. There are three configurations of media filtration:

- Continuously Washed Upflow Filters (e.g. 'Dynasand' brand)

CWUFs are provided as 316L stainless steel vessels to a proprietary design, rather than custom-designed for each installation.

- Box-style (normally open air) gravity filters, typically with backwash launders

Box filters are most commonly used for large WTPs and built in-situ of reinforced concrete and are not commonly available as pre-fabricated steel package units.

- Pressure filters – though these can be operated under pressure or under gravity.

Though pressure filters exist as proprietary design units, these generally do not meet the requirements of SPS250; hence, they are made to order.

Pressure filters are commonly used to filter seawater (desalination), raw water (water treatment) and treated effluent (treated wastewater effluent re-use). Glassed Reinforced Plastic (GRP) vessels may be used for vessel diameters up to 2.4m, and of a maximum working pressure of 800kPa, but limited to 20kPa backwash air pressure in all instances. For vessels with diameter greater than 2.4 m and/or for non-GRP[1] filter vessels please refer to the Principal Mechanical Engineer for consideration. The vessels shall be fitted with air valves, with no intermediate valve or other means of isolation, to ensure the low backwash pressure. Filter vessels protected in this way should be Hazard Level E as defined in AS 4343. GRP vessels shall comply with the Corporation's Strategic Product Specification SPS 250.

The filtration vessels shall be plenum type only, not lateral type.

The *Designer* shall specify the required filter operating requirements including flow rates, media types and bed depths. Refer to DS 114 for further information regarding media filtration.

[1] The primary concern is failure to achieve the design life when non-GRP materials are used. Submissions to the Senior Principal Engineer must demonstrate how this risk will be managed, including consideration of corrosivity and lining damage. Corrosive conditions may occur due to low alkalinity feed water and from chemical dosing (e.g. chlorine). Operation of the filter such as media agitation during backwashing or abrasion during media removal/loading/top-up may damage lining materials.

57 SAFETY SHOWERS

Refer to the EMERGENCY SAFETY SHOWERS AND EYEWASH STATIONS section of this Standard.

58 SIGNAGE AND LABELS

Signage and labels requirements shall be in accordance with the Signage and Labels section of DS 30-02 and where applicable shall be in accordance with the Chemical Signage, Labelling and Markers design standard DS79-04.

59 SITE CONDITIONS

Site conditions shall be in accordance with the Site Conditions and Selection section of DS 30-02.

60 STAIRWAYS AND LADDERS

Stairways and ladders shall comply with the Stairway, Landings and Ladders section of DS 30-02, which includes recommended materials for a particular chemical service.

61 STATUTORY AUTHORITIES

Designs shall consider compliance with the requirements of statutory authorities shown in the Statutory Authorities section of DS 30-02.

62 STRATEGIC PRODUCT SPECIFICATIONS

Corporation strategic product specifications are contained in Section 7.1.10 of DS30-01.

63 STORAGE TANKS

Process water storage tanks shall be in accordance with DS61.

GRP chemical storage tanks shall be to SPS 498. Some chemicals (though not sodium hypochlorite) may be suitable for storage in polyethylene tanks, which shall be to SPS 497.

64 SUMP PUMPS

Sump pumps design shall comply with Sump Pumps in the Water Pumps section of DS 32.

65 SURGE VESSELS

Surge vessel design shall comply with the Surge Vessels, Cushions and Surge Tanks section of DS 35.

66 TESTING

Pump testing shall comply with Testing in the General Design Factors section of DS 32.

67 TRANSMISSION DRIVES

Transmission drives design shall comply with the Transmission Drives section of DS 30-02.

68 VACUUM PUMPS

For information regarding vacuum pumps design the Designer should refer to the Vacuum Pumps section of DS 32.

69 VALVES

Valves shall comply with the Valves section of DS 31-02 and the following:

(a) Plug valves shall be preferred for use on sludge applications however the shaft should be installed horizontally;

(b) Pinch valves are not preferred as they readily fail due to lack of torque limiting protection and it is difficult to prevent this type of failure;

(c) Plastic valves are not preferred as they deteriorate with exposure over time. However, in chemical systems they may be preferred for chemical compatibility. Shading may be required to protect valves from degradation by direct sunlight;

(d) Use of brass valves installed in stainless steel pipelines should be avoided due to the potential for galvanic corrosion. Full 316 stainless steel valves shall be used on stainless steel pipework;

(e) Pipework design shall facilitate ready access to all valves for operational purposes and shall allow for ready removal;

(f) Brand rationalisation for the same type of valve should be practiced in order to minimise spares duplication;

(g) Pneumatic systems should be provided with a second air receiver to allow for maintenance;

(h) Critical valves should have a rotatable spare.

