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1 INTRODUCTION

The Water Supply Pumping Station Design Standard provides a standardised guide for public water supply systems which presents, as far as practical, uniform concepts for water system design. It offers some flexibility, enabling design engineers and consultants to consider alternative designs for specific situations whilst still delivering the optimum design.

1.1 SCOPE

The key issues addressed in these standards are

i. General design principles;
ii. Pumps and pump station design;
iii. Pipeworks and valving;
iv. Hydraulic considerations;
v. Mechanical and electrical design;
vi. Building construction;
vii. Telemetry and SCADA control systems;
viii. Generators and power back-up;
ix. Landscaping requirements;
x. Testing and commissioning requirements;

2 DESIGN AND CONSTRUCTION REQUIREMENTS

2.1 SITE REQUIREMENTS:

- Not be subject to flooding
- Be readily accessible at all times
- Be shaped to divert stormwater around the wells, pumps and structure
- Be protected to prevent vandalism

2.2 ACCEPTANCE OF ALTERNATIVE DESIGNS

For operational reasons it is a requirement that there be a large degree of uniformity among the Council's water supply pumping stations. Council will consider alternative designs on their merits, where the design results in an equivalent or better performing infrastructural development than that complying with this standard. Any acceptance of alternative designs applies to that particular proposal only.

Alternative designs may be considered:

i. To provide flexibility to meet the circumstances and requirements of the site
ii. As a means of encouraging innovative design
iii. To produce a lower life cycle costing and / or greater operational reliability or
iv. To provide the required resilience in case of land movement due to seismic events

2.3 OPERATION AND MAINTENANCE

Design all system components for safe and convenient operational and maintenance procedures:

i. Keep all equipment out of hazardous environments where possible and keep the number of confined spaces generated through the construction of the new facilities to an absolute minimum
ii. Lay out the site, including vehicular access, to allow easy access to the infrastructure components
iii. Locate pipework to facilitate access to and maintenance of equipment. Provide an uninterrupted accessway around pumps and detail any pipework crossing this path either below floor level in ducts with suitable removable gratings or fixed above head height.
iv. Mount surface pumps on a plinth 200mm above floor level.
v. Detail cables to be either below floor level in ducts with suitable removable gratings or fixed above head height.

vi. Place equipment to facilitate visual inspections and routine maintenance
vii. Specify guard rails or chains around the top of any potential hazard of falling
viii. Consider potential future expansions and make provisions for such
ix. Design the control and alarm system to enable operators to react quickly and properly in emergencies
x. Size and select equipment that facilitates a long service life, low operational costs and low maintenance requirements
xi. Keep the system as simple as possible but as sophisticated as necessary, whilst considering the implications of a rural versus an urban setting;
xii. Prepare complete and useful records - system and equipment drawings and specifications, system calculations, hydraulic models, user manuals and manufacturer/supplier contacts, flow charts, diagrams and Process and Instrumentation Diagrams (P&IDs), legal survey plans and address maps, etc. and include this information in the Operations and Maintenance Manual

2.4 PIPE HYDRAULICS

Design pressure pipelines and fittings to minimise hydraulic.

Velocities in pipes must not be greater than 2.0 m/s unless appropriate water hammer analysis has been done.

Provide a surge and fatigue analysis on all critical plastic pipelines including all pressure mains and where velocities in plastic pipes are greater than 1.0 m/s. Provide action points or mitigation measures to deal with the identified surges

2.5 WALL AND FLOOR PENETRATIONS:

Provide a water stop puddle flange, centred in the concrete for all pipes passing through walls below ground level

2.6 FIXINGS RESTRAINTS AND SUPPORTS

Design restraints, fixings and supports to the fittings, including the ability to withstand the required seismic loading. Where these items are not detailed on the drawings, ensure that the Contractor designs and supplies these fixings to comply with the Building Code.

All fixings to concrete or masonry shall be by bolts, cast-in fixings or chemical. Terrier and powder charged fixings shall not be used.

Specify corrosion protection on fixings, which exhibits equivalent or better corrosion resistance than the material to which they are connected.

Detail clamping to connect fixings to structural steelwork rather than welding or drilling.

2.7 SEISMIC DETAILING

Design flexible connections into pipework on the external side of exterior walls, to allow for relative movement during seismic events. Locate these joints no further than 1.0m from the external wall where possible. Consider punching shear when detailing both the pipework and the wall construction. Flexible connections can be provided by rubber joints, polyethylene pipe or mechanical couplings. If rubber bellows are used, specify that the flexible element is EDPM rubber.

2.8 HEALTH AND SAFETY SIGNAGE

Provide safety signage (no smoking, confined spaces, power, speed limits, potable/non potable water sources, hearing protection areas, site visitor instruction board, rotating machinery etc.) on all facilities prior to commissioning.

