WATER CORPORATION

Assets Planning and Delivery Group
Engineering

DESIGN STANDARD DS 34

Wastewater Treatment Plants - Mechanical

VERSION 1
REVISION 5

NOVEMBER 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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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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DESIGN STANDARD DS 34

Wastewater Treatment Plants

CONTENTS

Section *Page*

1 SCOPE AND GENERAL

1.1 Scope

Design Standard DS 34 sets out the Corporation's mechanical design standards, guidelines and preferred engineering practices for minor and major wastewater 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 has been out-sourcing most of its infrastructure design work since 1995. Prior to the year 2000 the Corporation had used the services of a single consultant for most of its design work. In 2000 the Corporation appointed a panel of consultants to share the engineering design of its infrastructure. At the same time it issued a suite of engineering design standards for use by the consultants.

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 or 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 Referenced Documents section of DS 30-01.

1.6 Mandatory Requirements

The use of the imperative "shall" denotes a mandatory requirement. Use of verbs other than "shall" such as "will", "should", "may", etc 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 Glossary.

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 of the DS 30-01 Glossary.

1.7.3 Abbreviations

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

1.7.4 Standards 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 ACTINO FOAM REMOVAL

Actino foam removal should be facilitated where applicable via:

(a) Use of chain and flight scrapers;

(b) Sprays fitted to wetwells;

(c) Completely enclosing the installation to prevent spray mist transmission;

(d) Provision of alarms on the doors to enclosure;

(e) Pumping foam removed to DAFT tanks.

3 AERATION DEVICES

3.1 General

Aeration devices are used to dissolve sufficient oxygen to satisfy the respiration requirements of the micro-organisms in the aeration tanks to maintain a small residual of dissolved oxygen. Typically, the dissolved oxygen (DO) concentration in anoxic zones should be less than 0.2 mg/L. However, in process configurations specifically designed to maximize nitrogen removal by simultaneous nitrification/denitrification, the aeration system would be required to maintain the DO concentration in the range 0.2 - 0.5 mg/L. The same system would also need to have the flexibility to achieve DO levels in excess of 2.0 mg/L at the end of an aeration cycle.

The secondary role of all aeration devices is effective mixing, to maintain suspension of the biomass. Some aeration devices do not require assistance from mixers e.g. horizontal rotors, floating turbine aerators in hydraulically discrete tanks and floor mounted diffused air systems may be used to achieve this. However, mechanical devices which aerate by means of variable speed operation e.g. platform mounted vertical shaft turbine aerators and submersible jet aerators generally require the installation of submersible mixers to maintain solids suspension during periods of low oxygen demand.

3.2 Process Selection Factors

The design and selection of the aeration system for an activated sludge plant is one of two key activities which define the performance capacity and capability of the plant - the other is definition of the plant process flow configuration. Aeration process selection for each plant depends upon:

- the type and flow rate of used water;
- plant performance and treated water quality requirements;
- aeration device type and energy efficiency i.e. kgO2 delivered per kWh;
- capital efficiency per ML treated over the life of the asset;
- plant location or remoteness (time to respond by maintenance personnel and support from equipment suppliers;
- the maintenance budget for the life of the plant.

3.3 Process Variations

Over recent years, the Corporation has incorporated a range of process variants into its treatment plants, including:

(a) Aerated lagoons, utilizing floating turbine aerators;

(b) Continuous inflow, intermittent outflow reactors, utilizing either floating turbine aerators, or fixed, wall mounted screw impeller aerators;

(c) Sequencing batch reactors (SBR) with submerged diffusers (lift-out for diffuser maintenance or replacement) which operate intermittently;

(d) Oxidation ditch reactors, utilizing fixed horizontal rotor aerators;

(e) Oxidation ditch reactors, utilizing lift-out submersible jet aerators, and mixers (to maintain biomass channel velocities during low aerator input);

(f) Oxidation ditch reactors, utilizing platform mounted vertical shaft turbine aerators and submerged mixers;

(g) Longitudinal tanks with discrete anoxic and aerobic zones, and floor mounted fine bubble diffuser systems;

3.4 Aeration Devices

Aeration devices may be categorised into the following groups:

(a) Mechanical surface aeration;

(b) Self-aspirating submersible jet aerators;

(c) Combined or submerged turbine aeration - small side-channel or positive displacement blowers operate in tandem with submerged screw impellers or similar mechanical devices to produce a directional pseudo-diffused air stream within the reactor volume;

(d) Diffused air aeration utilizing air provided under low pressure via centrifugal or positive displacement blowers. Air is forced through various types of submerged aeration diffusers, which may be either coarse or fine depending on the system used. Fixed and removable diffusers are generally located so as to produce a rolling motion of the mixed liquor. This action is designed to maintain suspension of solids and results in a small amount of additional oxygen being absorbed from the atmosphere.

3.4.1 Mechanical Surface Aerators

Mechanical surface aerators are available in a wide variety of configurations and these include:

(a) Floating, vertical shaft, high-speed screw-impeller type aerator (direct drive by motor, up to 150 kW). This is a simple, generally robust aerator with the motor and impeller mounted on a single circular doughnut-type float. However, this type is relatively inefficient with a maximum Standard Oxygen Transfer Efficiency (SOTE) of 1.1 kgO2/kWh;

(b) Floating, vertical shaft, low speed turbine impeller type aerator (driven via reduction gearbox, motor power up to 215 kW). This aerator is more complex and requires a large, robust triangular structure mounted on floats to keep it in contact with the water surface and at the correct depth. Modern aerators of this type are quite efficient, with an SOTE range of 1.8 - 2.1 kgO2/kWh;

(c) Platform mounted, vertical shaft, low speed turbine impeller type aerator (driven via reduction gearbox, motor power up to 215 kW), with or without draft tube. The advantage of the platform mounting is that the aerator impeller is located at exactly the right depth for maximum efficiency. For modern aerators of this type an SOTE of 2.1 kgO2/kWh is considered the norm;

(d) Floating, horizontal shaft, low speed rotor type aerator (driven via reduction gearbox, motor power up to 15 kW). This aerator type is relatively simple, suspended between two elongated floats. This type of aerator delivers an intermediate SOTE of about 1.39 kgO2/kWh, but is also useful as a mixer, if controlled via a variable speed drive;

(e) Platform mounted, horizontal shaft, low speed rotor type aerator (driven via reduction gearbox, with motor power up to 110 kW). This aerator configuration is still used in oxidation ditches, but is not as common as that described in (c) above. An SOTE range of 1.5 - 1.8 kgO2/kWh is typical for this type of aerator.