69.1 Treatment Process Valves Guide

Please refer to the Pipework and Valves section of DS79 for requirements specific to chemical systems. The Water Treatment Process Valves Guide in the following table lists valves and associated process mediums applicable and related strategic product specifications where applicable. The Strategic Products Register should be referenced to identify authorised strategic product where applicable.

Table 69-1: Water Treatment Process Valves Guide

PRODUCT	***TYPE***	***SIZE***	***SPS NO***	***BODY ENDS***	***FLUID***	***BODY MATERIAL***	***TYPICAL APPLICATION/COMMENTS***
AIR VALVES: Combination air release and vacuum break							
Air valves	Single orifice	DN 50 – DN 100	SPS 200	Screwed	Water	Bronze, Plastic	Air release
	Double orifice	DN 50 -DN 200		Flanged		DI, Plastic	Combination air release and vacuum break
	Double orifice	DN 50	SPS 201	Screwed	Sewage	Plastic, SS	Combination air release and vacuum break
		DN 100 – DN 150		Flanged		DI, SS, plastic	
BACKFLOW PREVENTION VALVES:							
Vacuum breakers	Hose connection (HCVB)	DN 15 and DN 20		Screwed	Water	Bronze, 316SS	All backflow prevention valves (devices) shall be provided and installed in accordance with AS/NZS 3500.0 and the devices shall comply with AS/NZS 2845.1, .2 and .3.
	Atmospheric type (AVB)	DN 6 – DN 80					
	Pressure type (PVB)	DN 15 – DN 50					
Check valves	Dual Flap – (Dual CV)	DN 10 – DN 40				Chrome plated bronze, 316SS	
	Dual – atmospheric port (DCAP)	DN 15 and DN 20				Bronze	
	Dual – Intermediate vent (DuCV)	DN 10				Bronze	
	Double (DCV)	DN 15 – DN 250	SPS 214	Screwed ≤DN50 Flanged ≥DN65		Bronze, cast iron, DI	

PRODUCT	*TYPE*	*SIZE*	*SPS NO*	*BODY ENDS*	*FLUID*	*BODY MATERIAL*	*TYPICAL APPLICATION/COMMENTS*
	Reduced pressure zone device	DN 20 – DN 250	SPS 215	Screwed ≤DN50 Flanged ≥DN65		Bronze, cast iron, DI	
NON-RETURN VALVES:							
Swing check	General purpose	DN 15 – DN 50	SPS 220	Screwed	Water	Bronze	
Piston check	Lift check	DN 25 – DN 80		Flanged	Water	Bronze	Used in conjunction with globe valves
		DN 15 – DN 50		Socket weld	50% caustic soda	316SS	
Swing check	Cast iron	DN 80 – DN 900	SPS 223	Flanged	Water	Cast iron	Polymeric coating
	CI - Resilient disc	DN 100 – DN 200					
Single spring flap	Wafer	DN 100 – DN 600		N/A	Water	Cast iron, DI	Polymeric coating
	Flanged	DN 100 – DN 600		Flanged			
Dual flap	Wafer	DN 50 – DN 600	SPS 226	N/A	Water	Copper alloy, 316SS	CI body/ Polymeric coating only acceptable for authorised designs e.g. non-intrusive post in body
	Flanged	DN 300 – DN 600	SPS 226	Flanged	Water	Copper alloy, 316SS	
Non return	Injection valve	DN 15		Screwed BSPF	98% Sulphuric acid	Hastelloy C	Supply with appropriately sized PTFE injection quill e.g. 125 mm, 175 mm (Hydramet)
CONTROL VALVES:							
Pressure relief	Copper alloy			Screwed	Water	Ductile iron	Adjustable spring tension
	Cast iron - globe	DN 80 - DN 600		Flanged			
Pressure sustaining	Cast iron - globe	DN 80 – DN 600					Hydraulic pilot control
	Copper alloy	DN 13 – DN 80		Screwed		Bronze	Adjustable spring tension

PRODUCT	*TYPE*	*SIZE*	*SPS NO*	*BODY ENDS*	*FLUID*	*BODY MATERIAL*	*TYPICAL APPLICATION/COMMENTS*
Pressure reducing	Cast iron - globe	DN 80 – DN 600	SPS 240	Flanged		Ductile iron	Hydraulic pilot control
Flow control	Copper alloy	DN 25 – DN 300		Screwed		Bronze	
	Cast iron - globe	DN 80 – DN 600		Flanged		Ductile iron	Hydraulic pilot control
Level control	Cast iron - globe	DN 80 – DN 600		Flanged	Water	Ductile iron	Hydraulic pilot control
Surge control		DN 80 – DN 600					
ISOLATING VALVES:							
Ball – 2 Way[2]	Plastic - manual lever operation	DN 15 – DN 50		Socket - solvent weld	Various chemicals	PVC-U	Refer manufacturer's recommendations for chemical and their concentration
		DN 15 – DN 150		Flanged			
		DN15 – DN50		Screwed			
	Metal - manual lever operation	DN 8 – DN 50	SPS 252	Screwed - Female BSP	Water	Bronze	General purpose
		DN 8 – DN 80		Screwed	Sulphuric acid	316 Stainless steel	98% acid solution PTFE Packing, seat and seals
		DN 15 – DN 100			Sulphuric acid	Carbon steel	Depends on concentration
Ball – 3 Way	Plastic	DN 10 – DN 50		Socket - solvent weld	Various chemicals	PVC-U	Refer manufacturer's recommendations for chemical and their concentration
Gate	Copper alloy	DN 8 – DN 50		Screwed			