Detail confined space warning signs for pump house accesses that are considered a confined space.

Provide a noise hazard warning sign on the personnel door if there are pumps or diesel inside.

2.9 SECURITY

Vandalism is likely at all sites. Detail the building architecture, façade, features and external equipment to discourage vandalism and to minimise damage. Provide an external security light, controlled by a passive infrared sensor for all but simple electrical cabinet installations. Fence all facilities for site delineation and where necessary to restrict access by humans or animals where: ·

i. There is a safety issue for any person that is on the site
ii. Significant vandalism or damage to the site could be expected, or
iii. There is potential for theft or sabotage

Landscaping to afford visibility of the whole site and so to prevent anti-social, unsafe or destructive behaviour.

2.10 LOCKS

Provide standard Council locks to all buildings, chambers and pits, gates and any sensitive or dangerous areas to prevent unauthorised access. Detail locking systems that prevent levers or bolt cutters being used to remove the locks.

3 BOOSTER PUMPS

Booster pumps may be in an open or closed system. Therefore, design the booster pump to either fill a reservoir or to directly supply the network. Each booster pumping station should contain at least two pumps (one duty pump and one standby pump).

Design in-line booster pumps so that:

- Negative Pressure Is Not Produced In their Suction Lines
- Total dynamic head and flow for the system curve can be obtained by all combinations

3.1 NUMBER OF PUMPS

When designing the pumps, include an extra pump over the required number for redundancy i.e. small pump stations shall have a minimum of two pumps. Ensure standby pumps are available for service at all times. Where possible, pumps in a pump set should be identical for operational purposes.

As a guide, where the pump station has the minimum three pumps, the likely set-up and operation may be as follows:

i. Two duty pumps and one stand-by:
   a. Both pumps on VSD - The pump will run up to close to its maximum before the VSD is disengaged and the pump runs at constant speed. The second pump will pick up and provide additional demand up to its maximum duty point
ii. One pump on VSD and one on a Soft start
   a. Once the first pump reaches close to its maximum duty point, the VSD is disengaged and the soft start pump will start and run at its full speed
   b. The VSD pump will then start again and provide any additional capacity required up to the maximum

In both cases the standby pump will be called on if one of the duty pumps goes down. Provide an optimal control scenario for the specific pump station. This approach ensures that the pumps are operated at the maximum possible efficiency for the duties.

Specify 3-phase 415 volt pumps if their motors are greater than 3 kW. Specify water detection and over temperature detection in the motor housing of pumps larger than 3kW. Rate pumps to achieve their design output at no more than 2900 rpm.

3.2 PUMP FEATURES

Specify pumps with hard metal-to-metal face mechanical seals, high quality stainless steel or high tensile steel shafts and high grade bronze, stainless steel or cast iron impellers.

Specify a dynamically balanced unit to ensure long life and vibration-free operational conditions, confirmed by specifying a vibration test to ISO 10816 on the installed unit to confirm alignment, vibration and base harmonics.

Detail grease lubricated, heavy duty ball or roller bearing type bearings and renewable shaft sleeves and wear rings.

<u>For dry-well mounted pumps, specify:</u>

i. Suctions with easy access to clear the impellor eye. This can be a special access cover or an easily removable section of pipe. For example, pumps with suctions greater than 200 mm diameter can be fitted with inspection plates for hand access into the volute and impellor.
ii. End suction pump sets complete with a substantial base plate to mount the pump and motor. Detail the mounting plate to ensure correct alignment at all times and to minimise harmonic vibrations.
iii. "Back pullout" design end suction pump sets, with the motor and wet end of the pump able to be slid out of the volute with minimal work.

<u>For in-line pumps ensure that:</u>

i. The inlet and outlet are placed at the same level where the inlet and outlet pipe diameters are the same.
ii. Accessibility is easy when the pumps are installed in parallel as the pipework can be in the way.
iii. Pumps are installed in a position to permit proposer lubrication and servicing

3.3 ALLOWANCE FOR FUTURE CAPACITY OR EXTENSION

For staged developments such as in Greenfield areas, pump stations can be staged with fewer pumps in the early stage(s) and provision made for the ultimate development scenario. Size these early stage pumping units for the ultimate design flow rate. If an intermediate design flow rate is required, select the pumping units for both conditions, intermediate and ultimate development.

Consider the feasibility of using smaller pump impellers for the earlier stages and upsizing the impellers for the later and ultimate development stages as this could be cost effective if the higher duties can be achieved without overloading the pump. Additional future capacity could also be achieved by replacing pumps installed in the early stages with larger pumps. The starters could be sized for the larger pumps from the start and fitted with circuit breakers and overloads.