A key advantage of mechanical surface aerators is that they are unaffected by biological or inorganic fouling. Also, they are not affected by excessive hydrocarbon concentrations in the influent, which are very harmful to rubber-based diffused air systems.

The Designer shall consider the following key criteria in the selection of mechanical surface aerators:

- vertical shaft impeller or horizontal rotor speed shall not exceed 60 rpm;
- turbine or rotor tip speed shall not exceed 5.5 m/s. For large impellers, it will therefore be necessary to reduce the speed of rotation to the range 30 to 35 rpm;
- vertical and horizontal throw of the aeration device must be within the structural confines of the process basin in which it is installed. If covers are considered for installation, the impact of these on SOTE reduction shall be taken into account;
- cranage access for floating devices;
- process basin depth – horizontal shaft rotors are not effective in depths greater than about 3 m, whereas with correct draft tube selection, slow speed vertical shaft devices can be used to aerate mixed liquor in the depth range 6 to 8m. In the more typical process basin depth range of 3.6 to 5.0 m, slow speed vertical shaft devices without a draft tube are usually the optimal selection;
- mixing energy input is important during periods of low oxygen demand. If the aeration device selected is to be used with variable speed control, mixer assistance may be required to maintain

solids suspension. The Designer shall therefore seek the expert advice of aerator and mixer supplier(s) to ensure an optimal solution – refer also to the Mixers section of this Standard;

- direction of impeller flow and lagoon depth are important for aerated lagoons, Aerator impellers which pump flow from outside to inside, and therefore down below the device, will require some form of robust scour protection on the lagoon floor.

3.4.2 Submersible Jet Aerators

Submersible jet aerators occupy a niche between mechanical surface aeration and diffused aeration. This aerator type is essentially a combination of a static vertical pipe protruding above the water surface, down through which air is drawn by the action of the associated high-volume pump forcing mixed liquor past an eductor ring. This generates a negative pressure and draws in air which is sheared and mixed with the pumped discharge downstream of the eductor. This highly aerated diffused air-water mixture is then discharged into the reactor as a pressurized jet.

SOTE increases with depth, such that at a submergence depth of 6.0m, approximately 1.5 kgO2/kWh is achievable. The main advantage of this type of aerator is that there is little noise other than the hiss of air entering the down-pipe and the “aeration” device is a standard, robust submersible pump.

Although the jet-aerator is a simple device, if it is to be used with variable speed control, mixer assistance may be required to maintain solids suspension during low oxygen demand periods. The Designer shall therefore seek the expert advice of the supplier to ensure an optimal solution – refer also to the Mixers section of this Standard.

3.4.3 Combined Aeration Devices

The Sinkair aerator is a low-lift screw impeller pump aerator which relies on discharge turbulence and mixing energy to achieve oxygen transfer. The manufacturers claim a high alpha factor and SOTE, but these devices generally only achieve about 1.0 to 1.2 kgO2/kWh. They are limited by motor size (maximum of 15 kW), and are prone to fatigue and seal failures of the GRP volute within 5 years. The device is considered applicable for small plants only.

Some combined aeration devices consist of several components, and therefore typically have a higher maintenance requirement. They also are relatively inefficient, with SOTEs in the range 1.1 to 1.3 kgO2/kWh. They are non-preferred technology.

3.5 Aeration blowers

Designers shall consider the following requirements:

(a) Refer to the section on Blowers contained in DS 35 and the following.

(b) For high speed single stage centrifugal blowers:

  (i) Cooling water should be demineralised not treated water. A fixed pipe or break tank should be provided for potable water backup to reclaimed effluent sidestream cooling.

  (ii) Inlet guide vanes should be of the latest generation using electric control.

3.6 Air Pipework

Designers shall consider the following requirements:

(a) Above tank air headers supplying air to submerged diffusers may require lagging to reduce transmitted noise. For large diffused aeration systems, the Designer shall check the potential of air-header pipework for harmonic vibration, especially if the blowers are operated by variable speed drive, Night-time loadings are much lower than the mid-morning peak, but this is the most likely time for generation of low-frequency noise in the air-delivery pipework. Where positive displacement blowers are to be used to supply process air, only tri-lobe devices shall be selected, since these devices are less prone to generation of low-frequency harmonic vibration;

(b) Lagging of air supply headers may be required to protect Operations personnel from contact with high-temperature metallic surfaces;

(c) All above-tank air headers shall be metallic;

(d) Individual droppers to floor distribution pipework shall be 316 stainless steel above the water level, and may be plastic below. Particular care shall be taken in the design of the steel-plastic flange connection to minimise the possibility of catastrophic fatigue failure;

(e) Individual droppers for removable aeration grids shall either:

   (i) be 316 stainless steel rigidly attached to the aeration grid, and connected to the above-ground air-header with high density reinforced marine-quality flexible hose designed to minimise the possibility of fatigue failure; or

   (ii) be high density reinforced marine-quality flexible hose between the above-ground air-header connection and the aeration grid pipework, similarly designed to minimise the possibility of fatigue failure;

(f) Fixed floor distribution pipework shall be plastic, Floor supports and fixings shall be 316 Stainless Steel;

(g) Removable aeration systems may be provided in either of two configurations:

   (i) central stainless steel lateral pipe, to which individual diffused aeration devices may be attached. The lateral pipe schedule shall be selected to minimise deflection during lifting for the worst case condition, which is dropper, lateral pipe and all diffusers completely flooded with mixed liquor;

   (ii) structural steel grid, to which plastic lateral pipes, with attached diffused aeration devices, may be fixed. The grid shall be designed to minimise deflection during lifting;

   Whichever removable aeration system is provided, the ballast weight provided shall incorporate a factor of safety of at least 2.5;

   The maximum allowable deflection for any removable aeration system shall be L/200;

(h) Designers shall ensure that thermal effects and induced vibration in droppers and floor distribution pipework are carefully engineered out;

(i) Designers shall ensure that the maximum air velocity in header and distribution pipework does not exceed 15 m/s at peak aeration demand. This will ensure that under average demand conditions air velocities are in the range 10 – 15 m/s, thereby reducing noise and back-pressure.