[2] DS79 requires that ball valves with a pre-drilled small-diameter vent hole on the upstream side of the ball shall be used for gassing applications.

PRODUCT	*TYPE*	*SIZE*	*SPS NO*	*BODY ENDS*	*FLUID*	*BODY MATERIAL*	*TYPICAL APPLICATION/COMMENTS*
		DN 10 – DN 100	SPS 255	Flanged	Water, oil, gas	Bronze	Isolating valve designed for unrestricted flow and infrequent operation
	DI - metal seated - flanged	DN 500 - DN 900	SPS 271	Flanged	Water	Ductile cast iron	PN 16, PN 21 and PN35
	DI resilient seated - flanged	DN 80 – DN 900	SPS 272				PN 16 all sizes
	Metal seated	DN 20 – DN 150		Screwed	Various chemicals	316 Stainless steel	Refer manufacturer's recommendations for chemical and concentration
Globe	Copper Alloy	DN 8 – DN 50		Screwed	Water, oil, steam	Bronze	Isolating valve designed for frequent operation and/or throttling or control
		DN 10 – DN 100		Flanged			
	Stainless steel	DN 15 – DN 50		Flanged	Sulphuric acid, Caustic soda	316 Stainless steel	98% acid solution, caustic soda. Valves shall be single piece forged body stainless steel with socket welded ends. Bonnets shall be bolted with rising stems and PTFE packing.
Butterfly	General purpose	DN 50 – DN 1200	SPS 260	Wafer	Water, oil, gas, powders	Cast iron	Non-terminating valve for non-strategic applications
		DN 50 – DN 500		Lugged – Table E to AS 2129			Terminating valve for non-strategic applications
	Flanged, waterworks	DN 100– DN 2000	SPS 261	Flanged	Water	Cast iron	For heavy duty waterworks applications
Diaphragm	Straight-through	DN 25 – DN 350		Screwed/ Flanged	General purpose, treatment plants	Cast iron	Water, solids, corrosive and abrasive fluids
	Weir	DN 8 – DN 350					Water, corrosive and abrasive fluids
Penstocks			SPS 295		Water	316 Stainless steel	

70 ULTRAVIOLET (UV) LIGHT DISINFECTION

UV light has been used by the Corporation in limited applications such as aboriginal community water supplies for disinfecting ground water supplies. Ultra Violet disinfection systems shall conform to design standard DS 110. UV disinfection has the following applications and characteristics.

70.1 Uses

(a) Used for wastewater treatment in disinfecting secondary and tertiary effluent;

(b) Used for drinking water disinfection;

(c) Used for small groundwater applications where water clarity and factors such as safety risk require consideration e.g. aboriginal communities.

70.2 Effectiveness

a) (Disinfection effectiveness for bacteria and viruses is good in clear water;

b) Effectiveness can be degraded where water contains solids which can shield pathogens preventing them from being destroyed;

c) UV has no residual killing power.

70.3 Advantages

a) Has no by-product formation;

b) Has low safety risk;

c) Has low complexity in terms of operational aspects;

d) Cost is relatively cheap being comparable to chlorine gas.

71 VIBRATION

Mechanical equipment shall be designed to achieve a minimum vibration levels. The acceptable equipment vibration limits are detailed in the Vibration section of DS 30-02.

72 WASHDOWN HOSES

Washdown hoses shall be provided in water treatment plant facilities in accordance with the following:

a) All clarifiers (thickeners, lime clarifiers, etc.) shall have retractable reel washdown hoses with appropriate delivery pressure for the washdown task;

b) All sludge handling facilities (sludge beds, lime beds, centrifuges, belt presses) shall have retractable reel washdown hoses with appropriate pressure for the washdown task;

c) Washdown hoses shall be fitted with backflow prevention devices as required in accordance with AS/NZS 3500.0, AS/NZS 2845.1, AS 2845.2 and AS/NZS 2845.3.

73 WATER HAMMER

Water hammer design shall comply with the Surge Vessels, Cushions and Surge Tanks section of DS 35.

74 WELDING

Welding design shall comply with the Welding section of DS 30-02.

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