If additional pumps are required, make provision for these pumps in the pump station building, the manifold pipework and switchgears. Analyse the various pumping combinations to arrive at the most cost effective combination of staging options.

3.4 WELL PUMP AND MOTOR INFORMATION

Provide the details of all proposed pumps and motors with the Design Report, specifically:

- Make and model
- Physical information (mass, dimensions, delivery diameter etc.)
- Mechanical details (materials, bearing and seal types etc.)
- Manufacturing and testing standards
- Guaranteed performance details (Q/H curves, total pumpset efficiency, rpm
- Minimum operating speed for a variable speed set-up and the reason for this limit
- Rating (kW, rpm, voltage)
- Maximum starts per hour
- Confirmation of continuous rating
- Methods of protection

4 PUMP SUCTION AND DISCHARGE

Design the suction and discharge manifold for future flows without having to take a pump out of service for extended periods of time. Design and size suction pipework so that:

i. It is one size larger than the pump inlet size
ii. Suction pipe is easily accessible to clear any blockages
iii. Suction pipe velocities in table 1 are not exceeded
iv. Allowed on short-term basis (e.g. emergency conditions)
v. Suction cavitation is avoided by flooded suction or having a NPSHA > NPSHR
vi. Eccentric reducers have the obvert horizontal to prevent air entrapment.
vii. Suction lift is within allowable limits for the pump.

Design and size discharge pipework so that:

i. It is one size larger than the pump inlet size.
ii. Discharge pipe velocities in table 1 are not exceeded. Higher velocities should only be allowed on short-term basis (e.g. emergency conditions).
iii. It can withstand the total maximum pressure (including surge)

Suction and Discharge Velocities (m/s)

Pipe Diameter	Velocity (m/s)
Suction Pipe Velocities	
≤ 250 mm ≤1.0	≤1.0
>250 mm ≤ 1.5	≤ 1.5
Discharge Pipe Velocities	
≤ 250 mm ≤ 1.5	≤ 1.5
>250 mm ≤ 2.0	≤ 2.0

5 PUMP MOTORS

Select motors with sufficient capacity to drive the pump. Ensure the motor is non-overloading over the range of duties at which the pumps is expected to operate. Where these requirements cannot be met, submit a non-conformance report to Council.

Do not unnecessarily oversize the motors to achieve the above requirements or the future capacity requirements. Select motors with care as efficiency and the power factor drops in motors running below the load rating.

6 PUMP STATION SCADA

Veolia is Council's manager / operator of the SCADA system.

Provide instrumentation and control at pump stations to measure, control, and monitor the pumping system, as covered in Electrical & SCADA Standard.

Swampfox RTU manufactured by Abbey Systems shall be installed to allow for remote monitoring and alarming functionality (details of IO template for SCADA signals shown in the Electrical & SCADA Standard).

- Developer to provide proposed method of RTU communication to Veolia for approval
- The developer is responsible for all costs associated with the provision of the SCADA communication
- Swampfox to be purchased from Abbey Systems and have area radio channel pre-configured
- Developer is required to use Veolia for all changes required for the software configuration to Council's SCADA system and includes graphical interface, pump station reports and pump station generated alarms

7 APPURTENANT DESIGN

If the pump station's electrical panel is located in a building as defined by the Building Code, specify as a minimum:

i. 4.5 kg fire extinguisher
ii. Approximately A3 size blackboard on wall by personnel door
iii. Lectern, or hinged plan table if space allows

7.1 PRESSURE GAUGES

Specify the installation of pressure gauges which read in kPa, with a pressure range such that the maximum pressure reading is around 50% to 60% of the range. Specify test points on the pump inlet and on ALL delivery pipes. Detail test points that are:

- 1/4 inch BSP female thread
- Fitted with a pipe plug
- Installed as close to the pump as possible
- On the pump side of any valves where possible
- With an accuracy to ±5% or better

Specify test points flush with the inside wall of the pipe, with the test point positioned to minimise the potential for the various velocities or turbulence inside the pipe to affect the gauge reading.

Detail a hole diameter through the test point fitting of less than 4mm to minimise turbulence. This diameter can be increased at distances greater than 4mm from the inside pipe wall.

7.2 WATER SAMPLE POINT

Provide lockable water sampling points that located in an easy and safe access to enable safe collection of water samples for both bacteriological and chemical analysis. These shall be located

On the outside of the Pump station building.

8 FLOW METERS

Specify a Mag-flow meter on the pressure main from the pumping station. Meter type shall be as detailed in QLDC the Water Meter Policy dated August 2015. Meter display shall be located with switch board cabinet.

9 VALVING

Detail sufficient isolation valves to enable the pump station to operate while one pump, or any other major plant item, is being serviced. Specify valves rated to PN16.