3.7 Aeration System Peak Load Capacity

Aeration systems shall be designed to treat the peak organic loading delivered to a treatment plant. The Designer shall take note of and allow for the following:

(a) The diurnal flow profile of the plant shall be accurately defined by careful review of influent flow meter data. The Designer should note that weekday and weekend diurnal flow profiles are usually different with the former likely having a more pronounced differential between minimum and maximum flow, whereas for the latter the diurnal peak is later, larger and lasts for longer;

(b) Locations with a tourist demographic will exhibit non-holiday and more extreme holiday period diurnal profiles;

(c) The nature of the catchment can have a significant effect on the shape of the diurnal flow profile. Factors which should be considered are:

   (i) whether all flows within the catchment are pumped, or gravity, or a combination of both;

(ii) distance between catchment and treatment facility, and

(iii) catchment size. Generally, small catchments with mostly pumped flow exhibit extreme diurnal peaks, from less than 0.10 times the average daily flow (ADF) up to 3.0 times AFD, while larger catchments with a mixture of gravity and pumped flows will have a much narrower range e.g. 0.4 times to 1.5 times ADF;

(d) The nature of a catchment will change with time and growth. The Designer shall carefully consider the implications of staging both hydraulic and aeration capacity to manage this change efficiently;

(e) Diurnal flow profiles for summer and winter can differ markedly, especially if the catchment suffers from infiltration;

(f) The diurnal load profile can only be determined by detailed sampling of the influent flows. Hourly sampling is considered to be the minimum requirement. Ideally, sampling for average dry weather and peak wet weather flow conditions should be carried out if possible;

(g) A typical design peak load factor for a continuous flow path plant, without flow and load equalization, will be in the range 1.3 - 1.5 times average load. For continuous plants with an equalization facility, the design peak factor may be reduced to 1.05 - 1.15 times average load;

(h) If an intermittent flow path plant is intended, the design peak load factor will be in the range 1.8 - 2.0 times average load, to ensure adequate nitrification during the batch cycle which coincides with the daily peak inflow. The peak load factor selected shall not be less than 1.8 times average load. If equalization is to be provided, a lower peak load factor may only be considered subject to the Principal’s agreement;

(i) The design diurnal load profile provides two key pieces of information:

(i) peak aeration system capacity required, and

(ii) minimum aeration system capacity i.e. turndown required.

Item (ii) specifically will have a significant bearing on the type and configuration of aeration system or device selected.

3.8 Aeration Demand Management

Designers shall consider the following requirements:

(a) The efficient operation of aeration systems in activated sludge plants shall be controlled by dissolved oxygen (DO) sensors immersed in the mixed liquor;

(b) There are two methods available for aeration control:

(i) DO setpoint control – the aeration system operates to maintain DO at or above a fixed setpoint e.g. 2.0 mg/L, usually to guarantee full nitrification;

(ii) DO demand control – the aeration system operates to match the DO demand profile resulting from the diurnal load profile into the plant. This method is more energy efficient, and involves the maintenance of the DO concentration within a narrow range e.g. 0.2 - 0.5 mg/L. It is commonly used in plants which have been specifically designed to maximize nitrogen removal by simultaneous nitrification-denitrification;

DO demand control is the preferred method;

(c) Designers shall allow for a minimum of two DO sensors per reactor basin in intermittent plants such as SBRs, IDEA or IDAL plants, and at least three DO sensors per reactor zone or tank in continuous plants such as oxidation ditches;

(d) There is a wide range of DO sensors available. Key selection criteria include:

- type of sensor e.g. membrane, luminescent, other;
- recommended sensor replacement frequency;
- calibration method and frequency e.g. manually by Operator, automatic;
- recommended installation location e.g. surface, in-basin;
- cleaning method e.g. manually by Operator, chemical, mechanical;
- sensitivity - this is particularly important for aeration systems designed to operate at very low dissolved oxygen concentrations, where a change of 0.1 mg/L can have a major impact on process performance;
- Operator preference - feedback from experienced plant Operators should never be discounted;

(e) Efficient aeration system operation is also highly dependent upon the type of device selected. This is covered in Aeration Blowers and Aeration Diffusers contained in this section of the Standard.

3.9 Aeration Diffusers

Coarse bubble diffusers produce the largest bubble size and have the lowest oxygen transfer efficiency (OTE), typically about 2.46%/m depth. Accordingly their use tends to be confined to temporary packaged treatment plants, or in selector zones of larger plants, where they are primarily used for mixing

Fine bubble diffusers have an increased OTE compared to coarse bubble systems, typically around 6%/m depth. The bubble size generated is very small, usually less than 1mm. For the same air volume supplied, the available surface area for absorption is more than 100 times greater than that for coarse bubbles. However, Designers should note that this OTE is dependent on several design parameters. These include:

- depth of submergence;
- mixed liquor concentration, which has a major influence on alpha factor selection;
- process operating temperature;
- diffuser design flux rate (air flow in m3/m2 of membrane surface.h);
- spatial arrangement of diffusers (lift-out systems require more diffuser area than fixed-to-floor systems to achieve the same OTE);
- propensity for fouling (which is influenced by used water quality, and mode of operation);
- age of diffusers (especially for rubber-based EPDM compounds).

Designers shall size a diffused aeration system to meet peak oxygen demand at the end of diffuser life, and shall apply a diffuser fouling factor of at least 0.90 in the calculation for converting Actual Oxygen Requirement (AOR) to Standard Oxygen Requirement (SOR).

The most common types of diffusers are:

(a) ceramic diffusers, manufactured from a material containing alumina and silica. These diffusers provide reliable service for up to 15-18 years with the correct maintenance procedures. They can deliver a 5:1 air-flow turndown, but are not recommended for use in intermittent aeration configurations, because of the risk of permanent fouling when the air is turned off;

(b) flexible membranes, manufactured either from rubber-based EPDM or silicon compounds. They are available in a variety of shapes and sizes e.g.

    (i) 150 mm, 225 mm and 300 mm discs;

    (ii) 65 mm, 95 mm and 110 mm diameter tubes up to 1.0 m long;

    (iii) 200 m wide plates from 0.65 m to 2.0 m long, and are typically installed as part of a mounded plastic or aluminium fitting. They are able to operate over wide flow ranges and have the advantage of self-sealing when air-flow is turned off, as the slits in the diaphragm simple close up under hydrostatic head. EPDM disc and plate diffusers have provided good service in intermittent and continuous aeration applications. However, EPDM tube diffusers do not perform well in intermittent aeration applications, because of accelerated material fatigue – this usually results in a catastrophic zipper-type failure along the top of the tube. The Corporation does not have extensive operational experience with silicon membranes, but recognizes that these devices have performed extremely well elsewhere.

Properly designed and operated flexible membrane systems are expected to provide a minimum of 5 years' service before requiring replacement.

A common type of aerator formerly used by the Corporation has been the sock type incorporating Dacron socks producing medium sized bubbles. These devices provide good service life in continuous aeration zones but are unsuitable where aeration is cyclical, as in batch reactors, and are no longer used.

Currently the most common aerator types used by the Corporation are:

(a) Ceramic diffusers, manufactured in a material containing alumina and silica, and more recently,

(b) Silicon rubber based membranes incorporating numerous fine slits across the grain of the material,

through which air is forced and emerges as a stream of fine bubbles.

NOTES:

1. Ceramic diffusers, which can operate with a 5:1 flow turndown, require high care to obtain long term service e.g. 20 years. Air is required to be forced through the diffusers to prevent backflow and blockage when the air supply fails or the operating pressure is less than the tank static head.

2. Rubber diaphragm based diffusers can operate over wide flow ranges, even down to zero air flow, as the rubber diaphragm self seals when the fluid head exceeds the air supply pressure. The expected life of rubber diaphragms is 5 to 7 years.

3.10 Moisture Eliminators

Air supply systems to submerged grids of diffusers suffer from moisture collection in the pipe network supporting the diffusers. Moisture, in the form of condensate or leakage of mixed liquor through diffuser seals or cracked pipework, must be removed from selected locations in the submerged network. Moisture eliminators are normally operated manually on small systems. Automation is preferred for large systems as they should be operated daily.

(a) Designers shall ensure that moisture eliminators are correctly sized;

(b) Designers shall select moisture eliminator material so as to ensure temperature effects do not cause shearing of plastic pipework;

(c) Operation of moisture eliminators should be automatic to minimise power consumption.

3.11 Tank Drainage

3.11.1 Purpose

Tank drainage is an infrequent operation, but may be required for a number of reasons as follows:

(a) For regular maintenance of aeration equipment;

(b) To allow removal of tank floor build up of solids;

(c) To allow removal of septic material.

3.11.2 Design

The Designer should consider the following requirements:

(a) Drainage of large aeration tanks should generally be to the final effluent stream.

(b) Tank contents (mixed liquor solids) are normally are returned to the head of the aeration system

(c) Valves shall be installed externally e.g. not inside the tank;

(d) Tank flushing should be designed to:

- have access to reclaimed effluent;
- incorporate an inlet opposite to the drain end;
- incorporate a channel on one side of the tank to aid drainage;
- incorporate a generously proportioned sump;
- be operated by a single operator.

3.12 Mixed Liquor Inlet/Outlet Valves and Pipework

(a) Submerged inlet/outlet pipework should be avoided;

(b) Service pipework shall be installed outside of the tank;

(c) Use of submerged aluminium components shall be avoided;

(d) Valve arrangements shall comply with relevant requirements contained in WC OSH 108 Safe Working in Confined Spaces.

3.13 Mixers

Mixers shall conform to the requirements of the Mixers section contained in this Standard.

3.14 Baffles

Designers shall carefully consider the following:

(a) Whether there is an important process requirement for movable baffles and if not, they should be designed as fixed permanent structures;

(b) If baffles are intended to be movable, they shall be manufactured and installed to facilitate easy and safe access for this purpose. Cranage access shall be carefully reviewed. In larger plants, movable baffle walls should be of the concrete beam type located in stainless steel wall brackets;

(c) Emptying of a process tank to relocate a baffle is a time-consuming and expensive exercise and should be avoided where possible. Ideally, it should be possible to relocate the baffle without emptying the tank or disrupting normal operations;

(d) The first-fill of a process tank often results in significant hydraulic heads being applied to structures intended to be non-hydraulic. Hence, even if a baffle is intended to be a non-hydraulic flow-training fixture, it shall be designed to structurally resist applied momentum forces. This will require the Designer to consider differential water levels during wet commissioning as a design criterion.

3.15 Tank Access

Aeration tanks should ideally be designed to eliminate personnel access. However where access is unavoidable the tank shall be designed to comply with the relevant requirements contained in WC OSH

108 Safe Working in Confined Spaces. Tanks shall be provided with sufficient lighting and ventilation for safe working during maintenance.

Aeration tanks shall incorporate a gate, landing and stainless steel ladders or stairways designed in accordance with AS 1657 and complying with the relevant requirements of S151 Prevention of Falls.

3.16 Aeration Control and Flow Measurement

Systems that control the delivery of air into diffuser systems need to control on mass flow and therefore require accurate measurement of temperature and pressure at airflow metering points. Automatic calculation of airflow which corrects for temperature and pressure would be an advantage. Besides orifice plates or ultrasonics, there exists a variety of air duct metering options with low headloss which are described in an AMCA (Air Movement and Control Association International Inc.) Publication 600-06 "Application Manual for Airflow Measurement Stations".

An appreciation of the accurate measurement ranges of each element of the mass flow computation is essential to. Orifice plates are robust for measuring airflow and maintenance costs are very low but don't have the turndown range and also incur a pressure drop which wastes energy. Hot wire anemometers are more energy effect but calibration is expensive.

Valves required to control air movement from header pipework to aeration zones require similar care in their selection. If control valves with pneumatic actuators are being considered, the Designer shall select devices that eliminate continuous use of instrument air. Airflow control valves should be of the plug valve type. Use of butterfly valves should be avoided.

Instrumentation shall comply with DS 40-09.

Where turbine aerators are being employed in oxidation ditches or ponds, energy consumed per ML of treated mixed liquor is a typical measure of energy efficiency of the process. Selection of the turbine type should involve consideration of its effectiveness over diurnal and seasonal wastewater inflows (speed changes or turbine blade pitch changes) and the overarching range of dissolved oxygen selections set on the DO controller. Refer also to the Clause dealing with Mechanical Surface Aerators

4 AIR COMPRESSORS

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

5 AIR CONDITIONERS

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

6 AIR VALVES

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

7 ALIGNMENT OF MACHINERY

Alignment of machinery shall be in accordance with the Alignment of Machinery section of DS 38-02.

8 AMBIENT CONDITIONS

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

9 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.

10 AUTHORISED PRODUCT

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

11 BACKFLOW PREVENTION DEVICES

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

12 BALANCING

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

13 BASEPLATES

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

14 BLOWERS

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

15 BUILDINGS

Building design shall be in accordance with the Buildings section of DS 30-02 and because of the nature of sewage shall avoid enclosed structures and buildings where potential gas accumulation may occur e.g. screens and grit areas.

16 CHEMICAL DOSE PUMPS

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

17 CHLORINATION

Chlorination requirements shall be in accordance with the Chlorination Design Criteria section of DS 33.

18 COATINGS

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

19 COMMINUTOR

Refer to the Macerator section in this Standard.