Reflux valves to be installed downstream of the pump and upstream of the isolation valve. These should ideally be inside the pump station building. Wafer type non-return valves can be specified for smaller pump headworks (<80 mm pipe diameter).

Locate isolation valves on the discharge pipe at least three pipe diameters from the pump control valves. As far as practicable provide each section of piping which may be isolated with a valved pipe drain.

Install pump control valves (valves to control flow during the start-up or shut-down of the pump) even when a variable speed drive is provided. Configure and connect the control valves so that:

- The pump starts on a closed valve
- They open slowly during start-up
- When the pump is signalled to stop the pump continues to run whilst the control valve slowly moves to the shut position, to avoid water hammer.

10 BUILDING CONSTRUCTION

Design the building to adequately house and allow the efficient operation, servicing and removal of all equipment in the building.

Provide adequate space to move tools and equipment required to perform the entire spectrum of operation and maintenance procedures. Consider future expansion in the design of the building.

Provide a minimum clearance around and between pumps, diesels, open cabinet doors and extended racks of 600 mm.

Locate electrical equipment away from wet areas.

Design a minimum 1.2m wide x 2.0m high personnel service door. Specify solid timber or aluminium doors, with heavy-duty hardware. Detail that large doors fitted for machinery access will open from the inside.

Specify pre-painted long run steel roofing.

Protection of Equipment, Surfaces, Coatings and Dissimilar metals, considering the site's context.

Do not build over pipes or fittings as they require replacement at a future date. If pipes are built over, detail a service pit to contain them, which is large enough for workman to replace the pipe without any excavation or demolition

11 ELECTRICAL AND INSTRUMENTATION DESIGN

Design the electrical installation, including the generator and diesel engines, the motor starters and the three phase generator inlet plug, in compliance with electrical standard.

12 NOISE, VENTILATION AND AIR CONDITIONING

Design ventilation to the pump station and control temperatures inside the room regardless of the outside temperature to a range of:

- Minimum of 5°C
- Maximum of 40°C,.

Consider heat contributions from all sources inside the building or cabinet. Design the ventilation in tandem with the soundproofing, as ventilation may increase external noise levels directly or indirectly.

If air conditioning is required to control the maximum temperature in an electrical room, include measures to maintain internal relative humidity between 40% - 60%, to avoid condensation and static electrical shock.

For intermittent ventilation i.e. active only when there are personnel inside the pump station, specify a fan capable of 30 complete air changes per hour.

Noise generated by the pumping station shall not exceed the Council District plan permitted levels. The design shall include measures to reduce noise appropriately.

13 GENERATORS – BACKUP POWER SUPPLY

Backup generators are required on most pumps. Whether or not a proposed project will require a backup generator will be confirmed by Council and will depend on the risks associated with power failure. Generators may be permanent and fixed or portable as discussed with and agreed to by Council.

As a minimum specify a unit capable of powering the largest pump, plus all auxiliary equipment (ventilation fans, battery chargers, lighting etc.). It must be capable of powering the pump sets from stand still and zero reticulation pressure and, if required, of starting the standby pump when the duty pump is already running at full load.

Size the generator to match the load and method of starting employed at the pumping station. The generator must be a minimum size in relation to VSDs and must have advanced speed control in order to avoid "hunting" of the generator. The generator set must be able to run continuously at the rated output for several days at a time.

Where an onsite generator is not required by Council a mobile standby generator connection shall be provided and located on the outside of the building. Ensure there is sufficient space for parking a standby generator adjacent to the pump station and way from the footpath or carriageway.

14 TESTING AND COMMISSIONING

Council Pumping and Control staff must witness any commissioning work and testing. Involve specialist suppliers and contractors as necessary. Provide at least five working days' notice of the SCADA functionality checking, any commissioning or testing to Council. Also notify Council of the expected date of handover of operation of the pumping station.

Pre-test any work required to be tested in the presence of Council, to prove it is satisfactory. Prior to pre-testing, ensure that:

i. The installation is in accordance with the specification and drawings, except as varied by accepted non-conformances
ii. All equipment is in proper working order
iii. Programming and settings have been completed and checked
iv. Any automatic controls that might invalidate the tests have been overridden
v. The testing and commissioning schedule (including has been prepared and presented to the commissioning personnel and to Council two weeks before the start of commissioning
vi. Rotation of installed pumps is correct
vii. The outstanding work/defect list is completed

Specify a water test for all concrete tanks and below ground structures to Testing Reinforced Concrete Structures for water tightness where testing is practical.

Provide draft Operations and Maintenance Manuals (OMM) and as-built plans to Council at least 5 days prior to commissioning.

Provide generator load tests.

Provide pump tests to confirm that the finished station meets the design flows.