20 COMPRESSED AIR

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

21 CONDITION MONITORING AND PROTECTION

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

22 CONFINED SPACE

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

23 CONVEYORS

Conveyors design requirements shall be in accordance with the following specific requirements. Refer also to Rag Disposal in this section of the Standard.

23.1 Shaftless Screw Conveyors

Designers shall consider the following requirements:

(a) Screenings washing should be conducted prior to conveying;

(b) The Corporation has had proven satisfactory service with shaftless screw conveyors up to 24 m in length e.g. SPIRAC;

(c) The design shall incorporate a readily removable screw plus lifting and handling equipment for removal of the screw. Screw removal, lifting and handling has been poorly addressed on past installations;

(d) Space shall be provided for access to facilitate liner replacement. Lack of space has caused problems with respect to liner replacement on past installations;

(e) Conveyors should incorporate laminated colour coded liners to provide an indication of liner wear;

(f) Selection of the appropriate shaft speed is important to provide optimal transport;

(g) High torque protection of the transmission and screw should be via electronic shear pins;

(h) Low transport flows causes grit dropout from the screenings which cause increased wear rates on the liner;

(i) When designing a screw conveyor system a sensitivity analysis should be conducted to ensure that future upgrading of large conveyors does not significantly affect operating parameters such as flow causing grit drop out etc e.g. consider four medium width screens rather than two large ones;

(j) Screenings should be dewatered after conveying.

23.2 Pneumatic Conveyors

Designers shall consider the following requirements:

(a) Screenings washing should be conducted prior to conveying;

(b) Pneumatic conveyors allow long transfer distance as well as changes in level and direction;

(c) Pneumatic conveyors need a preliminary screw to provide a plug of rags;

(d) Pneumatic conveyors air demand shall be appropriately designed;

(e) Screenings should be dewatered after conveying.

23.3 Belt Conveyors

Designers shall consider the following requirements:

(a) Screenings washing should be conducted prior to conveying;

(b) Belt conveyors properly designed are a viable option when compared with other conveyor types;

(c) Belt conveyors should incorporate side rollers to minimise tracking problems;

(d) Belts should be 'U-shaped';

(e) Corrosion of rollers, bearings and other components can be a problem and the design should seek to minimise this;

(f) Screenings should be dewatered after conveying.

24 CORROSION

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

25 CRANES

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

26 DESIGN PROCESS

26.1 General

The wastewater treatment plant (WWTP) process designers and the wastewater collection scheme planners shall determine the plant processes, the expected life of the plant, and the stages for its expected development. The process designers and planners design reports shall as a starting point provide the input for the mechanical and electrical WWTP 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.

26.2 Mechanical Design Process

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

27 DIESEL ENGINES

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

28 DIFFUSERS FOR CHLORINE INJECTION

28.1 General

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

28.2 Materials

Designers shall consider the following requirements:

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

(b) Since chlorine dosing may produce residual chlorine concentrations of up to 3,000 ppm 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 ppm). The Corporation has experienced failures where 316 stainless steel 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.

29 DISINFECTION

For gas and hypochlorite chlorination and UV light disinfection refer to the respective Chlorination and Ultra Violet (UV) Light sections of DS 33.

30 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 come into contact with dangerous chemicals.

Unless otherwise specified emergency safety shower and eyewash stations shall comprise a plumbed, stainless steel, free standing with stainless steel basin, 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 70-04 and shall be installed in accordance with the manufacturer's recommendations.

31 FANS

Ventilation fans shall comply with the Fans section of DS 35.

32 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.

33 FINANCIAL IMPACT STATEMENT

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

34 FLANGES FOR PIPEWORK

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

35 FLEXIBLE COUPLINGS

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

36 GEARBOXES

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

37 GENERATING SETS

Generating set design shall be in accordance with the Generating Sets section contained in DS 35.

38 GRIT REMOVAL

Grit removal is generally undertaken immediately downstream of screens or macerators by use of tanks or channels. Grit consists of sand, stones and other heavy inorganic material. Grit removal generally targets grit sizes down to 0.2 mm in order to eliminate problems that would otherwise occur to equipment downstream. Grit causes problems relating to wear from abrasion to mechanical components such as impellers, shafts, aerators and scraper mechanisms. It also causes clogging of pipework and channels, and reduces the capacity of tanks and digesters.

Grit removal can be facilitated by use of constant velocity grit chambers, or cross flow, aeration or vortex grit tanks. Cyclone separators and dewatering screws are also used for grit removal.

The following represents issues relating to grit removal:

(a) If grit removal is not undertaken it will impact adversely on the raw sludge pumps;

(b) When examining existing grit tanks a higher loading could be considered providing the higher maintenance costs required on the raw sludge pumps was factored in;

(c) Rags adversely affect pumping grit;

(d) Air should be used for organics removal;

(e) Grit tank flow guides should be stainless steel incorporating plastic bushes;

(f) Egg shaped digesters supposedly are not affected by grit although this is not clear-cut.

39 GUARDS

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

40 HANDRAIL

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

41 INSTALLATION

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

42 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 DS 33.

43 LUBRICATION

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

44 MACERATORS

Raw wastewater influent contains rags, metal, wood, stones glass etc. Macerators or comminutors are designed to reduce them sufficiently in size so that they don't seriously impact on the downstream processes, plant and equipment.

Macerators and screens protect equipment such as pumps from ragging, pipes and channels from becoming blocked and equipment such as scrapers from becoming jammed. Screens are further defined in the Screens section of this Standard.

A macerator is an electric motor driven cutting device designed to shred solid wastes at the start of a wastewater treatment process.

45 MAGNETIC FLOWMETERS

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

46 MATERIALS

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

47 MIXERS

47.1 Scope

Mixers used for sewage treatment are generally of the mechanical agitation type and this section will essentially focus on them. This includes floating type aerators for sewage treatment ponds and submerged mixers for sewage treatment process tanks.

Static or motionless mixers are also available but are restricted to blending and dispersing treatment chemicals into wastewater pipelines. 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.

47.2 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

47.3 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.

47.4 Mixer Arrangement

Mixing is generally achieved via a submersible electric mixer, which can be oriented from horizontal through to vertical depending on the application. The mixer comprises an electric motor driven propeller driven at motor speed or at reduced speed using a gearbox, generally immersed in the fluid on a guide rail. There are aerators used in treatment ponds that also operate either submerged or partially submerged. The type of mixing provided is a function of the impeller diameter, blade pitch and propeller speed.

47.5 Mixing Parameters

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

Table 47.1 - Information to be Provided for Mixer Design

Component	Specific Information
Type of tank	Contact zone, anaerobic, aerobic, sludge
Mixing outcome required	Homogenisation, suspension, flow creation

Component	Specific Information
Fluid concentration	g/L or %
Tank shape	Circular, square, rectangular, annular
Tank dimensions	Vertical and horizontal measurements
Obstacles	Pipes, columns, baffles, benching
Flow nozzles	Position of inlets and outlets

47.6 Mixer Selection

The following parameters provide selection criteria for the mixer:

(a) The tank dimensions, fluid concentration and mixing type required determine the mixer blade diameter;

(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.

47.7 Mixer Design Considerations

The following design considerations should be taken into account in designing the mixing system:

(a) Avoid flow orientations which produce short-circuits;

(b) Ensure flow jet expansion does not cause excessive wall friction;

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

(d) 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;

(e) Use wall reflections where appropriate to facilitate optimal mixing;

(f) Use opposing mixers in circular sludge silos with mixers oriented parallel with the sloping sides producing a jet towards the centre.

47.8 Mixer Technical Specification Requirements

The following mixer features should be provided:

(a) Fully submersible squirrel cage electric motor in accordance with the relevant motor requirements specified in SPS 503 for submersible sewage pumps;

(b) Cable entry cast in resin so that it remains watertight over its entire length;

(c) Stainless steel motor housing;

(d) Temperature sensors fitted to the motor windings;

(e) Anti-friction bearings fitted to the drive and non-drive end casings;

(f) Two bi-directional mechanical seals with silicon-carbide mating faces;

(g) An oil-filled chamber between the two mechanical seals containing oil that is environmentally safe;

(h) All fasteners in contact with the process fluid should be a minimum grade 316 stainless steel.

47.9 Accessory and Control Requirements

The following specific requirements should be provided for mixer installations:

(a) Masts shall be manufactured in stainless steel;

(b) Davits shall be designed to swing mixers over the top of the handrails;

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

48 NOISE LEVELS

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

49 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 DS 33.

50 OCCUPATIONAL SAFTEY AND HEALTH

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

51 ODOUR CONTROL

(a) Odour control covers, frames, support beams and appurtenances should be designed in accordance with the following:

- (i) Covers should be readily removable or accessible and designed to provide optimal sealing when closed in order to minimise air inflow requirements for odour extraction;
- (ii) Covers should be robust design with minimum deflection under the weight of two to three personnel and manufactured from corrosion and ultraviolet radiation resistant materials;
- (iii) Covers should be manufactured from appropriate material to provide a long service life (50 years) e.g. aluminium or glass reinforced plastic (GRP);
- (iv) Covers should incorporate a good non-slip surface, even in wet conditions, that does not pose a tripping hazard, is antiglare and of an acceptable non fade colour;
- (v) Covers and frames should be designed to provide a simple and clean surface, which minimises the collection of rubbish and debris;
- (vi) Covers should be designed and manufactured to facilitate run-off from rain or washdown;
- (vii) Covers should be designed and sized to be ergonomically sound in terms of opening effort and safe lifting access e.g. preferably be hinged and manageable by one person in windy conditions without risk of injury;
- (viii) Raised to avoid the need for handrails;
- (ix) Covers should incorporate fixing or locking with a fail-safe device to maintain them in the open position. They should be capable of restraint in windy conditions;
- (x) Covers should be latched or fastened to prevent lifting from wind effects;
- (xi) Incorporate an effective durable long lasting odour sealing system;
- (xii) Covers should be readily removable where fitted around mechanical/electrical equipment and designed to provide optimal sealing;
- (xiii) Handles and hinges should be simple and robust and manufactured from corrosion resistant materials. The hinge fasteners should be sealed to prevent ingress of moisture into the cover core for non-metallic cover materials;
- (xiv) All edges of the cover should be rounded to provide personnel protection and reduce likelihood of damage (cracking/chipping);

(b) Scrubbers

- (i) Caustic and hypochlorite should be dosed separately;
- (ii) Duty standby scrubbers should be provided;
- (iii) Fans, towers and pipework should be plastic or GRP;
- (iv) Scrubbing should be 2 to 3 stages;
- (v) Airflow design should be balanced;
- (vi) Sulphide detection should be provided on the outlet.

52 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:

52.1 Format and Language

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

52.2 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.

53 PENSTOCKS

53.1 General

Penstocks design requirements shall be in accordance with Penstocks contained in the Miscellaneous Valves and Appurtenances section of DS 31-02. In addition the following specific items have been identified for wastewater treatment:

(a) Penstock locations can be subject to high levels of H_2S and this can cause corrosion problems and also access for servicing. Areas subject to H_2S should be provided with ventilation;

(b) Stop logs should be provided upstream of penstocks to facilitate servicing;

(c) Penstocks should if possible be able to be serviced on-line;

(d) Penstocks should ideally be drop tight sealing or minimal leakage;

(e) Material should be stainless steel as cast iron suffers severe corrosion and glued co-plastics tend to delaminate or split;

(f) Inlet penstocks traditionally have suffered major shaft ragging. Use of screens with a finer opening as referred to in the Screens section would solve this.

53.2 Actuators

(a) Manual actuation should not involve the use of pneumatically operated handguns as they are dangerous;

(b) Actuation should be electric or permanently installed pneumatic pipework;

(c) Electric actuators should be fitted with decontactor plugs;

(d) Lifting equipment should be provided for servicing of the actuators.

53.3 Limit Switches

Limit switches should be heavy duty with a proven sound sealing performance. They are manufactured from corrosion resistant materials e.g. stainless steel as corrosion of limit switch components is a significant issue. Proximity switches should be considered in lieu of limit switches.

54 PIPEWORK

54.1 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 should be used where required.

54.2 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.

54.3 Copper Alloy Pipework

Designers shall consider the following requirements:

(a) Copper piping and copper-alloy fittings and appurtenances shall be avoided where sulphides are present, which is present most of the wastewater treatment plant.

(b) Dissimilar metals should be avoided e.g. brass valves on stainless steel pipes, steel bolts on stainless steel flanges etc.

54.4 Security of Supply

Service pipework for water and air should be ring mains with isolating valves to enable feeding from the reverse direction.

54.5 Process Pipeline Service and Materials

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

Table 54.1 –Process Pipeline Service and Pipe Specification

Service	Code	Specification
COMMON SERVICE PIPELINES		
Fire services water	XW	Copper, MSCL
Fuel oil	FO	Carbon steel
Compressed air[1]	CA	Copper, PE[2], SS
Instrument air[1]	IA	Copper, PE, SS
Plant (blower) air[1]	PA	Copper, PE, SS
Service water	SW	Copper, MSCL, PE, PVC-U, PVC-M
CHEMICAL		
Chlorine gas	CL2	PVC-U
Chlorine solution	CLW	PVC-U
Hydrochloric acid	HCL	PVC-U
Oxygen	O2	PVC-U
Ozone	O3	PVC-U
Powdered activated carbon	PAC	PVC-U
Sodium hypochlorite	SHC	PVC-U
Sulphur dioxide	SO2	PVC-U
Sulphuric acid	SA	CS, PE, PVC-U, SS 316 (Concentration dependent)
WASTEWATER		
Activated sludge	AS	GRP (Hobas), MSCL
Digester gas	DG	SS 316
Excess activated sludge	EAS	PVC-U, PVC-M, MSCL
Foul air	FA	PVC-U, PVC-M, SS 316
Grit	GR	ABS, DI
Mixed liquor	ML	MSCL
Primary effluent	PEF	MSCL
Primary sludge	PS	PVC-U, PVC-M, MSCL
Raw wastewater	RWW	MSCL
Reclaimed effluent	RE	PVC-U, MSCL
Return activated sludge	RAS	GRP (Hobas), MSCL
Secondary effluent	SE	MSCL
Skimmings	SK	PVC-U, PVC-M
Solids treatment liquor	STL	PVC-U, PVC-M,

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.

54.6 Process 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 80.

54.7 Process Pipework Colour Marking

Process pipework identification shall be in accordance with section 5 Colour Coding for Pipework (Drg EG71-1-1) contained in DS 80. Pipework (other than exposed PVC) identification shall be via colour banding and not fully painted. Exposed PVC pipework shall be painted to prevent ultraviolet degradation.

55 PITS AND CHAMBERS

Wherever operationally practicable, the use of below ground pits to house valves and equipment should be avoided. 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.

56 PREVENTION OF FALLS

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

57 PRIMARY SEDIMENTATION TANKS

57.1 Scrapers

Designers shall consider the following requirements:

(a) Scrapers should incorporate plastic stub shafts, sprockets and chain;

(b) Scrapers should incorporate fibreglass flights and a tracking system to avoid chain failure;

(c) The preferred chain and flight system is the BUDD, which is the only complete plastic system, has a proven satisfactory performance and has the lowest chain elongation.

57.2 Skimmings Removal

Designers shall consider the following requirements:

(a) The skimmings removal system requires a shredder to be fitted upstream of the ejector;

(b) Requires a chain and flight system (BUDD preferred as above);

(c) Requires a channel water flushing system;

(d) The number of wet wells should be minimised;

(e) A removable pipe section is required between the wetwell and ejector;

(f) The design should use ejector conveyance with a vent line > 40 mm which should be installed external to the wetwell;

(g) A load cell should control the ejector level;

(h) Skimmings disposal should be pneumatic from EAS and DAFT tanks with no concentration.

57.3 Shredders

Designers shall consider the following requirements:

(a) Shredders should be maintainable on line;

(b) Shredders shall be designed so that they do not overload;

(c) Shredder cutters should be designed for the product stream characteristics;

(d) The preferred shredder is the Flygt Muffin Monster.

57.4 Raw Sludge Pumps

Designers shall consider the following requirements:

(a) Raw sludge output limited to 3 – 4% out of tanks otherwise could result in head problems;

(b) To minimise pumping problems the sludge should be concentrated close to the digesters;

(c) Sludge pipework should be designed for the ultimate transfer duty;

(d) Discharge valves should be pneumatically operated in to cope with rags;

(e) Positive displacement pumps may be used however the direction of rotation should be such as to avoid packing box problems. A pressure relief system should be fitted on the discharge pipework;

(f) Centrifugal pumps should be of the prefrontal screw type (Hidrostal);

(g) Compact membrane (diaphragm) could be considered for this service however at this stage the Corporation has no experience in this regard;

(h) When using pumps fitted with mechanical seals the packed gland housing should be of a larger size than required for a packed gland shaft seal.

57.5 Modulating Penstocks

Refer to the Penstocks section of this Standard particularly with respect to the presence of H_2S.

57.6 Tank Drainage

Level detection design should be improved previous designs, which have traditionally been unsatisfactory.

57.7 Tank Sprays

Designers shall consider the following requirements:

(a) Tank sprays should be provided with external access e.g. Woodman Point;

(b) Tanks sprays should be designed for automatic self-cleaning;

(c) Reclaimed effluent should be used where practicable for tank sprays.

58 PROGRESSIVE CAVITY PUMPS

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

59 PUMPS

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

60 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.

61 QUALITY

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

62 RAG DISPOSAL

The following options are available for disposal of rags from the screening process:

62.1 Incinerator

An incinerator is not a preferred option because of high maintenance requirements and the issues related to producing environmental emission problems.

62.2 Burial

Burial of rags may be permitted subject to dewatering of the screenings and approval by the Corporation.

62.3 Dewatering

Designers shall consider the following requirements:

(a) A dewatering package option is available for shaftless screw conveyors e.g. SPIRAC;

(b) A hydraulic press is acceptable for dewatering however the problem of limit switches when integrating with an incinerator should be properly addressed.

62.4 Reclaimed Effluent

Designers shall consider the following requirements:

(a) Coarse and fine screens should be used in conjunction with reclaimed effluent;

(b) Automatic backwash should be provided;

(c) Performance measuring via a flow meter should be provided;

(d) Total flow should be carefully considered.

63 SAND AND MULTI-MEDIA FILTRATION VESSELS (GRP FILTER VESSELS)

Sand and multi-media filtration vessels are used by the Corporation for the removal of solid and organic particulate matter from suspension. The vessels are commonly used to filter sea-water (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.

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.

The filtration vessels shall be plenum type only (not distribution 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 iron and manganese filtration.

GRP vessels shall comply with the Corporation's Strategic Product Specification SPS 250.

For vessels with diameter greater than 2.4 m and/or for non-GRP filter vessels please refer to the Principal Mechanical Engineer for consideration.

64 SAFETY SHOWERS

Refer to the Emergency Safety Showers and Eyewash Stations section of this Standard.

65 SCREENS

Raw wastewater contains rags, metal, wood, stones glass etc. and accordingly screens shall be designed to remove these materials from the flow or reduce them sufficiently in size so that they don't seriously impact on the downstream processes, plant and equipment.

Screens shall protect equipment such as pumps from ragging, pipes and channels from becoming blocked and equipment such as scrapers from becoming jammed. The following screen requirements should be considered during design:

65.1 Bar Screens

Designers shall consider the following requirements:

(a) A redundancy of 100% should be provided;

(b) Design shall take into account working in confined space OSH requirements e.g. existing channels have a cast-in boot which is not desirable;

(c) Screens shall be fine e.g. 5 mm to avoid dealing with rags and debris further downstream;

(d) Materials subject to immersion shall be corrosion resistant e.g. Grade 316 stainless steel frames and plastic sprockets and chains;

(e) Chain guide channels should not be cast-in;

(f) Chain tension adjustment should be automatic or monitored to prevent scraping of the boot floor;

(g) The angle of inclination of the bars is important to ensure correct rag discharge;

(h) Transmission shear pins should not be of the mechanical type due to the associated maintenance problems. Electronic protection is too slow and if used should be provided with a mechanical backup. Transmission fluid couplings should be considered in lieu of shear pins and electronic protection;

(i) A channel drainage system should be provided incorporating fixed pumps. The channel drainage draw-off valves should be designed to minimise ragging.

65.2 Step Screens

Step screens are preferred with large proven installations overseas. Step screens are manufactured in stainless steel and are removable which avoids confined space problems.

65.3 Contra Shear Screen

The contra shear screen is a high quality screen, which has high quantity washwater requirements. The Corporation has no experience with this type of screen at this stage preferring the step screen or bar screen.

65.4 Climbing Screen

The climbing screen is not preferred because of the large headroom requirements, problems related to sharpening of the teeth and questionable applicability for fine screen service.

66 SECONDARY SEDIMENTATION TANK

66.1 Tank Centre Equipment

The gearbox shall be

(a) Rugged and conservatively rated;

(b) Provided with ready access to the gearbox for maintenance e.g. removable bridge;

(c) Provided with a large oil reservoir incorporating non-spillage features to eliminate potential pollution e.g. use of vacuum pumps.

66.2 Tank Peripheral Equipment

Designers shall consider the following requirements:

(a) Peripheral drive preferred;

(b) Handrail design should be carefully considered for peripheral drives;

(c) OSH aspects should be carefully considered because of the rotating bridge;

(d) Spare conduits should be provided to the central well;

(e) The clutch shall be designed to incorporate an over-torque mechanism;

66.3 Skimmings

Skimmings shall be provided with a flushing system off-take.

66.4 Sludge Withdrawal

Designers shall consider the following requirements:

(a) Valves should be of the plug type oriented with the shaft horizontal;

(b) Valve actuators shall be conservatively rated for the duty;

(c) Valve actuators shall be designed for semi-continuous operation e.g. many starts per hour.

66.5 Tank Drainage

Designers shall consider the following requirements:

(a) Valves (knife gate valves) should not be installed inside the tank e.g. submerged but should be installed externally;

(b) Tank flushing should be designed to:

(i) have access to reclaimed effluent;

(ii) incorporate an inlet opposite to the drain end;

(iii) incorporate a channel on one side of the tank to aid drainage;

(iv) incorporate a generously proportioned sump;

(v) be operated by a single operator.

67 EAS/RAS PUMPING

Hidrostal pumps preferred using AC drives. These pumps are energy efficient. The mechanical seal should be designed to accommodate the required end float.

68 SIGNAGE AND LABELS

Signage and labels requirements shall be in accordance with the Signage and Labels section of DS 30-02.

69 SITE CONDITIONS

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

70 SLUDGE DIGESTION

(a) Sludge dewatering should be provided via centrifuges;

(b) A jet-wet system should be used for polymer dosing;

(c) Munchers shall be installed on the following sludge digestion locations:

- Inlet to digesters;
- Inlet to centrifuges;
- Inlet to recirculation pumps;

(d) Flow measurement shall be provided on recirculation systems to monitor pump performance;

(e) Working platforms shall be designed in accordance with AS 1657 for access for operation and maintenance;

(f) The design should minimise ragging of level probes;

(g) The design for the telescopic withdrawal should minimise blockages by grit and rags;

(h) The design should allow for mixing in the sludge storage tank;

(i) The centrifuge room design should incorporate adequate floor grading, drainage of bunds and covering of floor penetrations. Floor grade and drainage of treatment plants has traditionally been poorly addressed;

(j) Sludge heating requirements should comply with the following:

- use of sludge in tube heaters;
- use of water bath sludge heaters;
- use excess heat from engines where applicable;
- heaters should cope with H_2S in the fuel;
- provision of separate hot water production and heat exchanger;
- provision of gas scrubbing;

(k) Pipework shall be of stainless steel construction.

71 SLUDGE THICKENING

71.1.1 Huber Thickening Screws

Designers shall consider the following requirements:

(a) All stainless steel;

(b) No odour problems with this system;

(c) Popular technology overseas.

71.1.2 Gravity Thickening

Gravity thickening has traditionally suffered problems relating to flow/density, corrosion, odour, capacity, pumping and confined space. There have been significant problems at Beenyup in the past.

71.1.3 Rotary Screens

Rotary screens were not successful at Subiaco WWTP however this may be applicable to raw sludge only.

71.1.4 Dissolved Air Flotation Thickening

Dissolved Air Flotation Thickening design shall comply with the Dissolved Air Flotation Design Guideline DS 211.

72 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.

73 STATUTORY AUTHORITIES

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

74 STRATEGIC PRODUCT SPECIFICATIONS

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

75 STOP LOGS

(a) Stop logs shall be provided with mechanical lifting provisions.

(b) Stop log guides shall be stainless steel not coated steel or cast iron as they breakdown.

76 SUMP PUMPS

Sump pump design shall comply with the Sump Pumps section of DS 32.

77 TESTING

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

78 TRANSMISSION DRIVES

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

79 VACUUM PUMPS

Vacuum pumps design shall comply with the Vacuum Pumps section of DS 32.

80 VALVES

Valves shall comply with the Valves section of DS 31-02, DS 33 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. It is difficult to prevent this type of failure;

(c) Plastic valves are not preferred as they deteriorate with exposure over time;

(d) Use of brass valves in stainless steel pipelines should be avoided due to the potential for galvanic corrosion;

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

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

(g) Division 1 and 2 areas shall use pneumatic actuators on valves utilising poly tubing and stainless steel fittings. Electric actuated valves should be used elsewhere;

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

(i) Critical valves should have a rotatable spare.

81 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.

82 WASHDOWN HOSES

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

(a) All thickeners shall have retractable reel washdown hoses with appropriate delivery pressure for the washdown task;

(b) All sludge handling facilities (sludge 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.

83 WATER HAMMER

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

84 WELDING

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

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